



PHYSICS

3B Scientific



Printed on paper
from a sustainable
forest company

3Bscientific.com

...going one step further

*Student Experiments
3B NETlog™
Mechanics
Waves*

*Energy and
Environment
Thermodynamics
Optics*

*Electricity
and Magnetism
Atomic and
Nuclear Physics
Laboratory Equipment*



Dr. Johannes Recht
Head of Physics

Dear Customers,

Your custom has elevated us to becoming one of the world's leading manufacturers of physics teaching resources in the short space of just ten years. Now we are continuing to work hard on improving even more, with your help and for your benefit. That is why you will find **many new innovations** and further developments of existing products alongside the familiar items on these pages.

It is worth casting an eye over the **space-saving table-top experiments** on mechanical oscillations (page 73) and the equipment for demonstrating wave properties using ultra-sound (page 105). We have worked closely with experienced teachers, and some particularly convenient and illustrative experiments have come into being as a result.

Due to popular demand from our customers, we will as of now be able to offer the tried and trusted **NEVA optics system** with modern optical lamps (page 140). This change was one that many of you had requested, as was the expansion of our student experiment range to include new equipment sets for **electrostatics** (page 18) and **radioactivity** (page 25).

Building circuits, whether simple or complex, will now be quicker and easier to understand. New products for this can be found on pages 184 and 185 as well as pages 190 to 192. Other brand new items include the **inexpensive** millisecond counter for our free-fall experiment (page 63), a durable fine beam electron tube complete with control unit (page 227), a dosimeter for detecting radioactivity which has been proven in everyday use (page 244), a high-quality scanning tunnelling microscope (page 229) and various models for demonstrating the structure of matter on atomic and sub-atomic scales (pages 230 – 232).

The use of **ultra-sound in medicine** can now be explained using the new apparatus on pages 102/104 and some possibilities for experimenting on the **Hall effect** in semiconductors can be found on page 242.

You can see that "... **going one step further**" really is our motto, because we are always taking that extra step to give you better quality, variety and value for money. So come and join because with your help, we can only keep on getting better.

Yours sincerely,

Dr. Johannes Recht
Head of Physics



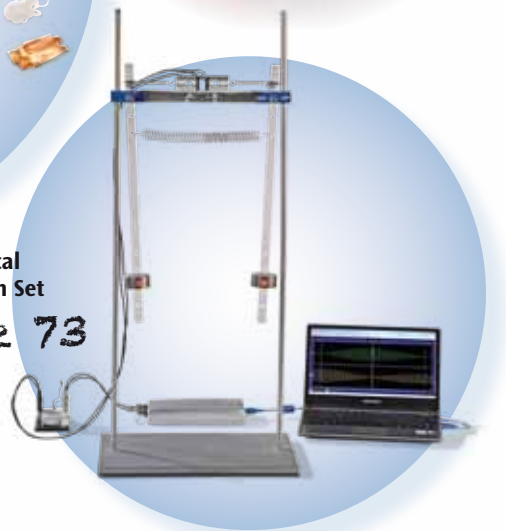
SW Ultrasonics Set
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STUDENT Kit – Electrostatics
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SW Physical
Pendulum Set
Page 73



Further 3B Scientific® Catalogues



Physics Experiments



Biology



Physiotherapy



Medical



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Committed to quality

3B Scientific provides you with good quality at fair prices. Our sophisticated quality management complies with the ISO 9001:2008 standards and the Worlddidac Quality Charter and is regularly approved by independent experts.

That's something you can rely on.



9 Reasons to Buy 3B Scientific Products

1 3-year quality guarantee

If, in spite of proper handling, you should discover any material or manufacturing defect within three years of the date of purchase, we will replace the product or correct the defect.

2 Low-price guarantee

With your purchase you obtain the highest quality at the lowest prices. If you can purchase a qualitatively comparable product at a lower price anywhere in the world within 14 days of purchase, you may return the product and we will refund the full purchase price.

3 14-day right of return

If, for any reason, you should not be fully satisfied with a 3B Scientific® product, simply return it in the original packaging and a copy of the invoice within 14 days. You will receive a complete refund.

4 Rapid delivery

We have an extensive range of products on site in our warehouse and can deliver most of the equipment within just a few days.

5 Special discounts

When orders entail larger volumes you can benefit from extra savings. Please ask our sales team about special volume discounts.

6 Continuous improvements

In order to be able to offer you the best possible quality, we continue to develop new products and innovate our product processes. For that reason it might be the case that actual products appear slightly different from the ones illustrated here.

7 Expanding the product spectrum

We are constantly expanding our product range and for that reason look forward to your ideas and comments to help inspire new developments.

8 Operational world-wide

In general, our products can be put into operation anywhere. Please pay close attention to your local mains voltage, i.e. 230 or 115 volts, when connecting up equipment with a mains power supply.

9 Quality management

As of June 2000 we have obtained a quality approval certification for service, products and organisational processes according to DIN EN ISO 9001:2008. This recognised Quality Management System has since lent us official support for our strategic commitment to innovation, product improvement and customer orientation. In addition to this we also continue to fulfil all of the quality standards associated with the introduction of the Worlddidac Quality Charter initiated in September 2004.

The 3B Scientific...

Group started in 2000 with the preparations for introducing an extensive range of Physics apparatus. It was to encompass equipment suitable for early Secondary School studies ranging up to University level. By the following year, the range was already in place for its launch and in the winter of 2001/2002 the first 3B Scientific® Physics Catalogue appeared. Even then it covered 144 pages.

From day one the company has been marketing products of its own manufacture, but the physics section took a major step forward in 2004 with the takeover of ELWE Didactic and another in 2005 with the purchase of TELTRON. Both Brands were already well-established with good reputations in the Educational Equipment market across the globe as outstanding product ranges, backed by decades of experience.

ELWE Didactic had its roots in a company called ELWE Lehrsysteme, which had already extended its commercial foothold in the pure sciences by taking over Kröncke in 1987, as well NEVA and Simeto in 1992. In 1995 ELWE Lehrgerätebau Klingenthal (formerly Simeto), which is now known as ELWE Didactic, took over the development, manufacturing and sales of teaching equipment for physics.

TELTRON was founded in 1963 and rapidly gained a worldwide name for its development of highly evacuated cathode ray tubes and a wide range of teaching equipment for the areas of atomic and nuclear physics.

Timeline

- | | |
|------|---|
| 1958 | Establishment of ELWE Lehrsysteme (Cremlingen, Germany) |
| 1963 | Establishment of TELTRON (London, England) |
| 1987 | Acquisition of Kröncke (Hanover, Germany) by ELWE Lehrsysteme |
| 1992 | Acquisition of Neva (Geißlingen an der Steige, Germany) and Simeto (Klingenthal, Germany) by ELWE Lehrsysteme |
| 1995 | Simeto renamed ELWE Lehrgerätebau Klingenthal, later to become ELWE Didactic |
| 2000 | Establishment of 3B Physics Department |
| 2002 | Introduction of Physics range to the global market with the 3B Physics catalogue, available in six languages. |
| 2004 | Integration of Elwe Didactic into 3B Scientific group |
| 2005 | Purchase of the TELTRON® brand and establishment of new factory in London, England |
| 2007 | First edition of 3B Physics Experiments catalogue in six languages |

3B Scientific Physics Manufacturing...

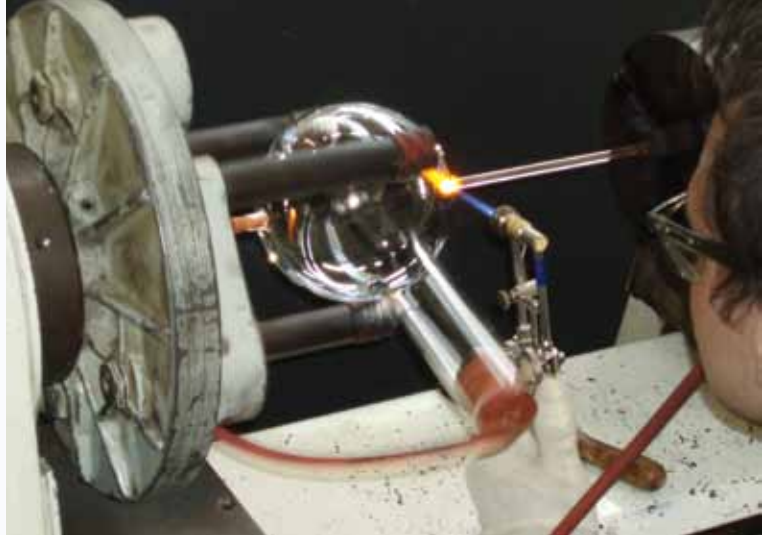
The physics business unit has seen highly positive developments at its various manufacturing sites in recent years.

In particular, the physics production facilities at ELWE and TELTRON have been modernised, reorganised and certified in accordance with ISO 9001:2008 so that we can fulfil your needs better and more quickly.

One thing is certain: for you we will always be pleased to go one step further.

Manufacturing a TELTRON® Electron Tube at UK 3B Scientific in London

Electron tubes are produced at only a very small number of places in the world. Only specially trained technicians with many years of experience have the skills that are needed for this technologically advanced manufacturing process, which ensures that every TELTRON® electron tube that you receive from us will have the same consistently high quality.



Assembly Production at the CNC Processing Centre of ELWE in Klingenthal

The universally recognised high quality of the teaching equipment produced under the ELWE® brand name is achieved through a combination of modern process technology with the best traditional craftsmanship. The skills and facilities of the CNC Processing Centre in Klingenthal guarantee not only the mechanical precision that is essential for high-quality physical instruments, but also cost-effective series production with consistently high quality.



A CAD/CAM Workstation at ELWE in Klingenthal

A direct extension from the principles of CAD (Computer Aided Design) is CAM (Computer Aided Manufacturing), here shown being applied to controlling a flat-bed milling machine. This manufacturing technology makes it possible to fulfil special project requirements with speed and with the usual high precision.



NEW

Mechanical Oscillations in a Space Saving Table Top Experiment

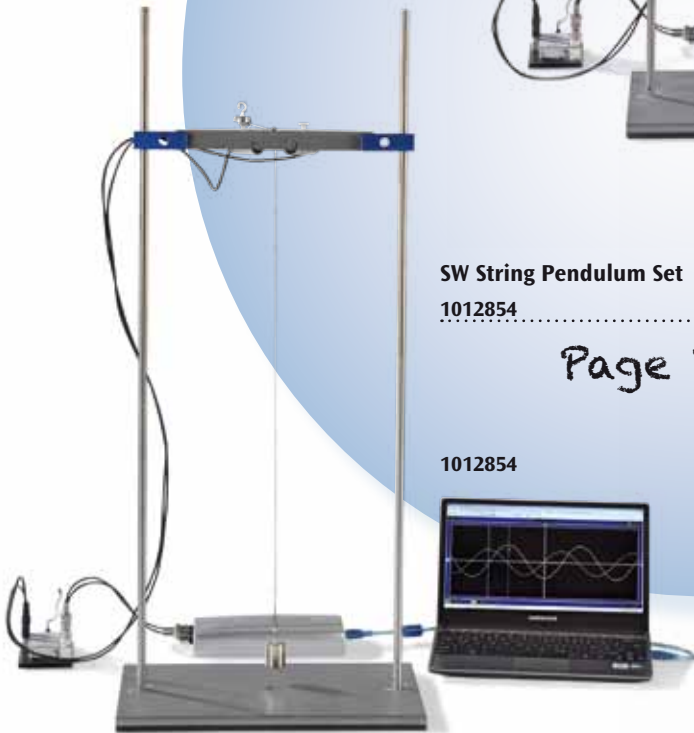
SW Physical Pendulum Set
1012853

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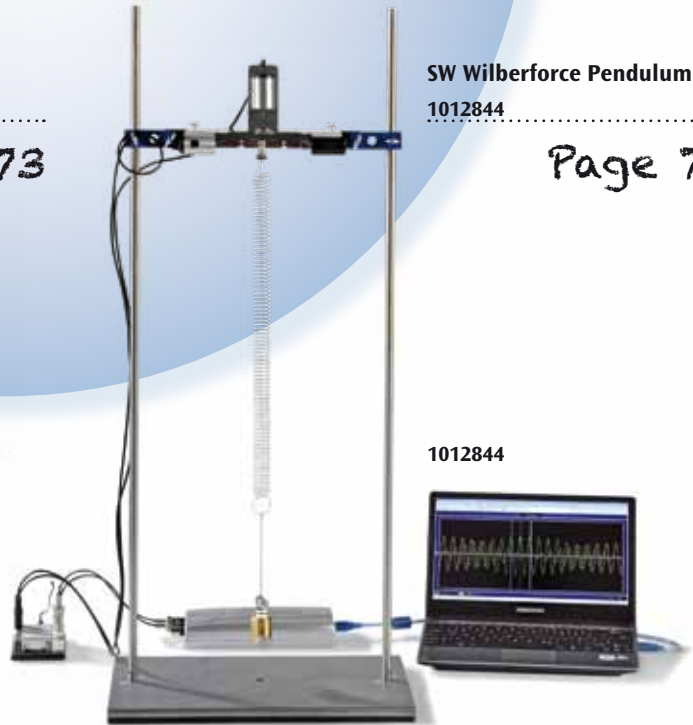
SW String Pendulum Set
1012854

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SW Wilberforce Pendulum Set
1012844

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SW Sensors Set (230 V, 50/60 Hz)
1012850

SW Sensors Set (115 V, 50/60 Hz)
1012851

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1012850



SW Ultrasonics Set (230 V, 50/60 Hz)

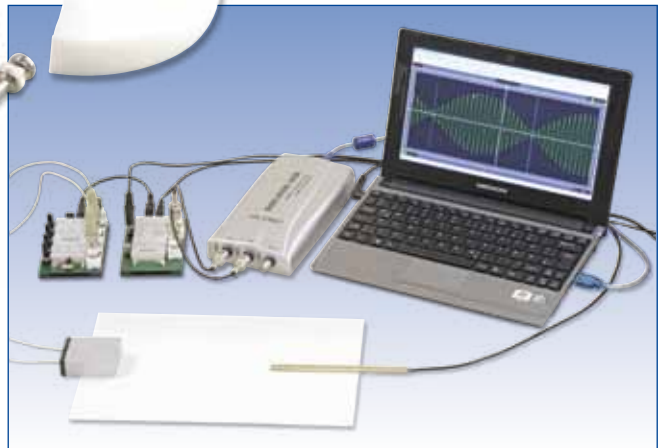
1012845

SW Ultrasonics Set (115 V, 50/60 Hz)

1012846

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1012845
1012846



Millisecond Counter (230 V, 50/60 Hz)

1012832

Millisecond Counter (115 V, 50/60 Hz)

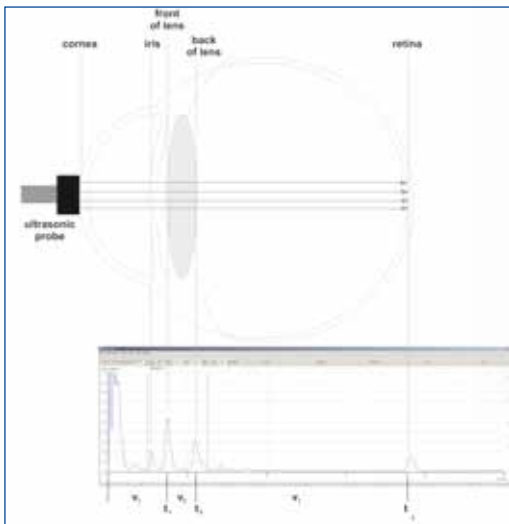
1012833

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1012869



Model Eye for Ultrasonic Biometry

1012869

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NEW

1012880



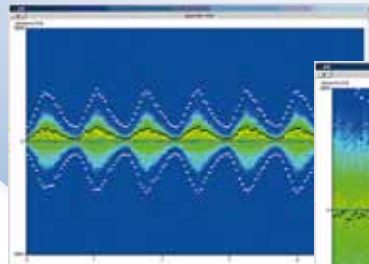
Experiment Topics:

- Doppler sonographic examinations of the human arm.
- Measurement of the flow velocity of blood
- Recording of Doppler spectra and pulse curves
- Diagnosis of stenosis (vascular stricture) in an arm

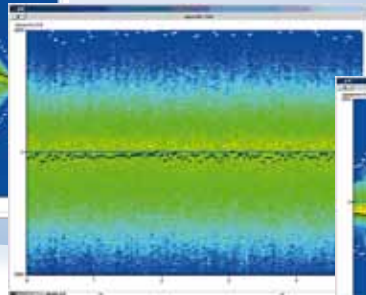
Arm Phantom Set

1012880

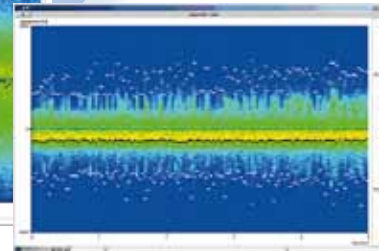
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Doppler spectrum at arterial flow



Doppler spectrum of a stenosis



Doppler spectrum at venous flow

Charge Indicator

1009962

Page 177

1009962



Complete Fine Beam Tube System

The complete fine-beam tube system consists of the following parts:

Fine Beam Tube T

U18575

Operating Unit for Fine-Beam Tube

U8481435

Page 227

U18575



U8481435

NEW



STUDENT Kit – Electrostatics
1009883

Page 18

1009883



1009883

Charge Storage Device with Piezo Charger
1009963

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1009963



Hall Effect Experiment

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New Products

...going one step further

NEW

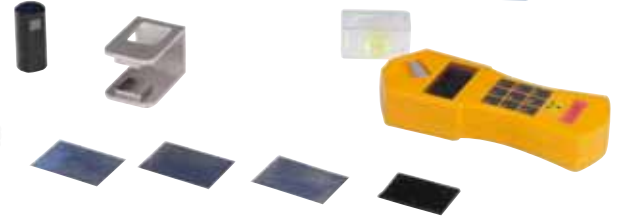


SEK Radioactivity

1006804

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1006804

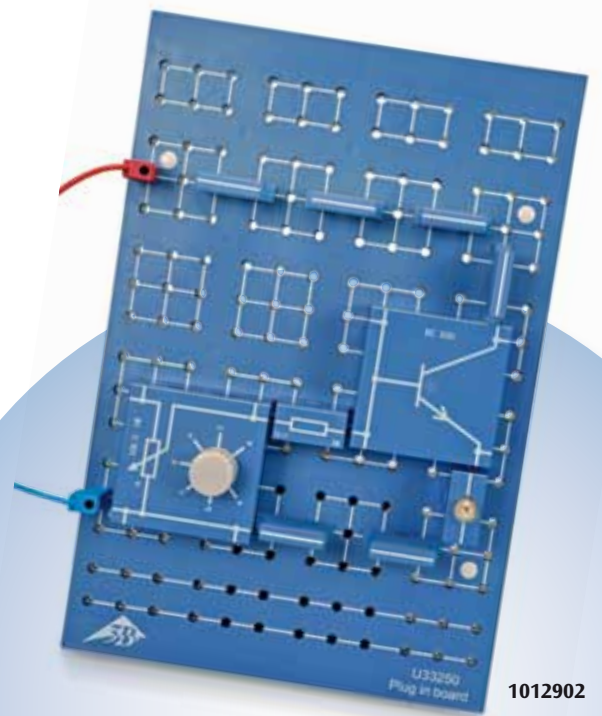


1012827

Falling Sphere Viscometer

1012827

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1012902

Plug-in Board for Components

1012902

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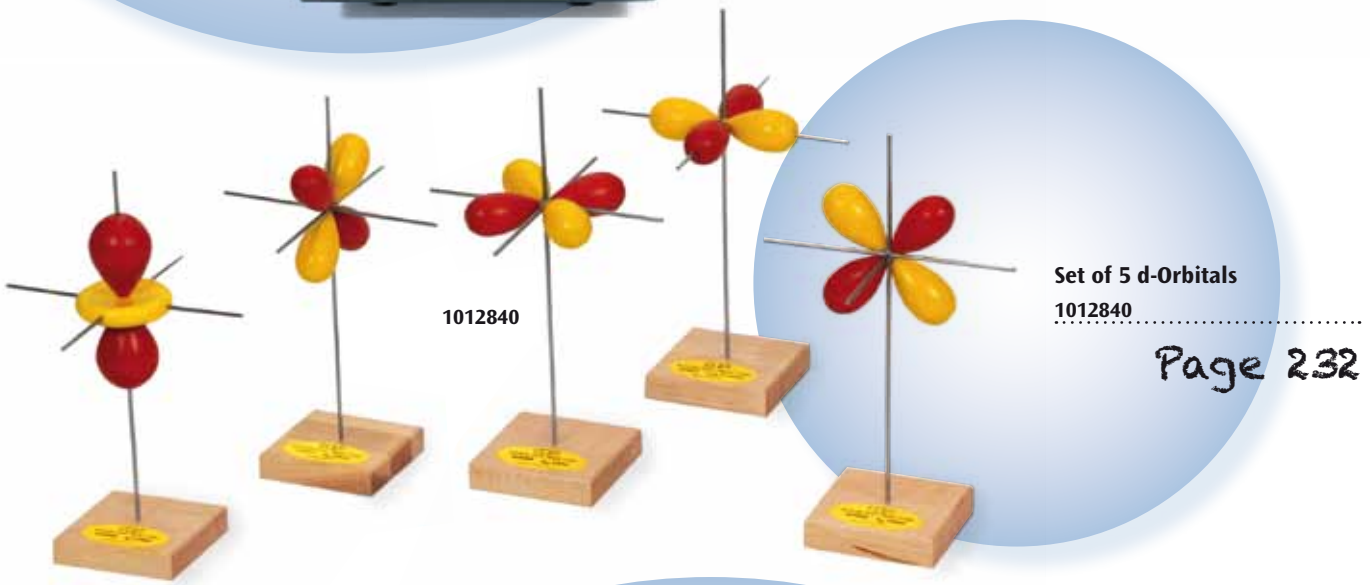
New Products



1012782

Scanning Tunnelling Microscope
1012782

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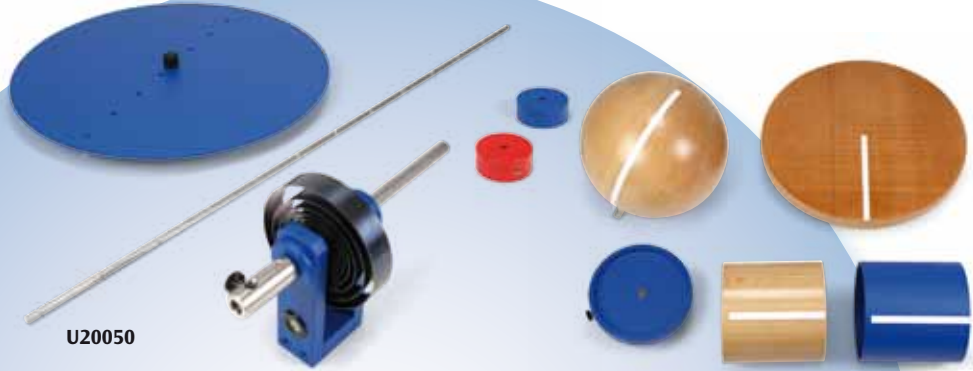
1012840

Set of 5 d-Orbitals
1012840

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Experiment Topics:

- Rotary oscillations
- Determination of moments of inertia using the oscillation method
- Moments of inertia of various geometric bodies
- Steiner's theorem



U20050

U20051

Torsion Axle
U20050

Set of Test Bodies for Torsion Axle
U20051

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1012827

...going one step further

NEW



U8470350



1009946

Optical Lamp N (115 V, 50/60 Hz)
1009945

Optical Lamp N (230 V, 50/60 Hz)
1009946

Object Holder N
U8470350



The NEVA optics system offers inexpensive reliability and ease of use for setting up basic experiments in ray optics.

All the optical components are set in a slide with a magnetic base and can easily be aligned on an optical base and moved into a beam of light.

Optical Bench N
4003987



4003987

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1012862

Gauge with Adapter

1012862

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Dosimeter Radex RD 1706

1012894

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1012894



New Products



1012696

U29530

LED Graetz Bridge in 3B Box

1012696

ELV Motor on 3B Box

U29530

Ohm's Law Apparatus in 3B Box

1012698

Universal Holder on 3B Box

U29528

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1012698



U29528

NEW



1012881



ABS Analytical Scales (230 V. 50/60 Hz)

1012881

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1012816

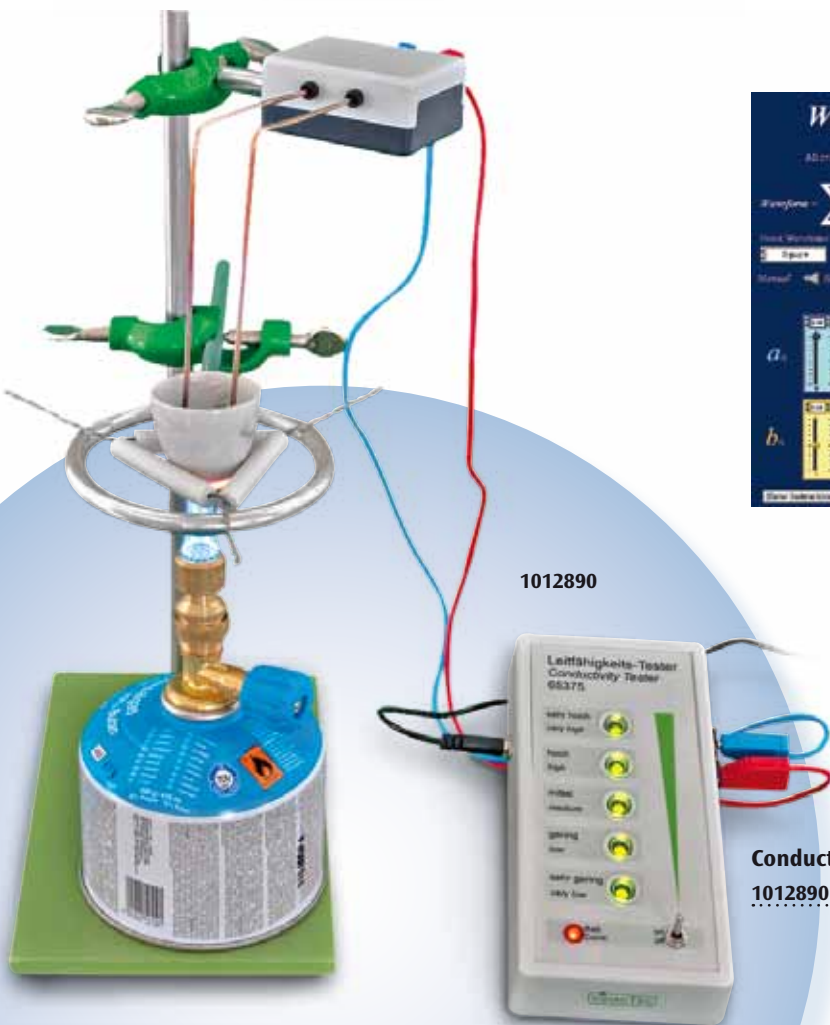
TRMS



DMM60 Digital Multimeter

1012816

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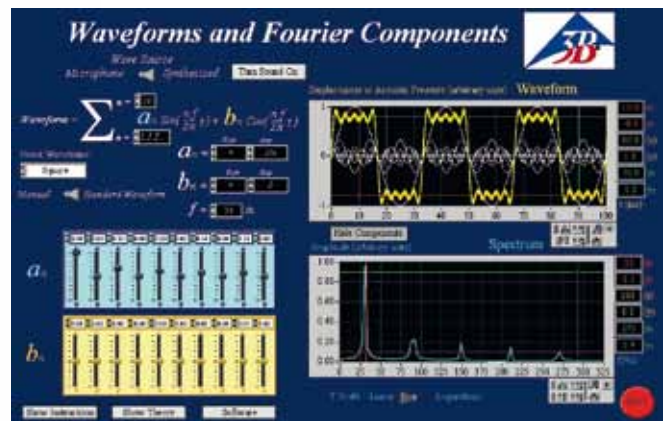


1012890

Conductivity Tester

1012890

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1012587

Software for Fourier Analysis

1012587

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More new products on page 298

New Products

...going one step further

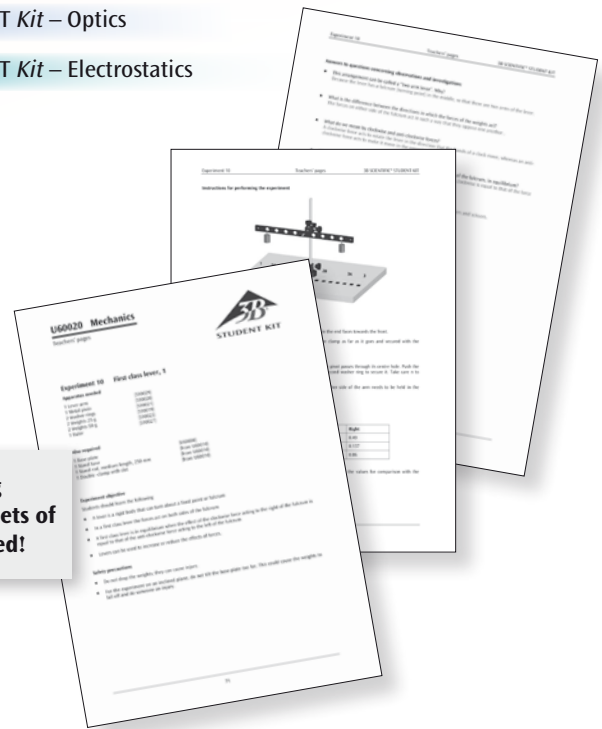
3B STUDENT Kit

Student Experiments for Lower Secondary

The versatile 3B STUDENT Kits allow students in lower secondary level to work independently in setting up and carrying out a comprehensive range of basic experiments on the topics of mechanics, heat and optics. Detailed instructions for the experiments, divided into pages for students and pages for teachers, help the students to perform the experiments and enable the teachers to make the necessary preparations.

Each equipment set-up enables students to work in pairs and requires a bench area of only 400 mm x 250 mm, which is sufficient to ensure a clear and stable set-up. The robust components are made of anodised aluminium, plastic or glass.

- 3B STUDENT Kit – Basic Set
- 3B STUDENT Kit – Mechanics
- 3B STUDENT Kit – Heat
- 3B STUDENT Kit – Optics
- 3B STUDENT Kit – Electrostatics



Please ask for quantity discounts on class sets of 8 pieces or more.

CD-ROM containing more than 70 different sets of instructions is included!

STUDENT Kit – Basic Set

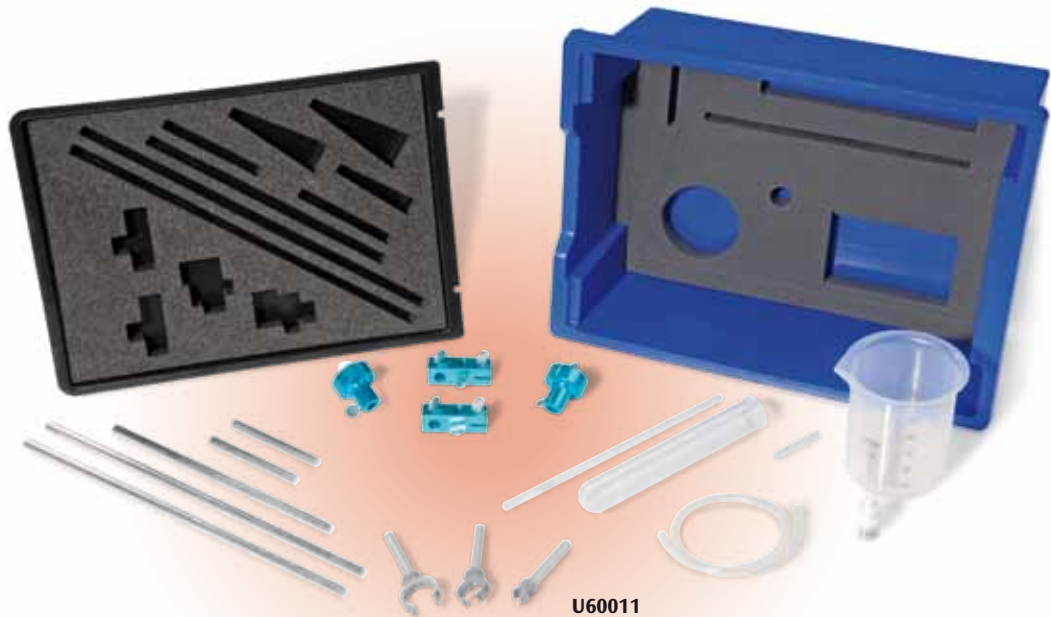
Basic set of apparatus for use with STUDENT Kits for mechanics (U60020) and heat (U60040). Consisting of a robust base-plate made of plastic, stands and clamps made of anodised aluminium and other components that are used in both mechanics and heat experiments. In a robust plastic box with foam inserts moulded to the shapes of the items plus a transparent lid. Includes a CD with instructions for the experiments.

Contents:

- 1 Base-plate
- 2 Stand bases
- 2 Stand rods, 360 mm
- 1 Stand rod, 250 mm
- 2 Stand rods, 100 mm
- 2 Double clamps with slot
- 1 Clip, 8 mm diam.
- 1 Clip 22 mm diam.
- 1 Clip 27 mm diam.
- 1 Beaker, 500 ml
- 1 Test tube
- 1 Glass tube, 50 mm
- 1 Glass tube, 250 mm
- 1 Silicone tube, 500 mm x 6 mm diam.
- 4 g Glycerine
- 1 CD with sets of instructions for experiments

U60011

3B STUDENT Kit – Basic Set



STUDENT Kit – Mechanics

Set of apparatus for carrying out 25 basic student experiments on the mechanics of solids, liquids, and gases. In a robust plastic box with foam inserts moulded to the shapes of the items and a transparent lid. The experiments are designed to occupy as little space as possible on the base-plate of the STUDENT Kit basic set (U60011), while remaining clear and easy to perform.

Contents:

- 1 Steel leaf spring
- 1 Lever arm
- 1 Ruler
- 1 Pulley
- 1 Pulley with hook
- 1 Weight, 100 g
- 3 Weights, 50 g
- 2 Weights, 25 g
- 1 Dynamometer, 2 N
- 1 Metal pivot
- 4 Washer rings to fit metal pivot
- 1 Pulley with cord
- 1 Trolley
- 1 Friction pad
- 1 Coil spring
- 1 Iron block
- 1 Aluminium block
- 1 Wooden block
- 1 Silicone tube, 500 mm x 3 mm diam.
- 1 Tubing connector
- 1 Clip, 8 mm diam.
- 1 Clip, 14 mm diam.
- 1 Syringe, 60 ml
- 1 Syringe, 30 ml
- 1 Plastic sphere
- 1 Rubber stopper (30 mm x 31/25 mm diam.)
- 1 Funnel, 40 mm diam.
- 1 U-tube manometer
- 1 Measuring cylinder
- 100 g Modelling clay



U60020

U60020

Additionally required:

U60011 STUDENT Kit – Basic Set

Includes 25 Experiments on the Subject of Mechanics:

- Effects of forces
- Action and reaction
- Deformation by forces (2 experiments)
- Masses and densities of bodies
- Friction
- Second class lever
- First class lever (2 experiments)
- Fixed pulley
- Moving pulleys
- Combinations of fixed and moving pulleys (block and tackle)
- Inclined plane (2 experiments)
- Connected vessels
- Pressure in liquids
- Principle of the U-tube manometer
- Pressure due to weight of fluids
- Buoyancy in liquids
- Floating and sinking
- Air as a body
- Pressure and volume
- Temperature and volume
- Effects of atmospheric pressure

Equipment mechanics:

U60020 STUDENT Kit – Mechanics

U60011 STUDENT Kit – Basic Set



First class lever

STUDENT Kit – Heat

Set of apparatus for carrying out 10 basic student experiments on heat. In a robust plastic box with foam inserts moulded to the shapes of the items and a transparent lid. The experiments are designed to occupy as little space as possible on the base-plate of the STUDENT Kit basic set (U60011), while remaining clear and easy to perform.

Contents:

- 1 Conical flask, 100 ml
- 1 Bimetallic strip
- 1 Concave mirror mounted on stem
- 1 Aluminium rod 200 mm
- 1 Thermometer, -10°C – $+100^{\circ}\text{C}$
- 1 Glass tube with 90° bend
- 1 Rubber stopper, 25 mm x 24/19 mm diam.
- 1 Spirit burner
- 1 Ceramic mat

U60040

Additionally required:

U60011 STUDENT Kit – Basic Set

3B STUDENT Kit – Heat

U60040

Please ask for quantity discounts on class sets of 8 pieces or more.

Includes 10 Experiments on the Subject of Heat:

- Principle of a thermometer
- Heating of solid bodies
- Heating of liquid bodies
- Heating of gases
- Behaviour of bimetallic objects
- Conduction of heat
- Radiation of heat
- Condensation
- Distillation
- Temperature of mixtures

Equipment heat:

U60040 STUDENT Kit – Heat

U60011 STUDENT Kit – Basic Set



Principle of a thermometer

STUDENT Kit – Optics

Set of apparatus for carrying out 23 basic student experiments in optics. In a robust plastic box with foam inserts moulded to the shapes of the items and a transparent lid. Includes a CD with instructions for the experiments. The experiments are designed to occupy as little space as possible on the included optical bench, while remaining clear and easy to perform.

3B STUDENT Kit – Optics

Contents:

- 2 lenses, $f = +100$ mm
- 1 lens, $f = +50$ mm
- 1 lens, $f = -100$ mm
- 1 lens, $f = +300$ mm
- 1 diaphragm holder
- 1 plug-in power supply unit for optical lights
- 1 optical light
- 1 overlay mask protractor
- 1 projection screen/experiment table
- 1 optic bench
- 2 tea lights
- 1 opaque body
- 1 single aperture slot
- 1 triple aperture slot
- 1 colour slide M-Y-C
- 1 F diaphragm
- 1 flexible mirror
- 1 coplanar board
- 1 semicircular body
- 1 converging lens
- 1 diverging lens
- 1 right-angled prism
- 2 sheets of graph paper, transparent DIN A5
- 1 scale



3B STUDENT Kit

STUDENT Kit Optics (230 V, 50/60 Hz)

U60050-230

STUDENT Kit Optics (115 V, 50/60 Hz)

U60050-115

U60050-230

Includes 23 Experiments on the Subject of Optics:

- Propagation of light
- Light and shadows
- Reflection at a plane mirror
- Concave and convex mirrors
- Refraction of light (2 experiments)
- Refractive index
- Optical lenses (paths of rays)
- Focal point of convergent lenses
- Focal length of convergent lenses
- Formation of images with converging lenses
- Laws of images
- Magnifying glasses
- Function of the eye
- Function of spectacles (2 experiments)
- Principle of a camera
- Principle of a slide projector
- Principle of a Galilean telescope
- Principle of an astronomical telescope
- Principle of a microscope
- Breaking down light into its components
- Mixing of colours

Equipment optics:

U60050-230 STUDENT Kit – Optics (230 V, 50/60 Hz)

or

U60050-115 STUDENT Kit – Optics (115 V, 50/60 Hz)



Principle of a slide projector

Student Experiments

STUDENT Kit – Electrostatics

Set of apparatus for carrying out 15 basic student experiments on electrostatics. Including electroscope, charge indicator, charge storage unit and Piezo charger. In a robust plastic box with foam inserts moulded to the shapes of the items and a transparent lid. Includes a CD with instructions for the experiments. The experiments are designed to occupy as little space as possible in the apparatus frame, while remaining clear and easy to perform.

Contents:

- 1 Stand base
- 1 Apparatus frame
- 2 Aluminium rods
- 1 Aluminium rod with magnet
- 1 Electroscope
- 1 Plastic plate, angled
- 1 Plastic rod
- 1 Glass rod
- 1 Conductor body
- 1 Set of needles
- 1 Spinner
- 1 Pendulum bob (polystyrene)
- 1 Screw-on needle
- 1 Set of plasticine
- 2 Experiment leads
- 1 Set of balloons
- 1 Set of papers with 1 plastic cloth
- 1 Set of metal strips
- 1 Piezo charger
- 1 Faraday cage
- 1 Faraday cup
- 1 Charge indicator
- 1 Charge storage unit
- 2 Capacitor plates
- 1 Dielectric

1009883

3B STUDENT Kit – Electrostatics

NEW

Please ask for quantity discounts on class sets of 8 pieces or more.

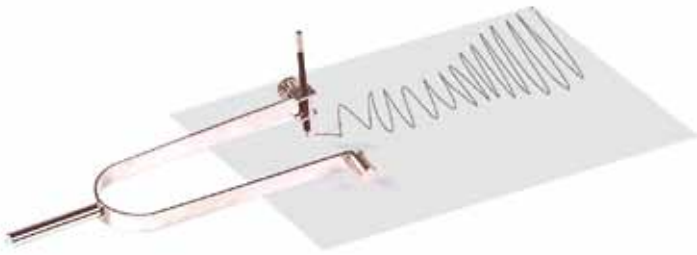
Includes 15 Experiments on the Subject of Electrostatics:

- Electrostatic charging of hair
- Forces on uncharged particles
- Charge indicator
- Forces between charged bodies
- Build your own electroscope
- Electroscope
- “Shock of hair”
- Demonstrating charge on a capacitor
- “Charge pendulum”
- “Spinner”
- Charging due to induction
- Transfer of charge using a “charge spoon”
- Faraday’s cup
- Faraday’s cage
- Plate capacitor



“Shock of hair”

The acoustics kit allows students to carry out numerous experiments on acoustics independently. A wide variety of sound sources are studied to begin with and the concepts of noise, bangs and tones as well as pitch and loudness are investigated. Waves along a rope are used to illustrate harmonic vibrations and overtones. There is also some extensive study of various different musical instruments. Different high-pitched tones are generated by means of a monochord and the ensuing intervals are calculated experimentally. These studies are expanded to other instruments and can easily lead over to a study of musical notes.



BEST SELLER

Acoustics Kit

Complete set of equipment for carrying out more than 30 student experiments on acoustics. In plastic tray with foam inlay. Includes CD with experiment instruction.

Dimensions: 530x375x155 mm³ approx.
Weight: 4.5 kg approx.

Contents:

- 1 Monochord, with ruler and musical scale
- 1 Steel string
- 1 Perlon string
- 1 Spring balance on support
- 1 Reed pipe with 8 valves
- 1 Tuning fork with plotter pen, 21 Hz
- 1 Tuning fork, 440 Hz
- 1 Light-metal tuning fork, 1700 Hz
- 1 Pipe
- 1 Variable-length closed air column
- 1 Tuned open air column
- 1 Chladni disc with rod
- 1 Bell dome
- 1 Galton whistle
- 1 Kundt pipe with retaining clip
- 5 g Lycopodium powder in sprinkling cellar
- 1 Metallophone with beater
- 1 Rope for demonstrating waves
- 1 Helmholtz resonator, 70 mm diam.
- 1 Helmholtz resonator, 52 mm diam.
- 1 Helmholtz resonator, 40 mm diam.
- 1 Helmholtz resonator, 32 mm diam.
- 1 Screw clamp
- 1 Plastic block
- 1 Plunger

U8440012.....

Experiment Topics:

- Noise, bangs, pure tones
- Vibrating air columns
- Whistles and pipes
- Vibrating bars, plates and bells
- Infra-sound
- Ultra-sound
- Tuning fork with plotter pen
- Travelling waves along a rope
- Velocity of propagation of sound
- Moving sources of sound (Doppler effect)
- Plate vibrations (Chladni figures)
- Vibrations of a bell
- Standing waves on a rope, overtones
- Sounds of musical instruments
- Representation of oscillations with a tuning fork with plotter pen
- Timbre of the human voice
- Measurement of wavelength (Kundt figures)
- Resonance
- Helmholtz ball resonators
- Sound analysis
- Loudness
- Pitch of string instruments
- Pitch of wind instruments
- Reed pipe
- C-major scale and its intervals
- Triads, harmonies
- Semitones, major and minor



U8440012

Student Experiment Kits (SEK)

SEK Mechanics

Set of equipment for carrying out 23 student experiments on the mechanics of solids. In a tough plastic box containing a foam insert with cut-outs for the equipment and featuring a transparent lid. Includes CD with experiment instructions. Experiments are set up and performed on the SEK base plate (U8408035) so that they are compact but still clear in their layout and objectives.



U8501000

SEK Mechanics

Contents:

- 2 Stand rods with external and internal thread, 400 mm
- 1 Stand rod with external thread, 400 mm
- 2 Stand rods, 110 mm
- 2 Double clamps
- 1 Beam balance
- 2 Weighing pans with holders
- 1 Scale for balance
- 1 Axle rod for pulleys
- 1 Rolling pin with add-on weights
- 1 Block and tackle with two pulleys and two hooks
- 1 Block and tackle with two pulleys and one hook
- 1 Multiple pulley
- 1 Plastic pulley, 40 mm
- 4 Weights, 25 g
- 1 Weight, 50 g
- 1 Weight, 100 g
- 1 Magnetic base
- 1 Adjustable bracket
- 2 S-shaped hooks, 1 g
- 2 S-shaped hooks, 2 g
- 2 S-shaped hooks, 5 g
- 4 O-rings
- 1 Body for friction and inertia experiments
- 1 Set of plastic strips for friction experiment
- 1 Dynamometer 1 N
- 1 Dynamometer 2 N
- 1 Leaf spring, 330 mm
- 1 Coil spring with 2 eyelets, approx. 5.25 N/m
- 100 m of twine
- 2 Pointers
- 1 Measuring cylinder
- 1 Stand base for measuring cylinder
- 3 Strips of velour paper
- 1 Set square
- 1 Ruler

U8501000

Includes 23 Experiments on the Subject of Mechanics:

- Hooke's law
- Calibrating a dynamometer
- Deformation of a leaf spring
- Addition of forces acting along the same line
- Resolution of a force into two components
- Investigation of inertia
- Types of friction
- Laws of static and kinetic friction
- Equilibrium conditions for a first-class lever
- Equilibrium conditions for second and third-class levers
- Forces, paths and work with fixed pulleys
- Forces, paths and work with non-fixed pulleys
- Forces, paths and work with block and tackle
- Forces, paths and work with multiple pulleys
- Forces on an inclined plane
- Determining the volume of solid bodies
- Determining the mass of solid bodies (beam balance)
- Determination of density
- Determining the nature of a material by measuring density
- Specific weight and buoyancy
- Period of a string pendulum
- Determining gravitational acceleration with the aid of a string pendulum
- Period of a spring oscillator

Equipment mechanics:

- U8501000 SEK Mechanics
- U8408035 SEK Base Plate



Forces on an inclined plane

SEK Heat

Set of equipment for carrying out 23 basic student experiments on heat. In a tough plastic box containing a foam insert with cut-outs for the equipment and featuring a transparent lid. Includes CD with experiment instructions. Experiments are set up and performed on the SEK base plate (U8408035) so that they are compact but still clear in their layout and objectives.

Contents:

- 1 Stand rod with internal and external threads, 400 mm
- 4 Wooden rods
- 1 Metal tube, short
- 1 Pointer/hook
- 1 Stirrer
- 1 Steel tube
- 1 Brass tube
- 1 Aluminium tube
- 1 Thermometer without scale, red liquid
- 2 Thermometers, -10 – 110°C, 1 K, red liquid
- 1 Capillary tube
- 1 Bimetal strip with 10-mm stub
- 10 Round filters
- 10 Sheets of thermal paper
- 1 Steel body
- 1 Lead body
- 1 Spirit burner
- 1 Beaker, 100 ml
- 1 Conical flask, 100 ml
- 1 Test tube holder with rod attachment
- 1 Test tube

- 1 Measuring cylinder, 50 ml
- 1 Calorimeter with heating filament, 200 ml
- 1 Rubber stopper with two holes
- 2 Rubber stoppers with one hole
- 1 10 g weight with hook
- 2 Double clamp
- 5 ml of food colouring
- 10 g of table salt

SEK Heat

- 1 Holder for metal beaker
- 1 Metal beaker, black
- 1 Metal beaker, aluminium
- 4 g of glycerine
- 3 Flow spirals
- 1 Hose
- 2 Round gaskets
- 1 Angle scale
- 10 Sheets of paper
- 5 Sheets of aluminium foil

U8502000

SEK Mechanics

SEK Heat

SEK Optics

SEK Electricity and Magnetism

SEK Radioactivity

CD-ROM containing more than 100 different sets of instructions is included!



U8502000

Includes 23 Experiments on the Subject of Heat

- Change in the volume of liquids due to heating
- Calibration of a thermometer
- Change in the volume of air due to changes in temperature
- Changes in state of an enclosed volume of air
- Changes in the length of solid bodies when heated
- Linear expansion coefficient
- Investigations using bimetal strips
- Transfer of heat in solid bodies
- Transfer of heat in liquids
- Transfer of heat in gases
- Radiation of heat
- Slowing down the transport of heat
- Temperature changes when liquids are heated
- Fundamental equation of thermodynamics
- Mixing water of differing temperatures, temperature of mixture
- Specific heat capacity of a calorimeter
- Specific heat capacity of metals
- Initial temperature of a metal body heated in a flame
- Conversion of electrical energy into heat
- Temperature changes when ice melts
- Specific latent heat of melting ice
- Boiling and condensation of water
- Distillation
- Evaporation of liquids (what it depends on and heat loss due to evaporation)

Equipment heat:

U8502000 SEK Heat

U8408035 SEK Base Plate



Changes in the length of solid bodies when heated

SEK Base Plate

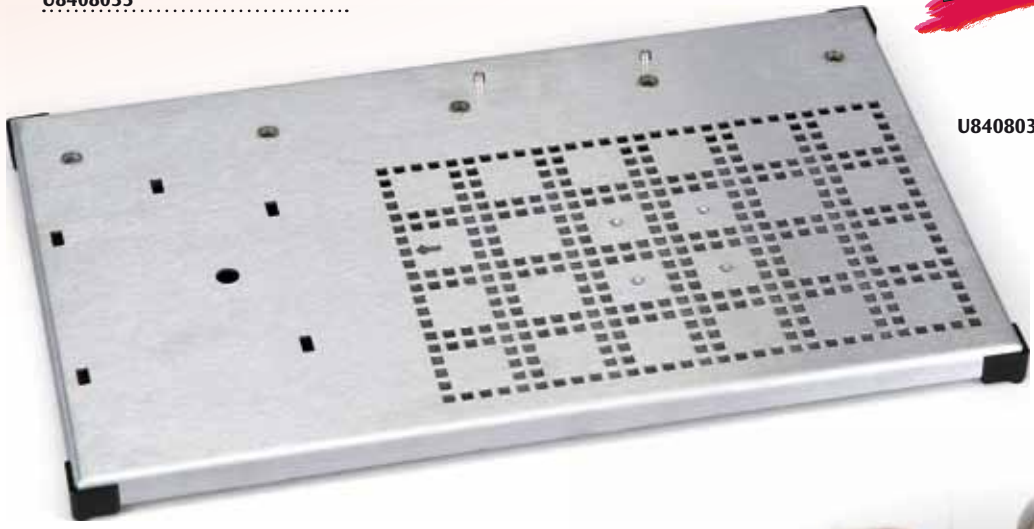
Tilt-resistant stainless-steel base with five special threads for the tilt-free insertion of stand rods, threads for mounting a dismantling transformer and numerous expansion slots for the insertion of electrical components. With stable and nonslip rubber feet.

Dimensions: 400x245x15 mm approx.

U8408035

NEW

U8408035



SEK Power Supply

AC/DC power supply for SEK electricity and magnetism kit (U8506000). Housing with attachment hooks for clamping into the SEK base plate (U8408035).

Voltages: 1.5/ 3.0/ 4.5/ 6.0 V AC/DC

SEK Power Supply (230 V, 50/60 Hz)

U8498030-230

SEK Power Supply (115 V, 50/60 Hz)

U8498030-115

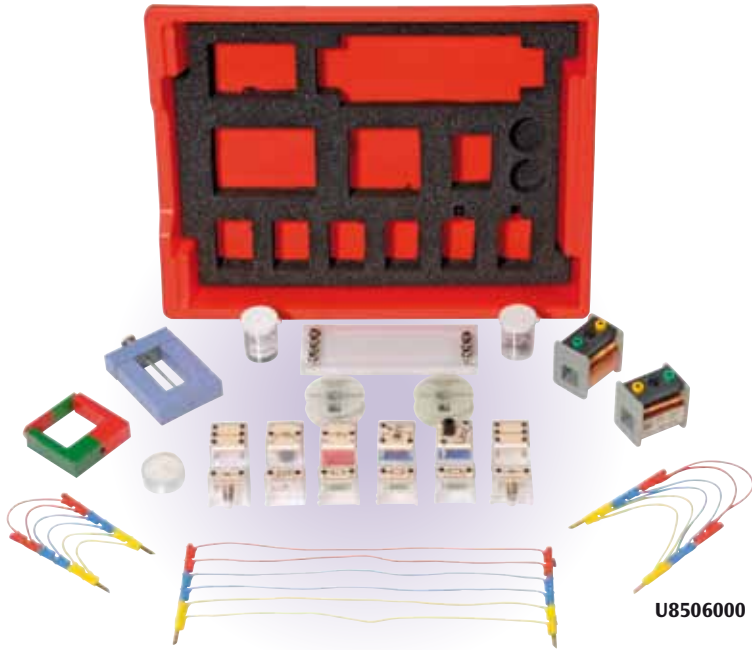


U8498030-230
U8498030-115

SEK Electricity and Magnetism

Set of equipment for carrying out 41 student experiments on electricity and magnetism. In a tough plastic box containing a foam insert with cut-outs for the equipment and featuring a transparent lid. Includes CD with experiment instructions. The experiments are set up and performed in a space saving fashion but are still clearly laid out on the SEK base plate (U8408035).

U8506000



U8506000

SEK Electricity and Magnetism

Contents:

- | | |
|--|---|
| 1 Set of experiment leads | 1 Resistor, 47 Ω
(plug-in component) |
| 1 Bar magnet, 65x16 x 5 mm approx. | 1 Resistor, 1 k Ω
(plug-in component) |
| 1 Horseshoe magnet, ALNICO, flat | 1 NTC-resistor, 100 Ω
(plug-in component) |
| 1 Resistor board | 2 Lamp sockets, E10
(plug-in components) |
| 1 Transformer core, 20 x 20 mm | 2 Light bulbs, E10, 7 V |
| 1 Tightening screw | 1 Storage box with 1 set of threads with washer, 2 threaded bushes, 2 threaded pins, 2 Paper clips, 2 aluminium electrodes, constant wire |
| 1 Coil, 200/400/600 windings | 50 g of iron filings |
| 1 Coil, 400/400/800 windings | 50 m of chrome/nickel wire, 0.2 mm |
| 2 Current branches
(plug-in components) | 50 m of iron wire, 0.2 mm |
| 1 Potentiometer, 100 Ω
(plug-in component) | 1 Tea candle |
| 1 Switch (plug-in component) | |
| 1 Capacitor, 4700 μ F
(plug-in component) | |
| 1 Capacitor, 10 μ F
(plug-in component) | |
| 1 Resistor, 33 Ω
(plug-in component) | |

Please ask for quantity discounts on class sets of 8 pieces or more.

Includes 41 Experiments on the Subject of Electricity and Magnetism:

- Closed circuits
- Conductors and insulators
- Circuits with no branches
- Circuits with branches
- Current in a circuit with no branches
- Current in a circuit with branches
- Initial voltage and terminal voltages
- Voltage in a circuit with no branches
- Voltage in a circuit with branches
- Voltage dividers
- Ohm's law
- Temperature dependence of a resistor (iron wire)
- Current-voltage diagram for a light bulb
- Current-voltage diagram for a thermistor
- Law of resistance
- Resistance in a circuit with no branches
- Resistance in a circuit with branches
- Resistance and voltage in a circuit with no branches
- Resistance and current in a circuit with branches
- Voltage dividers with and without a load
- Voltage-time diagram for charging and discharging of a capacitor
- Current-time diagram for charging and discharging of a capacitor
- Relationship between charge and voltage
- Capacitor in the DC and AC circuit (response)
- Test bodies in a magnetic field
- Magnetic poles
- Magnetic field of a horseshoe magnet and a bar magnet
- Magnetic dipoles
- A coil used as a magnet
- Forces in the magnetic field of a coil
- Induction due to relative motion
- Induction due to changes in magnetic field
- Induction law
- Ohmic resistance in AC and DC circuits



Transformer under load

- Capacitors in AC and DC circuits (resistance)
- Coils in AC and DC circuits
- How a transformer works
- Voltage and number of windings for a transformer with no load
- Transformer under load
- Transformer under heavy load
- Thermoelectricity

Equipment electricity:

U8506000 SEK Electricity and Magnetism

U8408035 SEK Base Plate

1006811 ESCOLA2 Multimeter

U8498030-230 SEK Power Supply (230 V, 50/60 Hz)

or

U8498030-115 SEK Power Supply (115 V, 50/60 Hz)

SEK Optics

Set of equipment for carrying out 38 student experiments on ray optics. In a tough plastic box containing a foam insert with cut-outs for the equipment and featuring a transparent lid. Includes CD with experiment instructions. The experiments are designed to be compact but still easy to see when set up and carried out on the supplied optical bench or the SEK base plate (U8408035). In both cases, the optical components are attached in non-slip fashion by magnets. Supplied overlays designate where the components are to be placed.

SEK Optics (230 V, 50/60 Hz)

U8503000-230

SEK Optics (115 V, 50/60 Hz)

U8503000-115

U8503000-230/
U8503000-115



SEK Optics

Contents:

- | | |
|---|--------------------------------------|
| 1 Optical bench | 1 Acrylic block with holder |
| 1 Optical lamp, 5 V, 2 W | 1 Semi-circular body |
| 1 Plug-in power supply, 100 – 240 V, 50/60 Hz | 1 Diverging lens, flat model |
| 4 Tea candles | 1 Converging lens, flat model |
| 1 Plastic container | 1 Right-angled prism |
| 1 Slide holder, magnetic | 1 Rectangular block |
| 1 F-shaped slide | 1 Objects for casting shadows |
| 1 Slide with triple and quintuple slits | 1 Flexible mirror, magnetic |
| 1 Slide with single slit | 1 Projection screen/Experiment table |
| 1 Object for use as an image | 2 Lenses, $f = +50$ mm |
| 1 Colour filter, red | 1 Lens, $f = +100$ mm |
| 1 Colour filter, blue | 1 Lens, $f = +300$ mm |
| | 1 Lens, $f = -100$ mm |
| | 1 Set of overlays |

NEW

Includes 38 Experiments on the Subject of Optics:

- Propagation of light, light beams and rays
- Transparency
- Light and shadow
- Umbra and penumbra
- Reflection from a plane mirror
- Concentration of light by a concave mirror
- Reflection and path of light for a concave mirror
- Reflection and path of light for a convex mirror
- Characteristics of the image from a plane mirror
- When light passes from air into glass / Determination of refractive index
- When light passes from glass into air / Determination of refractive index
- Determination of critical angle for total internal reflection (glass to air)
- Ray diagrams for a rectangular glass block, laws
- Ray diagrams for a glass prism
- Total internal reflection inside a prism
- Path of light through a converging lens
- Determination of focal length for a converging lens
- Ray diagrams with parallel ray and ray through centre of lens (converging lens)
- Path of light through a diverging lens
- Determination of focal length for a diverging lens
- Ray diagrams with parallel ray and ray through centre of lens (converging lens)
- Path of light through a system of lenses
- Image properties (converging lens)
- Image magnification and the lens equation
- Image aberrations with converging lenses
- Formation of images in the eye
- Short-sightedness
- Long-sightedness

CD-ROM containing all different sets of instructions is included!



- Astigmatism
- Cameras
- Slide projectors
- Microscopes
- Galileo telescope
- Kepler's telescope
- Terrestrial telescope
- Separation of light into a spectrum
- Recomposition of spectral colours
- Additive mixing of colours, complementary colours

Reflection and path of light for aconvex mirror

Equipment optics:
U8503000-230 SEK Optics (230 V, 50/60 Hz)
or
U8503000-115 SEK Optics (115 V, 50/60 Hz)

The optics experiments can be set up on the optical bench included in the SEK optics set (U8503000-230/U8503000-115) or on the SEK base plate (U8408035).

SEK Radioactivity

Set of apparatus for carrying out 10 basic student experiments on radioactivity. In a robust plastic box with foam inserts moulded to the shapes of the items and a transparent lid. Includes a CD with instructions for the experiments. The experiments are designed to occupy as little space as possible on the supplied base plate, while remaining clear and easy to perform. To determine the count rates, it is recommended that a GAMMA-SCOUT Geiger counter (U111511) be used (not included).

1006797

SEK Radioactivity

Contents:

- | | |
|---|--------------------------------------|
| 1 Base plate 340x250 mm | 1 Uranium glass cube |
| 3 Work templates | 2 Aluminium plates, 0.5 mm |
| 1 Holder for sources and deflecting magnet | 1 Aluminium plate, 1 mm |
| 1 Deflecting magnet | 1 Lead plate, 2 mm, in plastic cover |
| 1 Thorium irradiation module I (weld filler wire) | |

NEW



1006804



U111511

Student Experiment Kits (SEK)

Includes 10 Experiments on the Subject of Radioactivity:

- Determining background radiation
- Determining pulse rates for various radioactive preparations
- Statistical distribution of counter pulses
- Determination of equivalent dose for various radioactive preparations
- Penetrative capacity and range of radiation
- Deflection of alpha and beta radiation by a magnetic field*
- Absorption of alpha rays*
- Absorption of beta rays*
- Absorption of gamma rays*
- Inverse square law

Equipment radioactivity:

1006804 SEK Radioactivity

U111511 Geiger Counter GAMMASCOUT

*additionally required:

1006797 Radiation Cartridge ²²⁶Ra 4 kBq



Deflection of alpha and beta radiation by a magnetic field

Student Experiments

Kröncke Optical System for Student Exercises

The Kröncke optical system provides robust reliability that has been tried and tested for decades and offers all the precision needed for student exercises and practical courses in numerous experiments on ray and wave optics. The experiments are carried out in traditional fashion using the white light of an incandescent lamp, the filament of which can be projected through an adjustable slit to observe interference in particular.

All optical components are mounted in diaphragms with no stems and can easily be adjusted vertically and with precision into the optical light path when mounted on optical riders. Optical riders can freely move on the U-profile rail of an optical bench and can be attached with a minimum of force.

Basic Set for Kröncke Optical System

Contents:

- 1 Optical lamp
- 1 Transformer 12 V, 25 VA
- 1 Optical bench, 1000 mm
- 6 Optical slides
- 2 Clamps
- 2 Converging lenses, $f = 50$ mm
- 2 Converging lenses, $f = 100$ mm
- 2 Converging lenses, $f = 150$ mm
- 1 Converging lens, $f = 300$ mm
- 1 Converging lens, $f = 500$ mm
- 1 Diverging lens, $f = -100$ mm
- 1 Diverging lens, $f = -500$ mm
- 1 Diaphragm with 1 slit
- 1 Diaphragm with 3 slits
- 1 Photograph in slide frame
- 1 Transparent screen
- 1 White screen
- 1 Set of 4 colour filters
- 1 Ruler, 15 mm
- 1 Set of holes arranged to form the number "1"
- 1 Pinhole aperture, $d = 1$ mm
- 1 Pinhole aperture, $d = 6$ mm

U8477120-230
U8477120-115



Please ask for quantity discounts on class sets of 8 pieces or more.

CD-ROM containing all different sets of instructions is included!

Basic Set for Kröncke Optical System (230 V, 50/60 Hz)

U8477120-230

Basic Set for Kröncke Optical System (115 V, 50/60 Hz)

U8477120-115

Ray Optics:

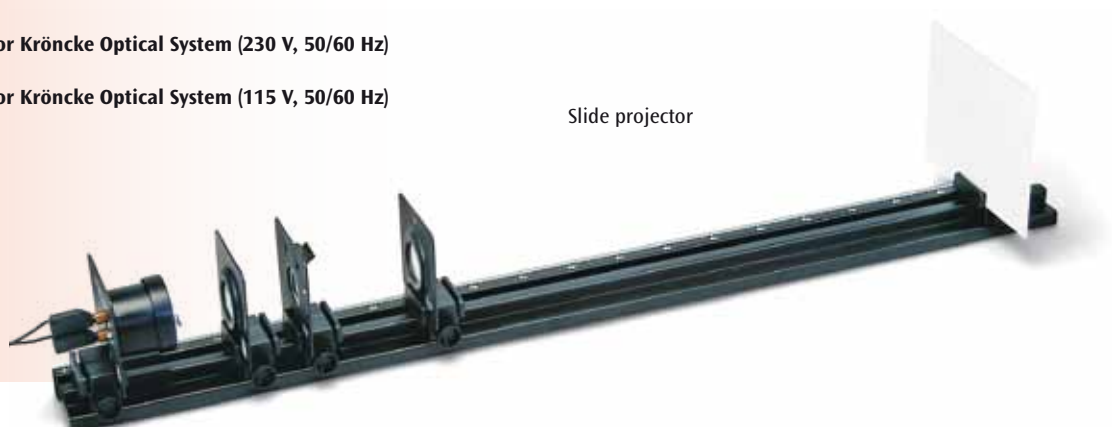
- Pinhole camera
- Imaging with converging lenses
- Image aberrations
- Images in the eye (eye model)
- Correction of vision
- Magnifying glasses
- Microscopes
- Astronomical telescopes
- Terrestrial telescopes
- Slide projectors

Equipment ray optics:

U8477120-230 Basic Set for Kröncke Optical System (230 V, 50/60 Hz)

or

U8477120-115 Basic Set for Kröncke Optical System (115 V, 50/60 Hz)



Slide projector



Visibility of polarised light in turbid water

Polarisation:

- Polarisation of transverse waves
- Polariser and analyser
- Visibility of polarised light in turbid water
- Double refraction
- Rotation of planes of polarisation by a sugar solution

Equipment polarisation:

U8477120-230 Basic Set for Kröncke Optical System (230 V, 50/60 Hz)

or

U8477120-115 Basic Set for Kröncke Optical System (115 V, 50/60 Hz)

U8477140 Supplementary Set for Polarisation



U8477140

Supplementary Set for Polarisation

Supplementary set to the Kröncke optics basic set (U8477120-230 resp. U8477120-115) for carrying out student experiments on the polarisation of light waves.

Contents:

- 1 Pair of polarising filters
- 1 Pinhole aperture, 10 mm
- 1 Rectangular cuvette

U8477140



U8477130

Supplementary Set for Interference

Supplementary set to the Kröncke optics basic set (U8477120-230 resp. U8477120-115) for carrying out student experiments on the interference of light waves.

Contents:

- 1 Optical bench, 500 mm
- 1 Adjustable slit
- 1 Diaphragm with 9 circular discs
- 1 Diaphragm with 9 circular holes
- 1 Diaphragm with 3 individual slits and 1 double slit
- 1 Diaphragm with 4 multiple slits and grating
- 1 Diaphragm with 3 ruled gratings
- 1 Micrometer screw
- 1 Fresnel mirror

U8477130

Interferences:

- Fresnel mirror
- Diffraction by small openings and plates
- Diffraction by an air gap
- Diffraction by the wire
- Diffraction by multiple slits
- Diffraction by the grating
- Optical resolution
- Determining the wavelength of light

Equipment interference:

U8477120-230 Basic Set for Kröncke Optical System (230 V, 50/60 Hz)

or

U8477120-115 Basic Set for Kröncke Optical System (115 V, 50/60 Hz)

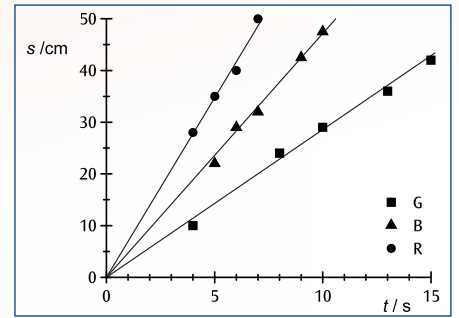
U8477130 Supplementary Set for Interference



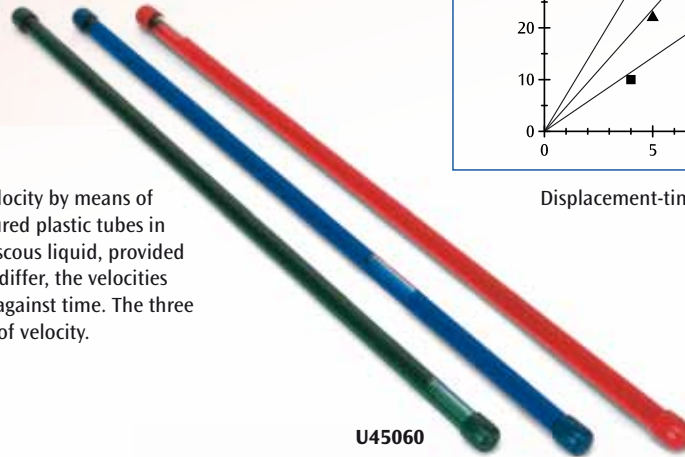
...going one step further

Experiment Topics:

- Displacement-time graphs
- Linear gradients
- Velocity



Displacement-time graph for air bubbles



U45060

Constant Velocity Student Kit

Set of equipment for investigating the concept of velocity by means of student experiments. Consisting of three small coloured plastic tubes in which an air bubble rises at constant velocity in a viscous liquid, provided the tubes are aligned vertically. Since the viscosities differ, the velocities also differ. The position of the air bubble is plotted against time. The three different resulting straight lines lead to a definition of velocity.

Length: 500 mm approx.

Diameter: 13 mm approx.

U45060

Additionally required:

U40801 Mechanical Stop Watch, 15 min

U10073 Pocket Measuring Tape, 2 m

Experiment Topics:

- Determining mass of evacuated air and density of air
- Effect of air pressure on a slightly inflated hot-air balloon and on a suction cap
- Lowering of the boiling point of liquids at decreased air pressure

Effect of air pressure on a slightly inflated balloon



Vacuum Student Kit

Set of equipment for introducing the fundamentals of vacuum physics by means of student experiments.

Contents:

- 1 Experiment plate with washer
- 1 Vacuum bell jar
- 2 Beakers
- 1 Pressure hose with check valve
- 1 Pressure hose with T-connector and check valve
- 1 Simple hand pump in storage container
- 1 Suction cap
- 2 Balloons

U45052

Additionally recommended:

U42048-230 Electronic Scales 200 g (230 V, 50/60 Hz)

or

U42048-115 Electronic Scales 200 g (115 V, 50/60 Hz)



U45052

Experiment Topics:

Colours:

- Coloured light and coloured objects
- Mixture of colours

Shadows:

- Casting shadows
- Coloured shadows

Reflection:

- Reflection from a plane mirror
- Reflected images, image reversal
- Multiple reflections from a mirror
- Reflection from a concave mirror (focal point and spherical aberration)
- Reflection from a parabolic mirror
- Reflection from a convex mirror

Refraction:

- Determining refractive index with a semi-circular object
- Determining refractive index with a parallel block
- Angle of minimum deflection for a prism
- Total internal reflection in a semi-circular object
- Total internal reflection in a prism
- Focal point of a converging lens
- Focal point of a diverging lens
- Spherical aberration

Light Box

Set of equipment for optical experiments to be carried out on a table, consisting of a light box in a sturdy plastic housing and numerous optical components. Complete set in sturdy wooden storage case. The light box has four light outlets: the two side outlets have two hinged mirrors for experiments on colour mixing and shadows. All openings are equipped with mounts for optical components in 50x50 mm² slide frames. Parallel, convergent and divergent light can be generated by adjusting a converging lens attached in front of the lamp. There are two double-sided slit diaphragms available so that four different beam configurations can be created.

Lamp: 12 V, 36 W
 Connections: 4-mm socket
 Light box: 175x100x65 mm³ approx.
 Storage case: 250x240x100 mm³ approx.

U30011

Contents:

- | | |
|---|--|
| 1 Light box | 1 Semi-circular object (transparent acrylic) |
| 8 Colour charts | 1 60° prism (transparent acrylic) |
| 1 Plane mirror (glass) | 1 Asymmetrical 90° prism (transparent acrylic) |
| 1 Concave mirror (metal) | 1 Symmetrical 90° prism (transparent acrylic) |
| 1 Convex mirror (metal) | 2 Slit diaphragms |
| 1 Bi-convex lens, large (transparent acrylic) | 8 Colour filters (in slide frame) |
| 1 Bi-convex lens, small (transparent acrylic) | 1 Pair of connector leads with 4-mm plugs |
| 1 Bi-concave lens (transparent acrylic) | 1 Spare lamp |
| 1 Parallel plate (transparent acrylic) | |

Optikit

Inexpensive set of optical components of cardboard to create instruments such as telescope, spectroscope, microscope and pinhole camera.

Contents:

- 3 tubes
- 1 eyepiece $f = +30$ mm
- 1 plane-convex lens, $f = +180$ mm, 38 mm diam.
- 1 biconvex lens, $f = +30$ mm, 16 mm diam.
- 1 shutter
- 1 grating 140 r/mm
- 1 slit
- 5 diaphragms with 0.8 to 20 mm diam.

U29618



U30011

Additionally required:

- U13900-230 Transformer 12 V, 60 VA (230 V, 50/60 Hz)
- or
- U13900-115 Transformer 12 V DC, 60 VA (115 V, 50/60 Hz)

Spare Lamp for Light Box (not shown)

Spare lamp for light box, 12 V, 36 W.

U30039



U29618

Enhance your lessons with a multitude of easily conducted experiments using the GASTEC gas detector.



GASTEC Gas Detector

Easy to use gas detector for analysing gas content in the atmosphere. For use in countless fundamental experiments. Includes hand pump and accessories for pumping air into specific test tubes, from which the gas content can be read off by means of the degree of coloration of the adsorption material.

Contents:

- 1 Hand pump for pumping in samples
- 1 Break-off tip for test tubes
- 1 Set of 10 pairs of protective rubber stoppers
- 1 Sealing grease
- 1 Carrying case
- 1 Teaching poster with suggested experiments, many illustrations and detailed instructions

W11730

Additionally required:

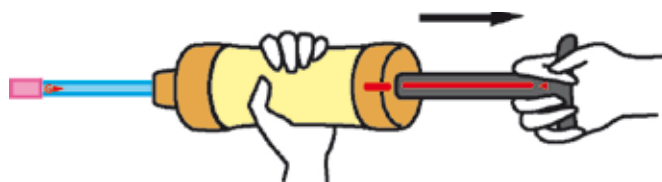
- W11731 Set of 10 CO₂ Test Tubes, 0.03 – 1.00% by vol.**
or
- 1012526 Set of 10 CO₂ Test Tubes, 0.5 – 8.0% by vol.**
or
- W11733 Set of 10 O₂ Test Tubes, 6 – 24% by vol.**

Experiments:

- Analysis of stuffy and of fresh air in a room.
- Investigation of how carbon dioxide and oxygen content changes in the atmosphere due to the following processes:
 - Burning of a candle.
 - Breathing of people and animals.
 - Photosynthesis of plants.
 - Burning of organic substances.

Gas Analysis Made Child's Play:

- Open glass test tube using the tip to break off both ends and close the ends using protective rubber stoppers.
- Push the test tube into the hand pump and hold it at the required position.
- Suck air into the tube using the pump and wait 30 seconds.
- Take the test tube out of the hand pump and read off the gas content from the degree of coloration.



Set of 10 CO₂ Test Tubes, 0.03 – 1.00% by vol. (not shown)
Set of 10 test tubes for the GASTEC gas detector, used for detecting changes in carbon dioxide content in the atmosphere due to combustion processes, for comparison of fresh and stuffy air or observing photosynthesis in plants.

W11731

Set of 10 CO₂ Test Tubes, 0.5 – 8.0% by vol. (not shown)
Set of 10 test tubes for the GASTEC gas detector, used for detecting changes in carbon dioxide content in the atmosphere due to combustion of organic materials or the breathing of people and animals.

1012526

Set of 10 O₂ Test Tubes, 6 – 24% by vol. (not shown)
Set of 10 test tubes for the GASTEC gas detector, used for detecting oxygen content of air in the atmosphere.

W11733

Set of 10 Pairs of Protective Rubber Stoppers (not shown)
Set of spares including 10 pairs of protective rubber stoppers for test tubes used with the GASTEC gas detector.

W11734

NEW



W11730

NEW



U40624

“Renewable Energy” Kit

Inexpensive modular equipment set for investigating the functioning of a complete system for renewable energy. Consisting of a wind turbine, solar module, electrolyser, fuel cell, motor with propeller and voltage display. Includes a battery box as an alternative power supply to the fuel cell. Batteries not included. Some components must be assembled by the user.

Contents:

- 1 Wind turbine on mast
- 1 Electrolyser
- 1 Fuel cell
- 1 Solar cell
- 1 Motor with propeller
- 1 Voltage display with 2 LEDs
- 1 Gas reservoir for hydrogen
- 1 Gas reservoir for oxygen
- 2-mm experiment leads, connecting tubes and accessories

U40624

Additionally required:
2 Batteries, 1,5 V AA
Distilled water



U40624



The experiment case for fuel cells allows students to gradually investigate the world of fuel cells and solar-hydrogen technology in many illustrative and quantitative experiments.



Experiment Topics:

- Current-voltage curve of a solar cell.
- Power curve and efficiency of a solar cell.
- Current-voltage curve of a PEM electrolyser
- Energy efficiency and Faraday efficiency of a PEM electrolyser
- Current-voltage curve of a PEM fuel cell
- Power curve of a PEM fuel cell
- Current-voltage curve of a direct methanol fuel cell

U109551

Fuel Cell Experiment Case

Solar-hydrogen cell system and accessories for carrying out student experiments. In storage case with foam inlay.

Contents:

- 1 Solar-hydrogen cell system (U109501, refer to p. 108) consisting of solar module, PEM electrolyser, hydrogen and oxygen reservoirs, PEM fuel cell and fan
- 1 Resistor decade with maximum load capacity of 1 W
- 2 Multimeters
- 3 Connector leads, 50 cm, red
- 3 Connector leads, 50 cm, black
- 1 Stop watch
- 250 ml Distilled water
- 1 Storage case

U109551



U109551



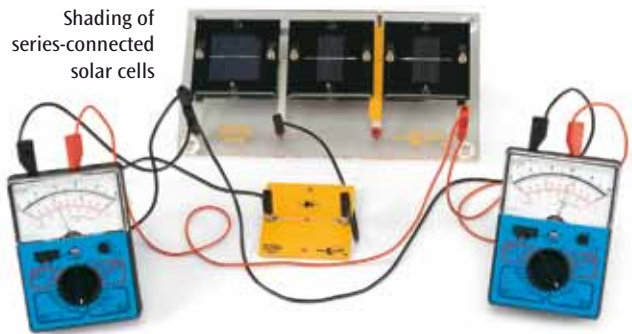
The set of photovoltaic equipment can be used for numerous qualitative and quantitative student experiments on the subject of photovoltaics for secondary school teaching. The supplementary set “Measuring without instruments” opens up a wide field of scientific experiments at pre-secondary level.

Photovoltaics:

- Series and parallel connection of solar cells
- Output of solar cell depending on the surface
- Output of solar cell depending on the angle of incidence of light
- Output of solar cell depending on the brightness of the illumination
- Efficiency of energy conversion
- Internal resistance of solar cells
- Diode nature of solar cells
- Current-voltage curve and bulk factor of solar cells
- Output of solar cells depending on temperature
- Shading of solar cells
- Output of solar cells depending on frequency of incident light

Equipment:

- U10970 Photovoltaics Equipment Set
- U17450 Analogue Multimeter (2x)
- U13800 Set of 15 Experiment Leads, 75 cm



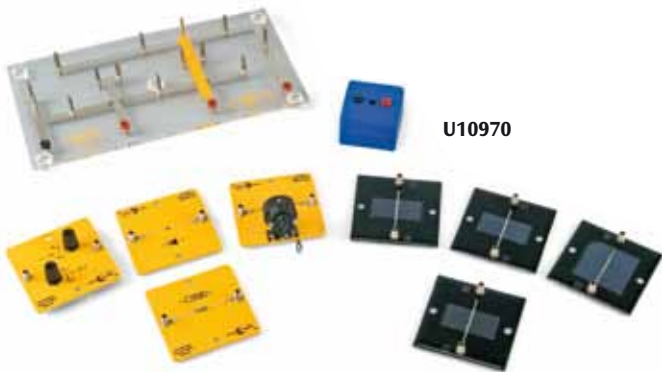
Photovoltaics Equipment Set

Set of equipment on the topic of photovoltaics for one student workplace. Includes storage container with inlays and circuit diagram overlay.

Contents:

- 1 Basic unit
- 1 Circuit diagram
- 3 Solar cells 50x25 mm²
- 1 Solar cell 50x50 mm²
- 1 Lighting module
- 1 Diode module
- 1 Motor module
- 1 Potentiometer module
- 1 Resistor module
- 4 Plastic covers and colour filters

U10970



U10970



U10972

Supplementary Set “Measurement without Measuring Devices”

Supplement to the photovoltaic equipment set (U10970) for student experiments at pre-secondary level.

Contents:

- 1 Plug-in horn
- 1 Plug-in incandescent lamp
- 1 Plug-in motor
- 1 Set of 8 rotary discs including holder

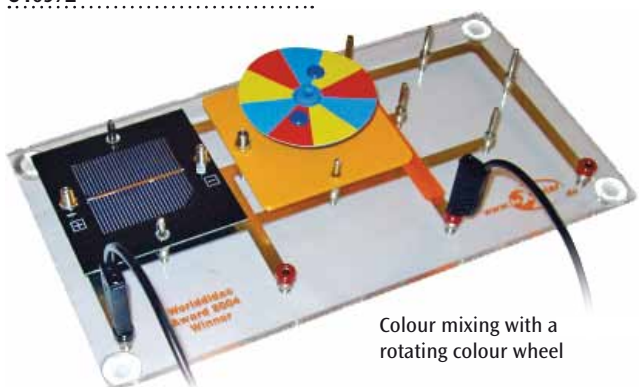
U10972

Simple Experiments on Electricity and Optics:

- Electrical loads
- Series and parallel connection of incandescent lamps
- Direction of rotation and velocity of an electric motor
- Brightness
- Diffuse radiation
- Albedo radiation
- Rotating discs
- Colour mixing
- Colour illusions

Equipment:

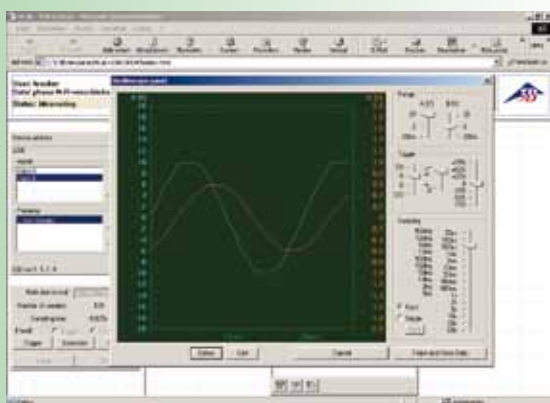
- U10970 Photovoltaics Equipment Set
- U10972 Supplementary Set “Measuring without Instruments”
- 2 Experiment Leads from U13800



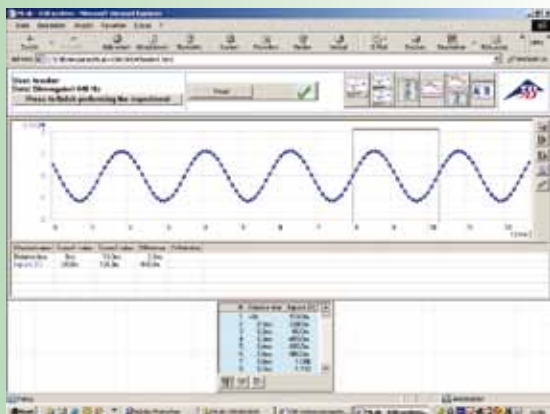
Colour mixing with a rotating colour wheel

3B NETlab™:

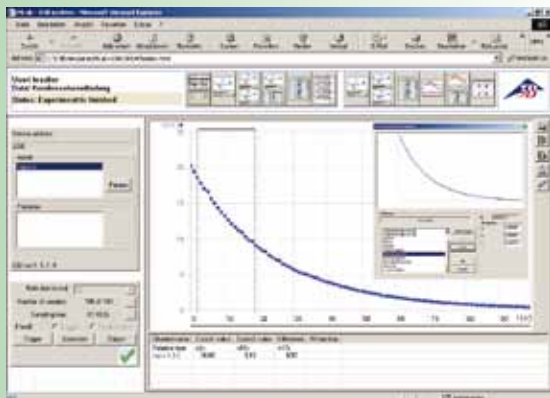
- Comprehensive range of data processing functions, including tangents, integration, curve matching, all kinds of formula calculations and interpolation.
- Data acquisition with date and time of each measurement.
- Recording and processing several series of measurements.
- Presentation of data in the form of graphs or tables, analogue or digital multimeter functions.
- Easy configuration of sensor and experiments on the basis of predefined experiment files.
- Text windows for comments about the experiment.
- Support for analogue and digital sensors.
- Automatic identification of sensors.



Oscilloscope: Voltage phase shift in RL series resonant circuit



Sound amplitude of a tuning fork as a function of time



Discharge curve of a capacitor

3B NETlab™

3B NETlab™ is a data acquisition and data processing program for the 3B NETlog™ interface that can also be operated in a network. As it is based on ActiveX technology, all the available functions can be integrated into web pages that can be displayed and used with the Microsoft Internet Explorer browser. The main function of 3B NETlab™ is computer aided experimentation for science education. For that purpose, a large number of experiment instructions are available in the form of web pages. Users can navigate through these in the same way as they would browse the Internet and all the operations can be controlled with the help of facilities incorporated into the web pages at appropriate points. Experiment Instructions for carrying out experiments can also be written by teachers using standard HTML tools and the programming environment made available for the purpose. All kinds of Internet tools and technologies, such as multimedia sequences, animations, films, etc. can be incorporated into the experiment files. A software measuring lab is available for solo experimentation that utilizes all the functions of the functions of 3B NETlog™ interface device. A wide range of graphical tools is available for processing experimental data. Thanks to its networking capability, 3B NETlab™ is ideally suited for use in schools. It enables teachers to check on the status and results of students' experiments from their own desk. Conversely, an experiment that is being carried out by the teacher can be followed by students on their own monitor screens.

U11310.....

Licensing:

3B NETlab™ contains a specified location license for the normal use of the computer program throughout a school or educational establishment, including the preparation of school or student work at home.

System requirements:

- Windows 2000/XP Prof. (SP3) with Internet Explorer 7, Vista Business (SP2) with Internet Explorer 7, Win 7 Prof. with Internet Explorer 8
- Intel Pentium III / AMD Athlon 600 MHz or higher
- 128 MB RAM
- 100 MB free hard-disk space
- Monitor with a resolution of 1024x768 pixels or higher
- USB port



3B NETlog™

3B NETlog™ can be used as an interface for data acquisition linked to a computer, or as a hand held instrument with a data-logger for measurements of current and voltage or in combination with various sensors. It incorporates sensor connectors with automatic identification of sensors. It can be connected to a computer via USB. Can optionally be connected via Ethernet to the same sub-net of an Intranet. Includes USB cable and installation CD with data transfer program and plug in power supply.

Channels: 2 Differential amplifiers (A and B)
 Measuring ranges: 0 – ±200 mV, 0 – ±2 V, 0 – ±20 V
 Connectors: Two twin 4 mm safety sockets

Current input:
 Channel: Parallel to A
 Measuring ranges: 0 – ±200 mA, 0 – ±2 A
 Connector: One twin 4 mm safety socket

Analogue sensor inputs:
 Channels: 2 (A and B)
 Connectors: Two 8-pin miniDIN sockets
 Sensor identification and calibration: Automatic
 Triggering: Quasi-continuous
 Sampling rate: 50 kilosamples/s
 Resolution: 12 bit

Voltage outputs:
 Channels: 2 (A' and B'), with common ground connection
 Voltage amplitude: 0 – ±5 V
 Connectors: Two twin 4 mm safety sockets

Analogue sensor outputs:
 Channels: 2 (A' and B')
 Connectors: Two 8 pin miniDIN sockets
 Sampling rate: 10 kilosamples/s
 Resolution: 12 bit

Digital Inputs:
 Channels: 4 (A, B, C, D)
 A: TTL
 B: TTL, high-speed sampling rate, 100 kilosamples/s
 C, D: High-speed optical coupler (galvanically isolated)
 Connector: One 8 pin miniDIN socket

Digital outputs:
 Channels: 6 (A', B', C', D', E', F')
 Signal: TTL
 Connector: One 8 pin miniDIN socket

Additional data:
 Computer connection: USB port
 Internal data storage: 128 k
 Monitor display: Large display (64x122) for data on all channels
 Power supply: 4.5 V DC/300 mA or 3 batteries LR6 AA alternatively 3 NiCd or 3 NiMH rechargeable batteries

3B NETlog™ (230 V, 50/60 Hz)

U11300-230

3B NETlog™ (115 V, 50/60 Hz)

U11300-115

3B NETlog™ with Ethernet Port (230 V, 50/60 Hz)

1000009

3B NETlog™ with Ethernet Port (115 V, 50/60 Hz)

1000541



NEW



1009955
1009954



U8533380



U11365

Photo Gate

Infrared photo gate for triggering the 3B NET/log™ unit (U11300-230 resp. U11300-115) or a digital counter (U8533341-230 resp. U8533341-115). For time measurements in experiments on free fall, motion on a track or pendulum oscillations and for counting pulses. It can be operated in internal mode using the built-in infra-red light source or in external mode with the aid of a laser pointer, which needs to be obtained separately. It then acts as a wide-range light barrier, allowing it to be used at sporting events, for example. The gate includes an operational indicator light, stand rod with screw thread, M6 bolt for attachment to a roller track (U35000) and connector lead with 8 pin miniDIN plugs.

- Barrier spacing: 82 mm
- Rise time: 60 ns
- Spatial resolution: < 1 mm
- Time resolution: 0.1 ms

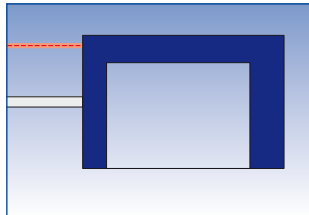
U11365

Additionally required for attaching multiple light barriers to 3B NET/log™ unit:

U11377 Digital Input Box

Also recommended for use connecting of photo gate to external digital counters:

- 1009955 Connector Box (230 V, 50/60 Hz)
- 1009954 Connector Box (115 V, 50/60 Hz)



Connector Box

Connector box for use in connecting light barrier (U11365) or laser reflection sensor (U8533380) to external digital counters. Includes plug-in power supply 12 V AC.

- Input: 8-pin miniDIN socket
- Output: Two 4-mm safety sockets

Connector Box (230 V, 50/60 Hz)

1009955

Connector Box (115 V, 50/60 Hz)

1009954

Laser Reflection Sensor

Sensor for triggering the 3B NET/log™ unit (U11300-230 resp. U11300-115) or a digital counter (U8533341-230 resp. U8533341-115) in time measurements on moving objects. Suitable for opto electronic scanning of light and dark markings on moving objects or in conjunction with a reflecting foil to form a wide spaced obstruction sensor. The intensity of the laser beam is adjusted automatically according to the distance of the object. Includes reflecting foil, stand rod with screw thread and connector lead with 8 pin miniDIN plugs.

- Maximum range: 2.5 m
- Laser power: <1 mW
- Laser protection class: II

U8533380

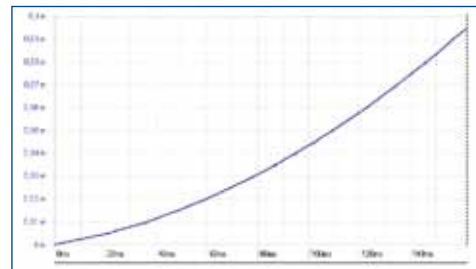
Additionally required for attaching multiple laser reflection sensors to 3B NET/log™ unit:

U11377 Digital Input Box

Also recommended for use connecting laser reflection sensor to external digital counters:

- 1009955 Connector Box (230 V, 50/60 Hz)
- 1009954 Connector Box (115 V, 50/60 Hz)

Computer Aided Experimentation



Distance travelled as a function of time

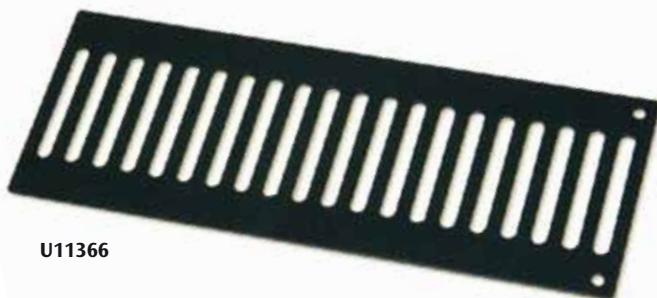


Picket Fence

Aluminium strip with 21 openings for determining gravitational acceleration g from time intervals recorded for a light beam passing through the individual openings of the strip as it falls freely past the beam. Anodised sheet aluminium with two holes for suspension of additional weights to demonstrate that the acceleration is independent of the mass.

- Distance between rungs: 10 mm
- Dimensions: 205x75 mm² approx.

U11366



U11366

Measurement of free fall using a picket fence



U11361



U11371

U11354



Ultrasonic Motion Sensor

Sensor for the measurement of unidimensional motion, e.g. on an air cushion track or in free fall. Can be used in conjunction with a 3B NET/log™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes connector lead with 8 pin miniDIN plugs and grill for protection against falling objects.

- Measurement range: 0.15 m to about 11 m
- Resolution: 2 mm
- Accuracy: ±1%
- Sensor type: Electrostatic 50 kHz converter
- Sampling frequency: 10 Hz

U11361

Acceleration Sensor, ±25g

Sensor for the measurement of unidimensional collisions and all kinds of high acceleration motion. Can be used in conjunction with 3B NET/log™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes connector lead with 8 pin miniDIN plugs.

- Measurement range: 0 – ±250 m/s²
- Resolution: 0.2 m/s²
- Accuracy: ±1%
- Sensor cable: 2 m
- Sensor type: Capacitive acceleration sensor

U11362

Displacement Sensor

Sensor with rotating wheel for detecting displacement via a string. Includes stand rod with thread and connector lead with 8-pin miniDIN plugs.

- Wheel: 24 mm diam.
- Maximum displacement: 66 mm approx.
- Displacement resolution: 1/6 mm approx.

U11371

Force Sensor, ±50 N

Force sensor for the measurement of unidimensional forces, with tare function. Can be used in conjunction with a 3B NET/log™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes connector lead with 8 pin miniDIN plugs.

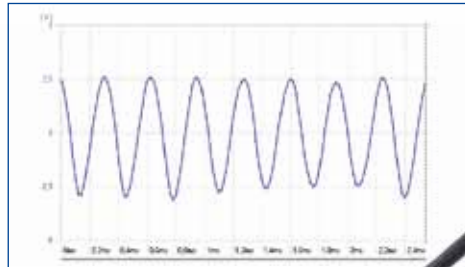
- Measurement ranges: 0 – ±5 N, 0 – ±50 N
- Accuracy: ±1%
- Sensor type: Metal strip strain gauges

U11354

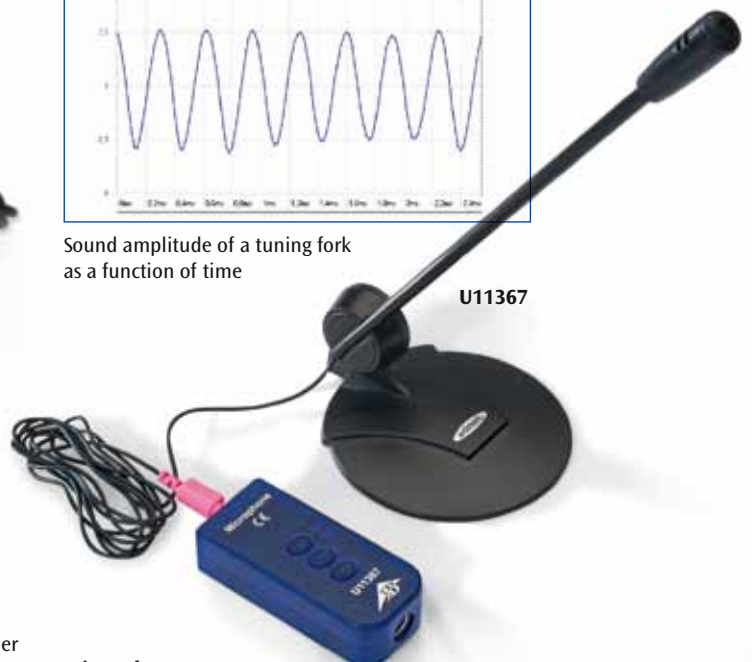


U11362

U11363



Sound amplitude of a tuning fork as a function of time



U11367

Acceleration Sensor, ±5g

Sensor for the measurement of unidimensional acceleration, e.g. of a rider on an air cushion track, of a coil spring pendulum or of a lift. Can be used in conjunction with 3B NET/log™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes connector lead with 8 pin miniDIN plugs.

- Measurement range: 0 – ±50 m/s²
- Resolution: 0.03 m/s²
- Accuracy: ±1%
- Sensor cable: 2 m
- Sensor type: Capacitive acceleration sensor

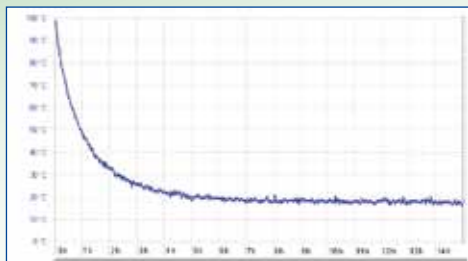
U11363

Microphone

Sensor for the measurement of the relative acoustic pressure or for plotting sound wave patterns, e.g. of voices or musical instruments. With built in electret microphone. Can be used in conjunction with a 3B NET/log™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes connector lead with 8 pin miniDIN plugs.

- Frequency range: 50 Hz – 20 kHz
- Microphone cable: 2 m

U11367



Fall in temperature as a function of time



Demonstration of Newton's law of cooling

UV-A/B Sensor

Sensor box with built-in photodiode for measurements in the UV A/UV B spectra. For use in conjunction with 3B NETlog™ unit (U11300-230 resp. U11300-115) for manual measurements or measurement acquisition via computer. Includes screw-in aperture, UV-A filter (SCHOTT UG-1) and connector lead with 8-pin miniDIN plugs.

Measuring ranges: 0 – 70 mW/m², 0 – 7 W/m², 0 – 700 W/m²

Max. spectral sensitivity: 21 mA/W approx. at 300 nm

Filter level

for visible light: 50

Sensor type: Titanium dioxide Schottky diode with built-in filter for visible light

U11369



U11360

Temperature Sensor, TC – K

Temperature sensor for the measurement of extremely low and extremely high temperatures, for example in liquid nitrogen or liquid oxygen, or inside a flame. With room temperature compensation. The immersible NiCr-Ni sensors (U11854 and U11855) can also be connected to the sensor box. Can be used in conjunction with a 3B NETlog™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes connector lead with 8 pin miniDIN plugs.

Measurement range: -270°C to 400°C

Accuracy: 0.2% plus 3°C (-270°C – 0°C)

0.1% plus 2°C (0°C – 400°C)

Resolution: 1°C

Sensor type: NiCr-Ni (type K)

Sensor length: 60 cm approx.

U11331



U11369



U11331



3B Scientific® Physics



U11330



1009922

Temperature Sensor, Pt100

Temperature sensor for the measurement of temperatures in organic liquids, solutions of salts, acids, and bases. The stem and tip of the temperature sensor are of stainless steel. Can be used in conjunction with 3B NETlog™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes connector lead with 8 pin miniDIN plugs.

Measurement range: -50°C – 150°C

Resolution: 0.1° C

Accuracy: 0.1% of measured value plus 0.25°C

Sensor cable: 1 m, with silicone insulation

Sensor type: Pt100 thermocouple

U11330

Temperature Sensor, Pt100 with Measurement Terminal

Temperature sensor for the measurement of temperatures on the copper tubing of a heat pump (U8440600-230/U8440600-115). Temperature sensor shaft made of rust-proof stainless steel. Tip with matching copper terminal. Can be used in conjunction with 3B NETlog™ unit (U11300-230) for manual measurements or for processing measurement data when connected to a computer. Includes connector lead with 8 pin miniDIN plugs.

Measurement range: -50°C – 150°C

Resolution: 0.1° C

Accuracy: 0.1% of measured value plus 0.25°C

Sensor cable: 1 m, with silicone insulation

Sensor type: Pt100 thermocouple

1009922

Magnetic Field Sensor ±2000 mT

Sensor for the measurement of magnetic flux density in the tangential direction. Can be used in conjunction with 3B NETlog™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes connector lead with 8 pin miniDIN plugs.

Measurement ranges:

0 – ±200 mT,

0 – ±2000 mT

Resolution: 0.1 mT, 1 mT

Accuracy: ±1.5%

Sensor type: Linearised Hall sensor

1009941

Magnetic Field Sensor ±100 mT

Sensor for the measurement of magnetic flux density in the tangential direction. Can be used in conjunction with 3B NETlog™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes connector lead with 8 pin miniDIN plugs.

Measurement ranges:

0 – ±2 mT,

0 – ±20 mT,

0 – ±100 mT

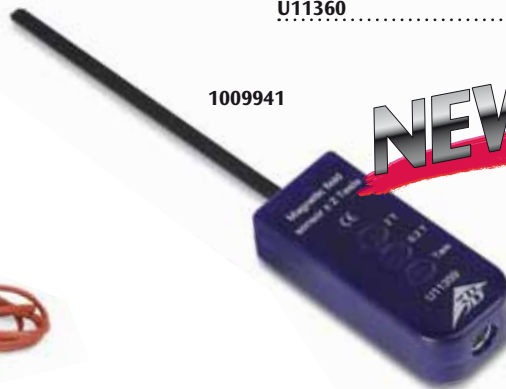
Resolution: 0.01 mT, 0.1 mT,

1 mT

Accuracy: ±1.5%

Sensor type: Linearised Hall sensor

U11360



1009941

U11315



High Current Sensor, 10 A

Sensor for the measurement of high electric currents in DC and AC circuits using a shunt resistor. Capable of withstanding loads up to 20 A for short periods. Can be used in conjunction with a 3B NET/log™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes connector lead with 8 pin miniDIN plugs.

Measurement range: 0 – ±10 A
 Max. current loading: ±20 A for 15 s
 Accuracy: <1%
 Sensor type: Shunt resistor,
 5 mΩ/2 W

U11315

Humidity Sensor

Sensor for the measurement of relative humidity (RH). Suitable for weather studies and for monitoring conditions in a greenhouse or terrarium. Can be used in conjunction with a 3B NET/log™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes connector lead with 8 pin miniDIN plugs.

Measurement range: 0 – 95%
 (non condensing)
 Sensor type: Capacitive sensor
 Accuracy: 3% of RH plus 1% in the range from 0% – 95%
 5% of RH plus 1% in the range from 0% – 5%
 Resolution: 0.1%
 Response time: 15 s

U11336

Absolute Pressure Sensor, 2500 hPa

Sensor for the measurement of absolute pressure, e.g. in experiments on the Boyle-Mariotte law. Can also be used for measuring the production of O₂ during photosynthesis and for experiments on transpiration in closed systems. Can be used in conjunction with a 3B NET/log™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes plastic syringe, silicone tube, and connector lead with 8 pin miniDIN plugs.

Measurement range: 0 – 2500 hPa
 Accuracy: ±1%
 Resolution: 1 hPa
 Sensor type: Semiconductor sensor
 Hose nipple: 4 mm diam.
 Plastic syringe: 20 ml
 Silicone tube: 1 m

U11320



U11320



U11336

Electrometer Box

Impedance converter with high input resistance for the measurement of very small charges and currents. Can be used in conjunction with a 3B NET/log™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes connector lead with 8 pin miniDIN plugs.

Input resistance: ≥ 10¹¹ Ω
 Measurement error: ≤ 1.5%
 Connectors: 4 mm sockets

U11375

Relative Pressure Sensor, ±100 hPa

Sensor for the measurement of relative pressure, e.g. the hydrostatic pressure in a column of water or the pressure difference in a Stirling engine D (U8440450). Can be used in conjunction with a 3B NET/log™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes silicone tube and connector lead with 8 pin miniDIN plugs.

Measurement range: 0 – ±100 hPa
 Accuracy: ±1%
 Sensor type: Semiconductor
 Hose nipple: 4 mm diam.
 Silicone tube: 1 m

U11321



U11323

U11375



U11325



Barometer

Sensor for the measurement of atmospheric pressure. Can be used in conjunction with a 3B NET/log™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes silicone tube and connector lead with 8-pin miniDIN plugs.

Measurement range: 700 hPa – 1200 hPa
 Resolution: 0.1 hPa
 Accuracy: 1.5% of the maximum value of the measuring range
 Sensor type: Semiconductor sensor

U11325

Relative Pressure Sensor, ±1000 hPa

Sensor for the measurement of relative pressure, e.g. the pressure difference in the Stirling motor G (U10050). Can be used in conjunction with 3B NET/log™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes silicone tube and connector lead with 8 pin miniDIN plugs.

Measurement range: 0 – ±1000 hPa
 Accuracy: ±1%
 Sensor type: Semiconductor
 Hose nipple: 4 mm diam.
 Silicone tube: 1 m

U11323



U11321



U11396

Important note: Our sensors for use with the 3B NETlog™ system are exclusively intended for educational purposes. No measurements obtained with them may be used for diagnosing the health of any individual.



U11395

ECG/EMG Box

Sensor box for reading electrocardiograms (ECGs) and electromyograms (EMGs) on skeletal musculature in three standard leads as defined by Einthoven. Feeds can be selected at the press of a button and are indicated by LEDs. For use in conjunction with a 3B NETlog™ unit (U11300-230 resp. U11300-115) for manual measurements or for computer-linked measurements. A connecting lead with 8-pin miniDIN plugs is included.

Input resistance: > 10 MΩ
Output voltage: max. ±1 V
Blocked frequency: 50 – 60 Hz

U11396

Set of Electrodes for ECG/EMG

Set of electrodes for ECG/EMG box for single use.

U11398



U11398

Blood Pressure Sensor

Sensor box for measuring blood pressure of a test subject using the oscillometric method with the aid of a cuff to fit around the extremities. It is possible to determine the highest systolic and lowest diastolic pressures, evaluation of pulse rate by means of an acoustic sensor and illustrate the Korotkov sound. For use in conjunction with a 3B NETlog™ unit (U11300-230 resp. U11300-115) for manual measurements or for computer-linked measurements. A connecting lead with 8-pin miniDIN plugs is included.

Pressure range: 0 mm Hg to 300 mm Hg (0 to 400 hPa)
Overload-proof: up to 1500 hPa
Sensor type: Precision pressure sensor, calibrated and temperature compensated

U11395

Light Sensor

Light sensor for the measurement of luminous intensity. Can be used in conjunction with a 3B NETlog™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes connector lead with 8 pin miniDIN plugs.

Measurement ranges: 0 – 600 lux, 0 – 6000 lux, 0 – 150,000 lux
Resolution: 0.8 lux, 8 lux, 200 lux

U11364



U11364

U11393



U11393



U11392

U11392



Skin Resistance Box

Sensor for measuring the resistance of a person's skin as influenced by external factors (stress, "lie detection"). Designed to conform to the latest safety requirements. Can be used in conjunction with a 3B NETlog™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes connector lead with 8 pin miniDIN plugs.

Measurement range: 1 MΩ – 10 MΩ
Input resistance: >100 kΩ
Safety category: Safety class II, classification BF

U11393

Human Pulse Sensor Box

Sensor for measuring frequency of the human pulse at an earlobe or fingertip using an infrared signal transmitter clip. Automatic adjustment of signal level. Designed to conform to the latest safety requirements. Can be used in conjunction with a 3B NETlog™ unit (U11300-230 resp. U11300-115) for processing measurement data when connected to a computer. Includes connector lead with 8 pin miniDIN plugs.

Measurement range: Pulse rates from 40 – 160 beats/min
Safety category: Safety class II, classification BF

U11392

Set of 3 Conductivity Standards

Set of 3 conductivity standards with conductivities 147, 1413 and 12880 $\mu\text{S}/\text{cm}$, each with a volume of 0.5 l.

U11334

Quinhydrone Buffer Solution (not shown)

Ready-to-use buffer solution with a pH of 7.00 for use with redox sensor.
Volume: 250 ml per container

U11352

pH-Sensor

Sensor for the measurement of pH values and redox potentials in aqueous solutions. Can be used in conjunction with a 3B NET/og™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes connector lead with 8 pin miniDIN plugs.

Measurement range: pH 0 – 14

Sensor type: Ag-AgCl combination electrode, gel filled, not refillable

Accuracy: pH 0.05 in range from 20°C – 25°C

Resolution: pH 0.01

Response time: ≤ 1 s to reach 95% of final value

U11350

Additionally recommended:

U11351 Buffer Solution

Buffer Solution

Set of buffer solutions in three flasks with pH values of 4.00, 7.00 and 9.00.

Volume: 250 ml each

U11351

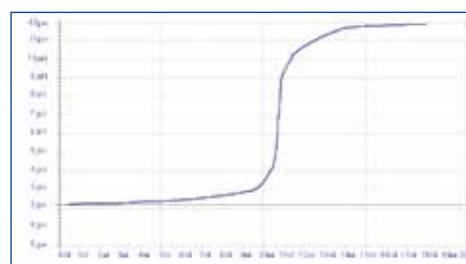
U11351

U11334



Sensors

Determination of the pH value of an aqueous solution



Titration of acetic acid solution with sodium hydroxide solution



U11350

U11335

Conductivity Sensor

Sensor for measuring the specific electrical conductivity of liquid media, the total concentration of dissolved substances and the diffusion of ions through membranes, and for showing the difference in conductivity between ionic and molecular compounds and between strong and weak acids. The accessories supplied include a calibrating solution. Can be used in conjunction with a 3B NET/og™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes connector lead with 8 pin miniDIN plugs.

Measurement ranges: 0 – 200 μS , 0 – 2 mS, 0 – 20 mS

Resolution: 1 μS , 10 μS , 100 μS

Sensor type: measurement electrode using four wire technology, with graphite cells and integrated Pt100 temperature sensor

Accuracy: 5% without calibration, 0.5% with calibration

Sensor cable: 1.5 m

U11335



U11337

Redox Sensor

Sensor for measuring redox potentials in aqueous solutions. For use in conjunction with 3B NET/og™ unit (U11300-230 resp. U11300-115) for manual measurements or measurement acquisition via computer. Includes connector lead with 8-pin miniDIN plugs.

Measuring range: -450 mV to +1100 mV

Sensor type: Ag/AgCl combined electrode filled with gel, non-refillable

Precision: ± 4.5 mV in a temperature range from 20°C to 25°C

Resolution: 0.9 mV

Response time: ≤ 1 s for 95% of final value

U11337

Additionally recommended:

U11352 Quinhydrone Buffer Solution



U11305-230U11305-115

**3B POWERlog**

Programmable voltage and current source with power output for connection to the two analogue outputs of the 3B NETlog™ unit (U11300-230 resp. U11300-115). Includes plug in power supply and two connector leads with 8 pin miniDIN plugs.

Output power: 6 W
 Current: 0 – ±1 A
 Voltage: 0 – ±10 V
 Bandwidth: 0 – 50 kHz

3B POWERlog (230 V, 50/60 Hz)

U11305-230

3B POWERlog (115 V, 50/60 Hz)

U11305-115

Additionally required:

U11310 3B NETlab™

U11300-230 3B NETlog™ (230 V, 50/60 Hz)

or

U11300-115 3B NETlog™ (115 V, 50/60 Hz)

or

1000009 3B NETlog™ with Ethernet Port (230 V, 50/60 Hz)

or

1000541 3B NETlog™ with Ethernet Port (230 V, 50/60 Hz)



U11377



U11376

Digital Output Box

Output box for connecting the digital outputs A, B, C and D of the 3B NETlog™ unit (U11300-230 resp. U11300-115) to four pairs of 4 mm safety sockets. Includes connector lead with 8 pin miniDIN plugs.

Output signal: TTL level
 Connectors: 4 mm safety sockets

U11376

Digital Input Box

Input box for connecting the digital inputs A, B, C and D of the 3B NETlog™ unit (U11300-230 resp. U11300-115) to four miniDIN8 sockets. Includes connector lead with 8 pin miniDIN plugs.

Input and output signal: TTL level
 Connectors: 8 pin miniDIN sockets

U11377



U11394

Response Box

Microprocessor-controlled box with a foot switch and three coloured finger-operated buttons (blue, green and red) and a combined LED, which can light up in the same colours as the hand buttons or in white to indicate use of the foot switch. Once the LED has lit up in some arbitrary colour, the response time before the appropriate switch has been activated is measured. For use in conjunction with 3B NETlog™ unit (U11300-230 resp. U11300-115) for manual measurements or measurement acquisition via computer. Includes connector lead with 8-pin miniDIN plugs.

Duration of measurement: max. 9.2 s
 Display resolution: 1/100 s
 Footswitch connector: 3.5 mm jack plug

U11394



U11368

Relay

Power relay with a set of change over contacts for initiating measurements using 3B NETlab™ software. The relay is controlled by the digital output of the 3B NETlog™ unit (U11300-230 resp. U11300-115) and it features both normally open and normally closed contacts. Safe potential separation between coil and contact set in accordance with VDE 0160. The contacts are made of a high performance silver alloy. Includes connector lead with 8 pin miniDIN plugs.

Max. switched voltage: 250 V AC / 220 V DC
 Max. switched current: 6 A AC / 0.12 A DC
 Max. switched power: 1500 VA
 Min. switched power: 1 mW
 Connectors: 4 mm safety sockets

U11368

Additionally required:

U11310 3B NETlab™

U11300-230 3B NETlog™ (230 V, 50/60 Hz)

or

U11300-115 3B NETlog™ (115 V, 50/60 Hz)

or

1000009 3B NETlog™ with Ethernet Port (230 V, 50/60 Hz)

or

1000541 3B NETlog™ with Ethernet Port (230 V, 50/60 Hz)

SW Sensors Set

Set incorporating two dynamometers and an amplifier board for recording and analysing mechanical oscillations using a standard oscilloscope. The dynamometers can be fitted to 10-mm diameter stands or the SW tie bar in order to measure dynamic forces along their axes. The amplifier board converts signals from both dynamometers so that they can be recorded and also evaluates the phase differences between both oscillation signals, outputting them as a DC signal. If the MEC amplifier board is connected to the 2x40 MHz USB oscilloscope (1012879), it is possible to perform detailed analysis and evaluation of measured signals using the oscilloscope software on a PC.

- Dynamometers:
- Maximum force: 5 N
 - Frequency range: 0.3 – 200 Hz
 - Connectors: 3.5-mm jack plugs
 - Dimensions: 52x37x26 mm³
- MEC amplifier board:
- Input sockets: 3.5-mm jack sockets
 - Output sockets: BNC
 - Dimensions: 65x100x40 mm³

Contents:

- 2 Dynamometers
- 1 MEC amplifier board
- 1 Power supply, 12 V AC, 700 mA

SW Sensors Set (230 V, 50/60 Hz)

1012850

SW Sensors Set (115 V, 50/60 Hz)

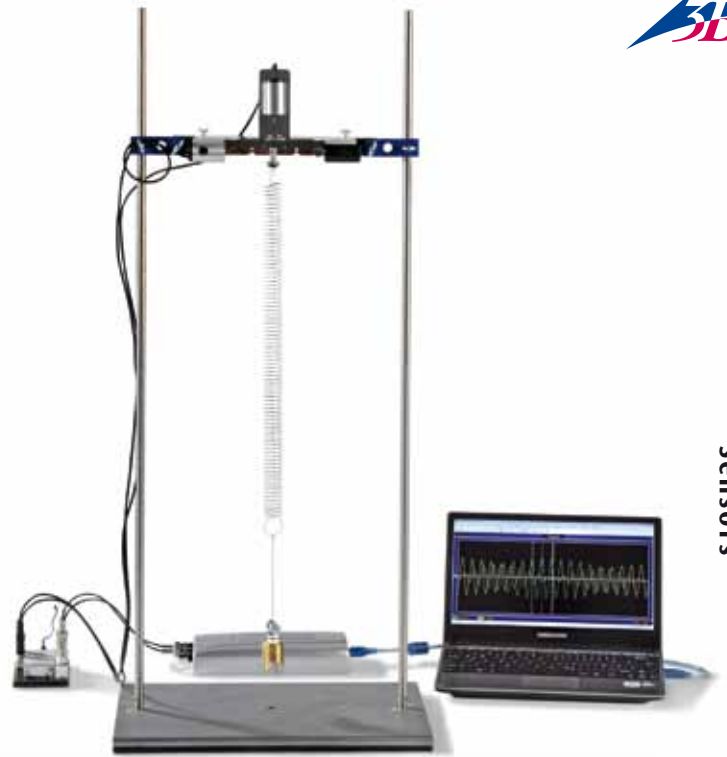
1012851

Additionally recommended:

1012879 USB Oscilloscope 2x40 MHz

or

U33070-230 Analogue Oscilloscope 2x20 MHz



Wilberforce pendulum

Sensors



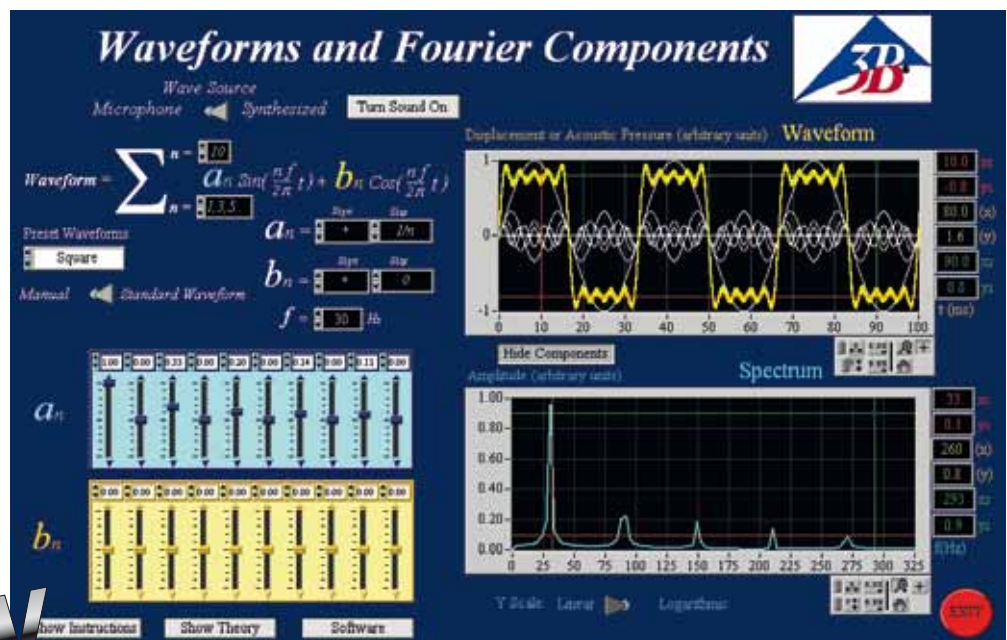
1012850
1012851

NEW

Software for Fourier Analysis

Software for Fourier analysis and synthesis with depiction of waveform and amplitude spectrum. Analysis of audio signals recorded using a microphone and sound card. Synthesis of Fourier components with an arbitrary choice of fundamental frequency for periodic signals. Signals can be listened to on audio. System requirements: Windows XP or higher, 512 MB RAM or higher, 128 MB graphics card or higher, 16 bit sound card or higher, microphone and speaker

1012587



1012587

NEW

Computer Aided Experimentation

Experiment Topics:

- Inclined plane
- Lever laws
- Torques and forces
- Forces acting on a lever arm
- Force as a vector
- Pendulum motion
- Physical pendulum
- Fixed and movable pulleys
- Block and tackle
- Hooke's law
- Coupled resonance
- Centre of gravity
- Friction

BEST SELLER



Mechanics Kit for Whiteboard

The mechanics kit for whiteboard demonstrations includes more than 25 large, coloured and easily distinguished components stored in a case with foam inlay. More than 30 experiments can be set up in rapid time.

- Large components ensure that experiments can be viewed from a distance.
- Secure attachment is guaranteed by high-grade AlNiCo magnets.
- Quick and easy configuration of experiments.
- Measuring units, vector diagrams and explanations can be provided right next to the experimental configuration on the blackboard.

U8400040

Additionally required:

U10030 Whiteboard, 600x900 mm²

or

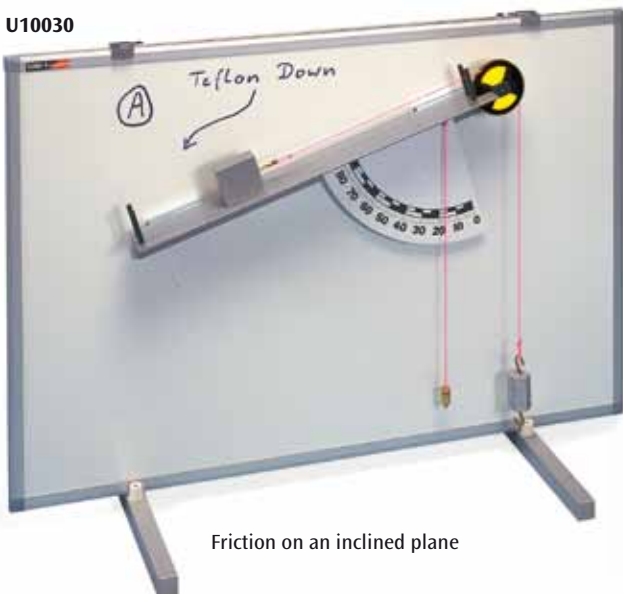
U10031 Whiteboard, 900x1200 mm²

Contents:

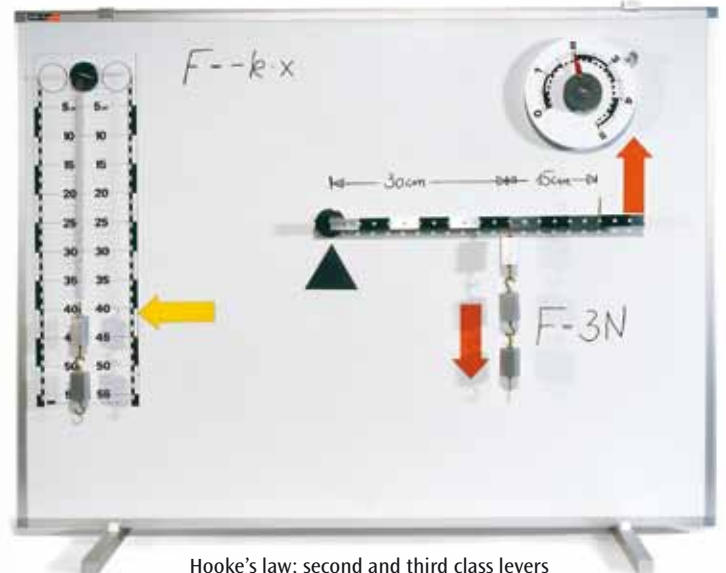
- 1 Inclined plane with pulley and angle scale
- 1 Rolling mass, 500 g
- 1 Lever with 20 holes, 545 mm long
- 1 Pointer for lever, 400 mm long
- 1 Slotted counterweight with knurled screw, approx. 20 g
- 1 Pulley, double, 70 mm diam., 40 mm diam.
- 1 Pulley, 70 mm diam.
- 1 Pulley, 40 mm diam.
- 2 Round scale dynamometers, 5 N
- 3 Magnetic tabs with 8 mm axis
- 3 Springs with hook, $k = 6.2 \text{ N/m}$
- 1 Dual scale on a magnetic foil, 600x180 mm²
- 4 Arrows and one equilateral triangle on a magnetic foil
- 6 Weights with 2 hooks, 100 g each
- 1 Friction block
- 1 Set of nylon cords
- 1 Centre-of-gravity plate
- 1 Plumb
- 3 Rubber grommets
- 3 Brass hook
- 1 Brass clip
- 1 Storage case
- 1 Manual

U10031

U10030



Friction on an inclined plane



Hooke's law; second and third class levers

Mechanical Cumulative Stopwatch

Cumulative stopwatch with start, stop and reset buttons in shock-resistant plastic casing. Dual dial for minutes and seconds. With pendant cord.

Measuring range: 15 min
Scale accuracy: 1/10 s
Diameter: 55 mm

U11901



U11901

Mechanical Stopwatches

Stopwatch in stainless steel casing with dual dial for minutes and seconds. In pouch with pendant cord.

Art. No.	Measuring range	Reading accuracy	Diameter
U40800	30 min	0.2 sec	45 mm
U40801	15 min	0.1 sec	45 mm



U40801

U40800

BEST SELLER

Digital Stopwatch

Stopwatch with 7-digit LCD display in robust plastic casing with start/stop and split/reset buttons for starting and stopping, cumulative, lap-time and dual-time measurement. Includes pendant cord.

Measuring range: 9 h, 59 min, 59 s, 99/100 s
Accuracy: 1/100 s
Battery: button cell 1.55 V, Type 389
Dimensions: approx. 65x65x18 mm³

U11902



U11902



U16100



U11900

Digital Timer

We recommend the use of the digital timer (U8533341-230 or U8533341-115) along with one or two photo gates (U11365) for reliable measurement of the time a carriage on a track takes to cover a distance or when it obscures the light sensors. Also suitable for measuring oscillation periods of a swinging pendulum or similarly the times when it obscures the sensors. As an alternative to a light barrier, a laser reflection sensor (U8533380) can also be used for the opto-electronic sampling of light and dark markings on moving objects or can be used as a long-distance light barrier when connected in conjunction with reflective foil.

Digital Timer (230 V, 50/60 Hz)

U8533341-230

or

Digital Timer (115 V, 50/60 Hz)

U8533341-115

Photo Gate

U11365

or

Laser Reflection Sensor

U8533380



U8533380



U8533341-230
U8533341-115



U11365

U8611210

For measuring times when, e.g. a swinging pendulum obscures a sensor

Vertical Ruler, 1 m

Ruler with fastening pin (d = 12 mm) so that it can be set up vertically in a stand base. Scale as per U8401550.

U8401560



U8401570

U8401560

U8611200

Pocket Measuring Tape, 2 m

Made of spring band steel, with locking button and rewinding spring.

Length: 2 m / 79 inch
Scales: cm, mm / 1/32 inch

U10073



U10073

U8401550



Ruler, 1 m

Wooden ruler with mm scale on one side and two-coloured cm scale on the reverse.

Cross section: 25x8 mm²

U8401550



U10070

External Micrometer

Precision micrometer with thimble and locking system. Measuring surfaces coated with hardened metal, polished with fine lapping. Tempered measuring spindle with polished thread, chromed micrometer arc with insulation, scale drum and sleeve in matt-chrome finish. In plastic pouch.

Measuring range: 0 – 25 mm
Graduation: 0,01 mm

U10070

Precision Spherometer

For measuring plate thicknesses, depressions and radii of curvature of spherical surfaces, for example, lenses. The device consists of a tripod with three steel tips which form an equilateral triangle. A micrometer screw with a measuring tip is recessed in the middle. Attached to the micrometer screw is a disc with circular divisions from 0 to 500 and a vertical scale with millimeter divisions from -10 to 15 mm at the tripod.

Measuring ranges: 0 – 25 mm and -10 – 15 mm
Screw pitch: 0,5 mm
Measuring accuracy: 0,001 mm
Support spacing: 50 mm

U15030

Additionally recommended:
U21885 Plane Mirror

U14200U14201

Callipers S

Inexpensive callipers with 125 mm scale suitable for measuring internal and external dimensions and depths.

U29625



U29625

Set of Riders for Rulers

The set of riders consists of two red plastic pointers to match rulers U8401550 and U8401560 that can be used as movable cursors.

Dimensions: 120x40x20 mm³

U8401570

Digital Callipers, 150 mm

For measuring internal and external dimensions and depth. Tempered stainless steel, LCD display. Including locking screw, adjustment from cm to inch, zero-calibration in any position, with plastic pouch.

Measuring range: 150 mm / 6 inch

Graduation: 0,01 mm / 1/128 inch

Display: 5-digit LCD, 6 mm

U10072



U10072



U10071

Callipers, 150 mm

Precision callipers for measuring internal and external dimensions and depth. Tempered stainless steel, precision polished measuring surfaces, gauge with matt-chrome finish. In imitation leather pouch.

Measuring range: 150 mm / 6 inch

Graduation: 1/20 mm / 1/128 inch

U10071

U15030



Watch Glasses from **U14200** and **U14201**

Callipers Model

Model of a set of callipers suitable for measuring internal and external dimensions and depths of up to 300 mm.
Dimensions: 420x195 mm²

U29622



U29622

Vernier Model

For demonstrating Vernier readings on length measuring devices and protractors.

Length: 600 mm

Vernier length: 260 mm

Height: 190 mm

U15035



U15035



U30041

U30042

Wooden Rulers

These wooden rulers are a classroom staple.

Wooden Ruler, 1 m, Set of 10

U30041

Wooden Ruler, 0.5 m, Set of 10

U30042

U8404550

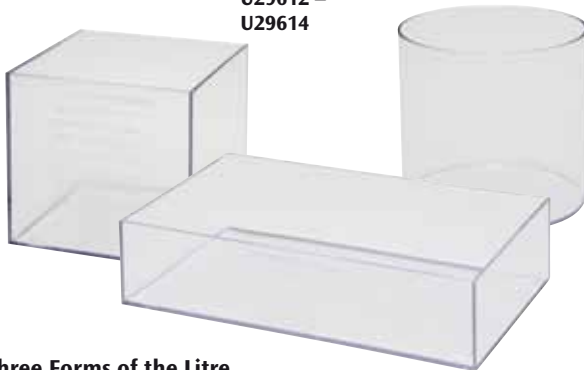


Object for Measurement Exercises

Irregularly shaped body, which is especially well suited for practising measurement using Vernier callipers.

U8404550

U29612 –
U29614



Three Forms of the Litre

Fully transparent; the graduations are engraved.

Art. No.	Designation	Inner Dimensions
U29612	Graduated Cube 1l	approx. 100x100x100 mm ³
U29613	Graduated Cuboid 1l	approx. 200x100x50 mm ³
U29614	Graduated Cylinder 1l	approx. 100 mm Ø x 120 mm

Set of 1-Litre Bodies

Set of equipment consisting of 5 transparent hollow bodies with engraved volume scale.

Cylinder, 1 l	100 mm (diam.) x 120 mm approx.
Cylinder, 0.5 l	75 mm (diam.) x 115 mm approx.
Cylinder, 1 l	160 mm (diam.) x 50 mm approx.
Cube, 1 l	100x100x100 mm ³ approx.
Cuboid, 1 l	200x100x50 mm ³ approx.

1012882



1012882

Vessel with Overflow, metal

Vessel with overflow, 900 ml, made of metal.

U30080



U30080

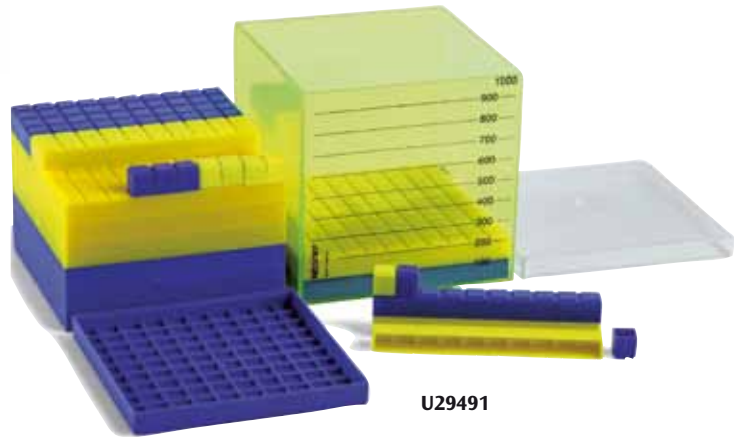
Vessel with Overflow, Transparent

Vessel with overflow, 275 ml, made of Plexiglas.

U8411310



U8411310



U29491

Broken Down Cubic Decimetre

Transparent and graduated cube of 100x100x100 mm³ with contents:

9 cuboids, 100 cm³ (4 yellows and 5 blues)

9 cuboids, 10 cm³ (4 yellows and 5 blues)

10 cubes, 1 cm³ (5 yellows and 5 blues)

U29491



U11010 – U11013

Dynamometer, Transparent

Dynamometer with easily read scale printed on a transparent plastic sleeve. Suitable for projection using a projector. With protection against over extension of the spring.

Precision: ±3% of total measuring range
 Length: 185 mm
 Scale length: 60 mm

Art. No.	Measuring Range	Scale Division
U11010	1 N	0.02 N
U11011	2 N	0.04 N
U11012	5 N	0.1 N
U11013	10 N	0.2 N

Dynamometer with Round Dial

Spring dynamometer for experiment demonstrations. Grooved pulley on ball bearings and cord with hook. Large, easily read round dial. Zero-point calibration via knurled screw. With magnet for attachment to a whiteboard.

Art. No.	Measuring range	Scale Division
U8402501	1 N	0.02 N
U8402502	2 N	0.05 N
U8402505	5 N	0.1 N
U8402510	10 N	0.1 N



U8402501



U8402502



U8402505



U8402510

Dynamometer, Colour Coded

Colour coded dynamometer for measuring weights or masses as well as forces. Scaled in newtons or grams and kilograms with zero-point calibration.

Art. No.	Colour	Measuring Range	Scale Division
U40810	Blue	250 g / 2.5 N	5 g / 0.05 N
U40811	Green	500 g / 5 N	10 g / 0.1 N
U40812	Brown	1000 g / 10 N	20 g / 0.2 N
U40813	Red	2000 g / 20 N	50 g / 0.5 N
U40814	White	3000 g / 30 N	50 g / 0.5 N
U40815	Yellow	5000 g / 50 N	100 g / 1 N



U40810 – U40815



U20030 – U20038

Precision Dynamometer

Colour coded precision dynamometer in a transparent plastic casing with easy-to-read scale, protection against over extension of the spring and zero-point calibration capability.

Precision: < 1% of total measuring range
 Scale division: 1% of total measuring range
 Dimensions: 280 mm x 16 mm diam.

Art. No.	Colour	Measuring range
U20030	Silver	0.1 N
U20031	Beige	0.2 N
U20032	Yellow	1 N
U20033	Red	2 N
U20034	Blue	5 N
U20035	Green	10 N
U20036	Violet	20 N
U20038	Brown	100 N

Set of Helical Springs for Hooke's Law

5 helical springs with a hook and an attached pointer for determining spring constants

U40816

Spring constant	2.5 N/m	5 N/m	10 N/m	15 N/m	25 N/m
Length	122 mm	145 mm	150 mm	147 mm	142 mm
Diameter	15 mm	15 mm	19 mm	20 mm	20 mm

Additionally recommended:

- U8404760 Set of Slotted Weights 10x10 g, Red and Grey
- U8401560 Vertical Ruler
- U8401570 Set of Riders for Rulers

Dynamometers for Demonstrating Hooke's Law

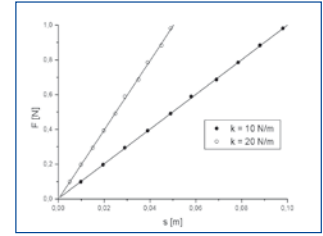
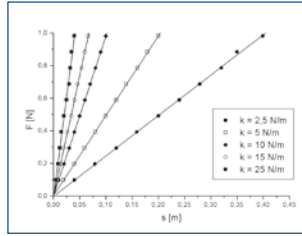
Two colour coded dynamometers in transparent plastic sleeve with easy-to-read cm/mm scale for demonstrating Hooke's law and calculating the spring constant. Protection against over extension of the spring and zero-point calibration.

Spring constants: 10 N/m and 20 N/m
 Length of scale: 115 mm
 Dimensions: 280 mm x 16 mm Ø

U20037

Additionally recommended

- U30031 Set of Slotted Weights 10 g



Helical Springs

Helical Springs

For experiments on expansion and oscillation, with two suspension eyelets.

Art. No.	Spring constant	Maximum loading capacity	Length	Diameter
U8405840	1.5 N/m	0.75 N	120 mm	20 mm
U8405820	2.5 N/m	0.5 N	120 mm	16 mm
U15027	3 N/m	1.5 N	80 mm	32 mm
U8401010	5 N/m	2 N	60 mm	20 mm
U11025	16 N/m	2.5 N	115 mm	6 mm
U11026	43 N/m	6.5 N	110 mm	9 mm
U15028	20 N/m	8.0 N	180 mm	9 mm
U11027	86 N/m	13.5 N	95 mm	10 mm

Set of 10 Weights

Brass weights with hooks on both sides so that they can be suspended from one another.

Set of 10 Weights, 10 g

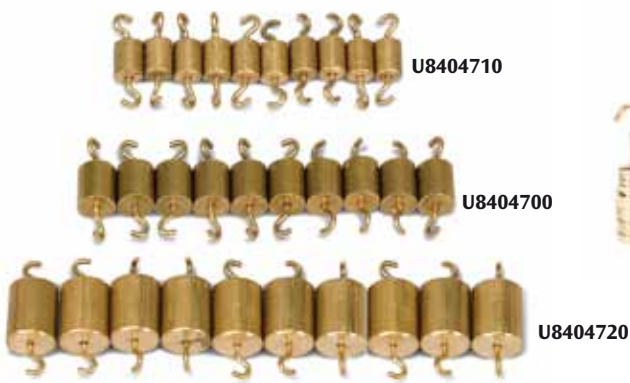
U8404710

Set of 10 Weights, 20 g

U8404700

Set of 10 Weights, 50 g

U8404720



Sets of Slotted Weights on Weight Holder

Slotted brass weights and holder.

Art. No.	Designation	Weights (incl. holder)	Holder diam.
U30030	Set of slotted weights, 20-100 g	2x 5 g, 1x 10 g, 4x 20 g	22 mm
U30031	Set of slotted weights, 10x 10 g	10x 10 g	18 mm
U30033	Set of slotted weights, 5x 50 g	5x 50 g	32 mm
U30032	Set of slotted weights, 5x 100 g	5x 100 g	38 mm

Set of Slotted Weights on Holder, red and grey

Coloured slotted weights with holder for use in experiment demonstrations.

Art. No.	Designation	Weights (incl. holder)	Holder diam.
U8404760	Set of slotted weights, 10x 10 g, red and grey	10x 10 g	25 mm
U8404775	Set of slotted weights, 8x 50 g, red and grey	8x 50 g	25 mm
U8404785	Set of slotted weights, 4x 100 g, red and grey	4x 100 g	25 mm



Set of Weights 10 g to 1000 g

9-piece set of brass weights in storage box, each with hooks on both sides. 1x 10 g, 2x 20 g, 1x 50 g, 1x 100 g, 2x 200 g, 1x 500 g, 1x 1000 g

U30016

Set of Weights, 1 g to 1000 g

13-piece set of brass weights in storage block. 1x 1 g, 2x 2 g, 1x 5 g, 1x 10 g, 2x 20 g, 1x 50 g, 1x 100 g, 2x 200 g, 1x 500 g, 1x 1000 g

U30014

Set of Weights 1 g to 50 g

8-piece set of brass weights, delivered in storage box. 1x 1 g, 2x 2 g, 1x 5 g, 2x 10 g, 1x 20 g, 1x 50 g

U30012

Set of Weights 100 g to 2000 g

7-piece set of weights with hooks. 1x 100 g, 2x 200 g, 1x 500 g, 2x 1000 g, 1x 2000 g

U8671420

Set of Weights 1 g to 500 g, slotted

12-piece set of brass weights on convenient storage rack. 1x 1 g, 2x 2 g, 1x 5 g, 1x 10 g, 2x 20 g, 1x 50g, 1x 100 g, 2x 200 g, 1x 500 g

U30013

Weight Holder, 50 g

Weight holder for weight set U30013.

U30017



Set of Weights 1 g to 500 g

12-piece set of brass weights in storage block. 1x 1 g, 2x 2 g, 1x 5 g, 2x 10 g, 1x 20 g, 1x 50 g, 2x 100 g, 1x 200 g, 1x 500 g

U29576

NEW



U29576

Set of Weights 1 mg to 500 mg

Set of 12 aluminium weights in a plastic box. 1x 0.5 g, 1x 0.2 g, 2x 0.1 g, 1x 0.05 g, 2x 0.02 g, 1x 0.01 g, 1x 5 mg, 2x 2 mg, 1x 1 mg.

U29952



U29952



U30019

Set of Three Weight Holders with Slotted Weights

Slotted brass weights on holder comprising 3 sets with 2x 5 g, 2x 10 g, 2x 20 g, 3x 50 g.

U30019

NEW



U29543

Set of Weights with Hooks

11-piece set of weights with hooks on both sides so that they can be suspended from one another. Tolerance: 10%. 1x 1 g, 2x 2 g, 1x 5 g, 2x 10g, 1x 20 g, 1x 50 g, 2x 100 g, 1x 200 g.

U29543

NEW

Bench Scales, Harvard Junior

Inexpensive and colourful two-pan scales made of plastic. No less stable or accurate than many more expensive scales. With high-precision manufactured metal beam, interchangeable pans and zero adjustment. Includes a set of 8 weights. Built-in interlock to protect against vibration during transport or during long-term storage. Stackable.

Maximum load: 2 kg

Precision: 0.5 g

Pans: 150 mm diam., plastic, shallow and high-sided versions

Set of weights: Set of 8, 370 g

1012872



1012872

Additionally recommended:
U22000 Diode Laser, Red 650 nm



Oscillation about the two equilibrium positions

U40205

Tungsten Wire (not shown)
 Roll of torsion wire for Cavendish torsion balance (U40205).
 Diameter: 25 μm

U40210

Experiment Topics:

- Day and night
- Motion of the sun across the sky
- Seasons
- Changing periods of daylight
- Sundial and the shadow of a gnomon
- Phases of the moon
- Crescent moons of various different widths
- Solar and lunar eclipses and their cycles
- Lunar months and festivals based on lunar periods

Orbit™ Tellurium

Attractive and easy-to-operate three-dimensional model of the sun, moon and earth, for comprehensive demonstration of their motions. Earth and moon in two different sizes in order to demonstrate day and night, motion of the sun across the sky, annual seasons, the changing amounts of daylight, phases of the moon, as well as solar and lunar eclipses and the cycles they exhibit. Shadows have clear edges since the sun is represented by a bright lamp with a Sunbeam™ reflector. As an alternative to turning the whole system together, the rotation of the earth on its axis and the position of the moon in its orbit can be adjusted individually by hand.

Dimensions: 650x250x300 mm

Includes:

Tellurium with earth and moon in two sizes; display cards showing dates, solar eclipses, lunar eclipses and phases of the moon; small figure; sundial; detailed instructions in English; mains transformer, 100–240 V/6V

U19600

Cavendish Torsion Balance

A Cavendish torsion balance demonstrates the force of gravity between two masses and allows the gravitational constant to be determined. Thanks to the short oscillation period of just 2 – 4 minutes, the gravitational constant can be determined within the space of a single lesson with an accuracy of better than 10%. The core of the apparatus is a torsion pendulum made of a light bar with two small lead spheres, which is suspended horizontally from a thin wire. The apparatus is moved from its equilibrium position by the attraction of the two spheres to two larger lead spheres. When the two large spheres are rotated to a new position, the torsion balance will oscillate about a new equilibrium position. The rotary motion is measured using a capacitive differential sensor, which largely suppresses noise and vibration components in the signal. The output is then recorded using a computer. For subsequent evaluation, the data can be exported to a spreadsheet. Alternatively, the motion can be demonstrated with the aid of a light pointer.

- Mass of large lead spheres: 1 kg
- Mass of small lead spheres: 15 g
- Gravitational attraction: $< 10^{-9}$ N
- Torsion wire: Tungsten, 25 μm
- Period of oscillation: 2–4 mins
- Angular resolution: 25 microradians
- Sampling rate: 0.5, 1, 2, 5, 10 samples/s
- Dimensions: 190x180x200 mm³
- Weight: 5 kg

Includes:

- 1 Cavendish torsion balance
- 1 Measurement software
- 1 USB cable

U40205

NEW



U19600

Force Table

Equipment for quantitative investigation of the combination and resolution of forces, consisting of a circular workplate on a stable base with dual protractor scale. Weights from set of three weight holders with slotted weights U30019 (included), are suspended from 3 cords strung over pulleys with ball bearings.

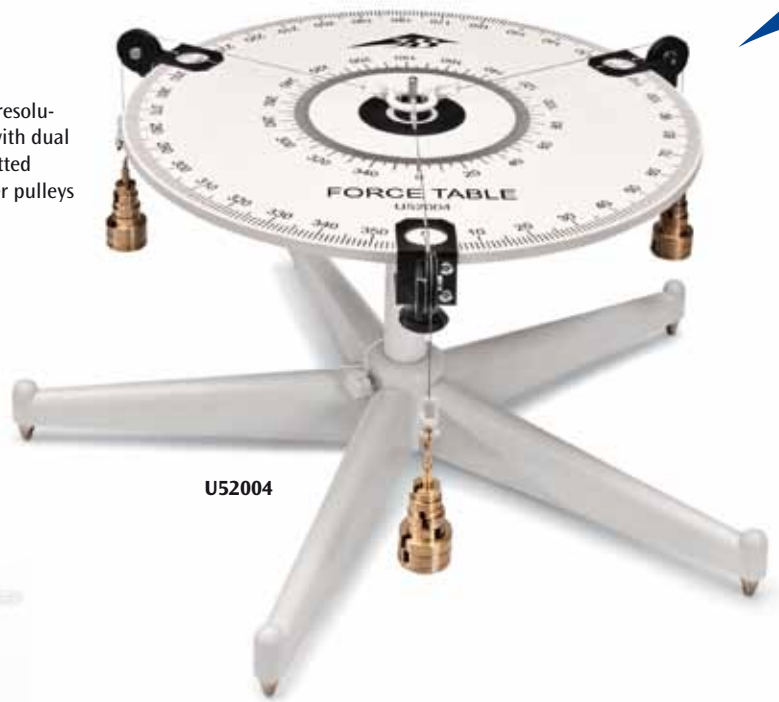
Dimensions: approx. 300 mm x 390 mm Ø

Weight: approx. 3,1 kg

U52004

Additionally recommended:

U52011 Extra Pulley



U52004

Statics



U52011

Extra Pulley

Additional pulley for use with the force table (U52004) with clamp, cord and holder with set of slotted weights 2x 5 g, 2x 10 g, 2x 20 g and 3x 50 g.

U52011



U10074

Universal Spirit Level, 250 mm

Spirit level made of shock resistant plastic for measuring angles to horizontal, vertical and inclined planes and for joinery. With two plexiglass level gauges, resistant to breakage and leakage. Horizontal gauge built-in and accurately calibrated. Gauge for measuring inclination can be rotated and fixed in place. Scale markings for 45°, 60° and 120°, mm scale on measuring surface, protractor scale for inclination gauge.

Scales: 250 mm/1 mm, -90° – +90°/2°

Dimensions: 250x54x15 mm³

U10074

Stability Apparatus

For demonstrating the stability of an object as a function of the position of its centre of gravity above the supporting surface. The position of the centre of gravity can be adjusted by tilting the device. The position of the centre of gravity over the base of the stand is indicated by a built-in plumb bob.

Dimensions: 180x150x290 mm³

U15033



U15033

Centre-of-Gravity Plate

Plastic plate with 6 boreholes for introducing the concept of centre of gravity and determining centroids.

U8409270

Additionally required:

U15015 Plumb with Line



U15015



U8409270

Plumb with Line

Brass body with a line.

Height: 100 mm

Diameter: 20 mm

Weight: 220 g

Line length: 1600 mm

U15015

U15015

Roman Arch Kit

Kit for building a Roman arch, which demonstrates static equilibrium and the resolution of forces in clear fashion. The arch is designed in such a way that the downward and sideways forces are distributed through all of the individual blocks. The kit consists of 23 hardwood blocks of 6 different shapes and a base plate with two supporting pillars. When it is assembled, the arch is capable of supporting the weight of a student.

Supported weight: max. 70 kg

Dimensions: 455x50x180 mm approx.

Weight: 2 kg approx.

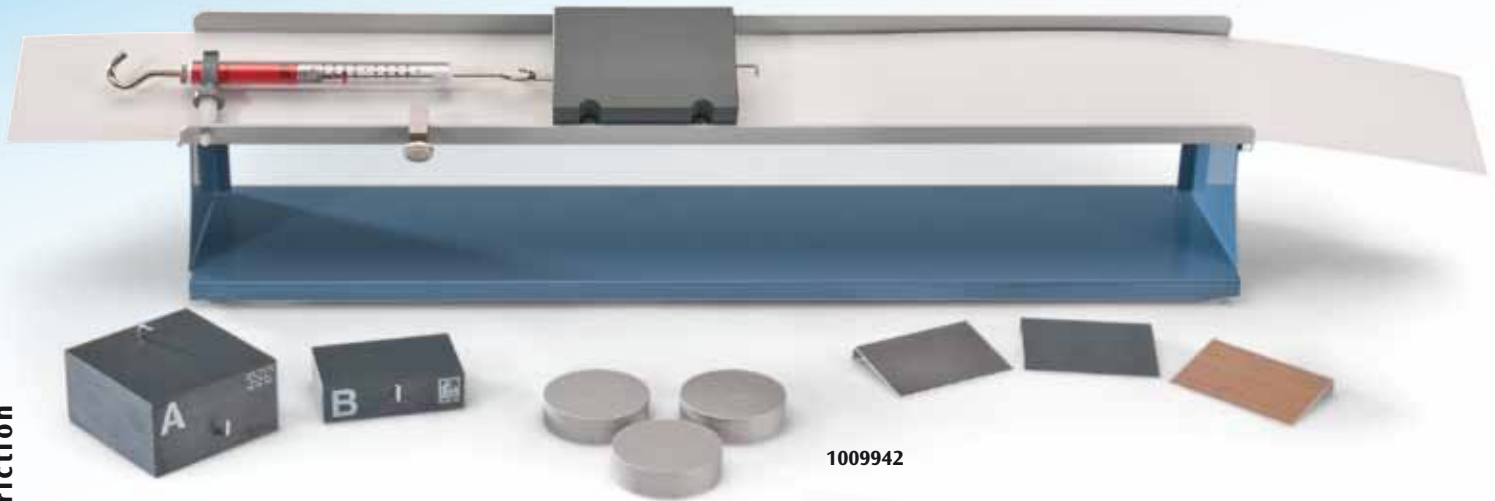
U30090

NEW



U30090

Mechanics



Friction Measuring Apparatus

Demonstration apparatus with movable friction surface for measuring static and dynamic friction between two surfaces as a function of area, force between the surfaces or the combination of materials. For easy measurement of dynamic friction, the movable surface is moved at constant speed under a static body connected to a dynamometer. The friction track can be inclined along its length in order to vary the force between the two surfaces.

Dimensions: 600x140x150 mm³

Weight: 3 kg

Contents:

Basic apparatus with movable friction surface, 2 N dynamometer, three different static bodies, three rails for holding static bodies, three 100 g weights.

1009942



U8409250

Wooden Blocks for Friction Experiments

Two wooden blocks with plastic coated surfaces and hook for attaching a dynamometer.

Dimensions: approx. 120x60x60 mm³ and 120x60x30 mm³

U15026

Additionally recommended:

U20032 Precision Dynamometer, 1 N

U20033 Precision Dynamometer, 2 N

U20035 Precision Dynamometer, 10 N

U30014 Set of Weights, 1 g to 1000 g



U15026

1009942



U20032

U20033

U20035

Precision Dynamometer

Colour coded precision dynamometer in a transparent plastic casing with easy-to-read scale, protection against over extension of the spring and zero-point calibration capability.

Precision: < 1% of total measuring range

Scale division: 1% of total measuring range

Dimensions: 280 mm x 16 mm diam.

Art. No.	Colour	Range
U20032	Yellow	1 N
U20033	Red	2 N
U20035	Green	10 N

Block for Friction Experiments

Aluminium block with a teflon-coated surface and 2 hooks.

Dimensions: 55x50x25 mm³

U8409250



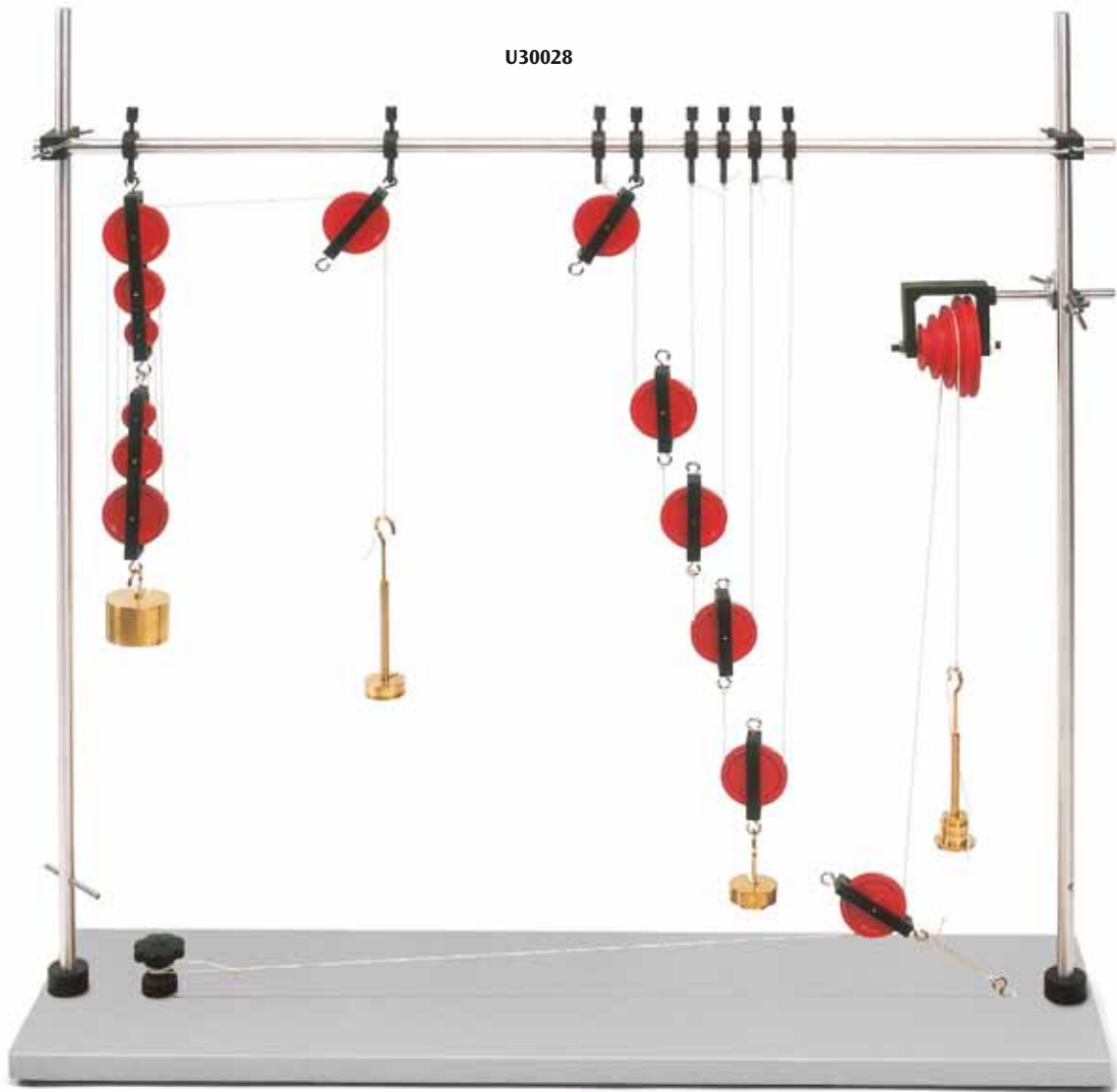
U30014

Set of Weights, 1 g to 1000 g

13-piece set of brass weights in storage block. 1x 1 g, 2x 2 g, 1x 5 g, 1x 10 g, 2x 20 g, 1x 50 g, 1x 100 g, 2x 200 g, 1x 500 g, 1x 1000 g

U30014

U30028



Experiment Set Pulleys and Block and Tackle

For demonstrating how forces can be altered in direction and distributed over an area by simple machines (fixed and movable pulleys, block and tackle) and introducing the concepts of mechanical work, power and energy. Complete set of equipment consisting of a stable base plate, retort stand rods, pulley blocks, block and tackle, a set of pulleys of various diameters on an axle, weight holders, slotted weights and a reel of cord. All the experiments can be set up quickly and easily since the closed plastic frame around the pulleys prevents the cord from slipping.

- Base plate: 810x200 mm²
- Pulleys: 50 mm diam.
- Stand rods: 810 mm x 12,5 mm diam.
- Slotted weights: 2x 10 g, 2x 20 g, 2x 50 g, 4x 100 g, 4x 200 g, 1x 500 g
- Holders: 1x 10 g, 1x 20 g, 5x 50 g

Contents:

- 1 Base plate
- 3 Stand rods
- 2 Plastic clamps
- 1 Universal sleeve
- 8 Hooks
- 7 Pulley blocks with 1 pulley
- 2 Pulley blocks with 4 pulleys
- 2 Tandem pulley blocks with 3 pulleys
- 1 Wheel on axle
- 15 Slotted weights
- 7 Weight holders
- 1 Reel of cord
- 1 Screw pin

U30028

Additionally required:

- U10073 Measuring Tape, 2 m**
- U11012 Dynamometer 5 N**
- U40801 Mechanical Stopwatch, 15 min**



U8724980

Cord for Experiments

Red and white plaited hemp string on a bobbin. For a variety of uses, e.g. setting up block and tackle using pulleys U30020 to U30027 or making a pendulum with bobs U30035.

- Length: 100 m
- Diameter: 1 mm
- Maximum tension: 50 N

U8724980

Pulley with Table Clamp

Pulley for altering the direction of forces. Plastic pulley with ball bearings and cord groove plus securing clamp. Also has a bore so that it can be attached to a retort stand of up to 12.5 mm diameter.

Pulley: 50 mm diam.
Span of bracket: up to 35 mm span

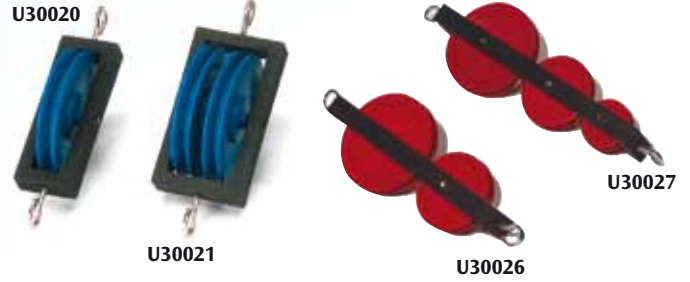
U30025



U30025

Pulleys and Block and Tackle

For experiments with fixed and movable pulleys. Non-deformable, low-friction pulleys with cord grooves and hooks at the ends of both axes for suspending from fixed supports or other pulleys. The enclosed design of the plastic frame prevents the cord from slipping off the pulley.



Art. No.	Designation	Pulleys	Diameter	Material
U30020	Pulley block	1	50 mm	plastic
U30021	Pulley block	2	50 mm	plastic
U30022	Pulley block	3	50 mm	plastic
U30023	Pulley block	4	50 mm	plastic
U30026	Tandem pulley	2	37/50 mm	aluminium
U30027	Tandem pulley	3	25/37/50 mm	aluminium

Experiment Topics:

- Inclined planes
- Uniformly accelerated motion
- Static friction
- Kinetic friction
- Rolling friction
- Elastic and inelastic collisions

Inclined Plane

Equipment for investigating forces acting on a body on an inclined plane, and determining the holding friction as a function of the angle of inclination. Metal base and inclined plane. The plane is hinged with scales for angle, length and height. Angle of inclination can be adjusted between 0 and 45°. Includes adjustable pulley, roller, weight pan and cord.

Length of inclined plane: 600 mm
Length of base: 450 mm
Scales: divided into cm or degrees

U30015

Additionally recommended:
U11013 Dynamometer, 10 N
U30014 Set of Weights 1 g to 1000 g



U30015



U8552001

Lever

Complete set of equipment for demonstrating laws of leverage and for experiments on equilibrium. Consists of a retort stand to which is attached a lever mounted on ball bearings with three rows of holes for adjusting the axis of rotation or for suspending weights, red and white block scale with pointer for accurate display of equilibrium state. Can also be used to model balance scales.

Includes set of weights 10x 50 g.
Length of lever: 1 m
Mass of lever: 0.458 kg
Number of holes: 21
Separation of holes: 50 mm

U8552001



Experiment Topics:

- Regular movements and movements with uniform acceleration
- Newton's laws of motion
- Conservation of energy
- Elastic and inelastic collisions



U35000

Trolley Track

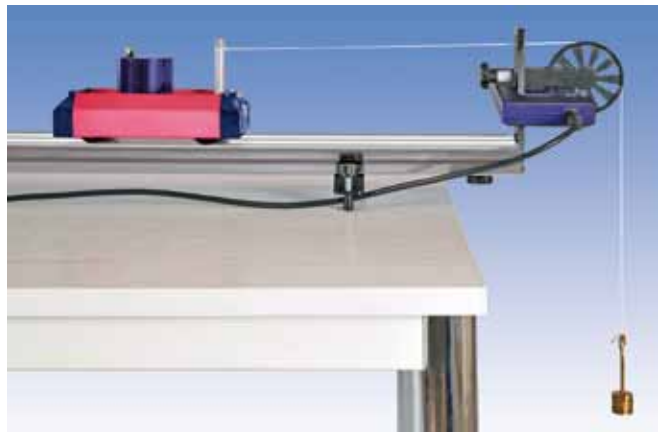
Track with two trolleys and other accessories for investigating linear motion, plus three adjustable point supports for setting horizontal alignment. The trolleys move with minimum friction on wheels with high-quality ball bearings. They are fitted with magnets at their front ends for experiments involving both elastic and inelastic collisions. Including a spoked wheel suitable for use as a pulley with the trolley track. It can be used in combination with a light barrier (U11365) for recording the motion of a trolley.

Mass of trolleys: 500 g
 Length of distance scale: 1800 mm
 Overall length: 1800 mm

Contents:

- 1 Track, 1.8 m
- 1 Two-point support
- 1 Single point support with end stop
- 1 Trolley
- 1 Trolley with interchangeable buffer pad
- 1 Additional weight, 500 g
- 2 Holder for light barrier
- 1 Holder for pulley
- 1 Pulley
- 1 Clamp for stand rods
- 1 Set of contact-breakers
- 1 Set of magnets

U35000



Additionally recommended:

U11365 Photo Gate
U11300-230 3B NETlog™ (230 V, 50/60 Hz)
 or
U11300-115 3B NETlog™ (115 V, 50/60 Hz)

U11361 Ultrasonic Motion Sensor
U11300-230 3B NETlog™ (230 V, 50/60 Hz)
 or
U11300-115 3B NETlog™ (115 V, 50/60 Hz)

U11365 Photo Gate (2x)
U11300-230 3B NETlog™ (230 V, 50/60 Hz)
 or
U11300-115 3B NETlog™ (115 V, 50/60 Hz)

Physics on a small budget



U15014

Set of 6 Steel Balls

Ball bearings made of hardened and polished steel. Can be used with a guide rail for experiments on elastic collisions or in combination with watch glasses to demonstrate various states of equilibrium. Rail not included.

Diameter: 30 mm each
 Weight: 110 g each

U15014

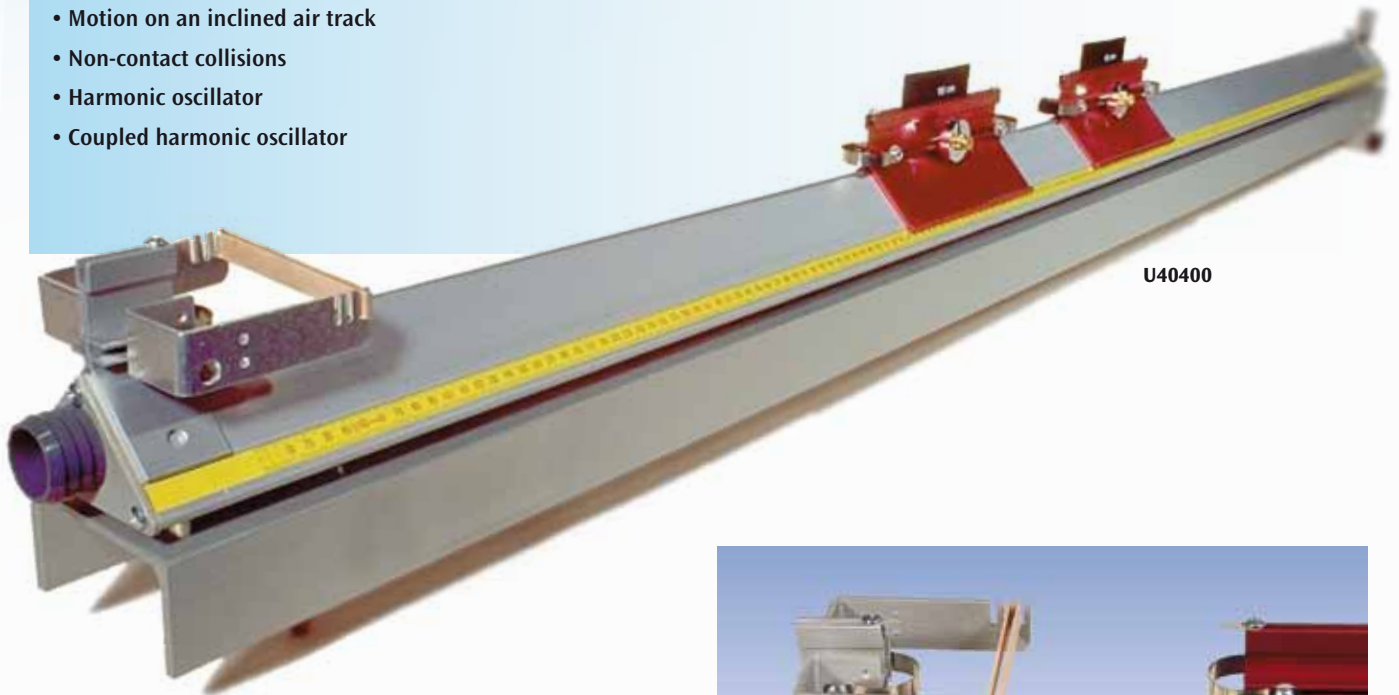
Additionally recommended:
U17150 Optical Bench U, 1200 mm
U14200 Set of 10 Watch Glass Dishes, 80 mm
U14201 Set of 10 Watch Glass Dishes, 125 mm
U21885 Plane Mirror

Experiment Topics:

- Regular movements and movements with uniform acceleration
- Newton's equations of motion
- Laws on the conservation of momentum and energy
- Elastic and inelastic collisions
- Motion on an inclined air track
- Non-contact collisions
- Harmonic oscillator
- Coupled harmonic oscillator

Note:

Air tracks of differing lengths are available on request.



Air Track on U-shaped Base Profile, 1.9 m

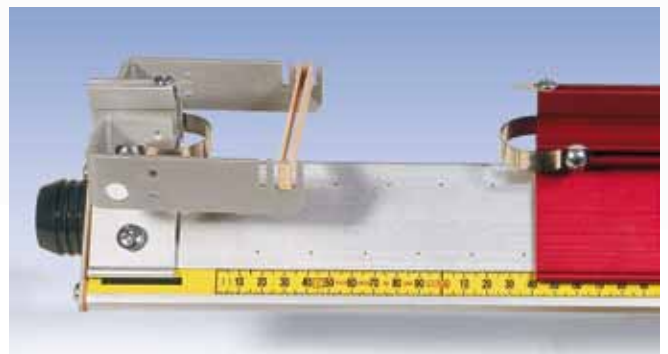
Track with triangular profile and riders for investigating frictionless linear motion. The air is blown in from the front and escapes through small air outlets arranged in 2 rows along the track. This allows for practically frictionless movement of the riders on the triangular track with no tilting. A millimetre rule is set into a groove on one side. Mounted on a robust U-shaped base resting on three feet that can be adjusted to ensure horizontal alignment.

Material:	Anodised aluminium
Total length:	2.07 m
Working length:	1.90 m
Maximum deviation from straight line over complete length:	0.04 mm
Track profile:	Equilateral triangle
Width of base:	94 mm
Sides of triangle:	67 mm
Thickness of walls:	3 mm
Separation of air outlets holes:	24 mm
Base profile:	U-shaped profile
Width of base:	100 mm
Height of base:	50 mm
Wall thickness of base:	5 mm

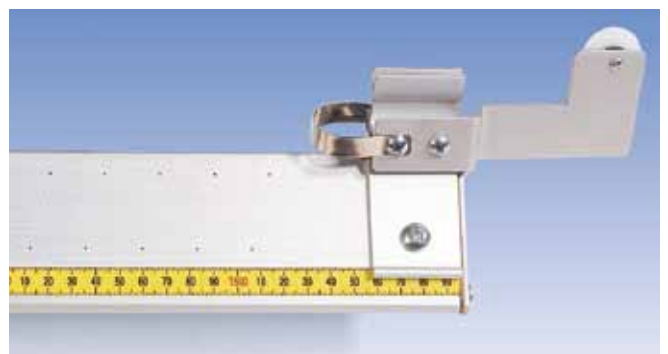
Contents:

- 1 Air track on U-shaped base profile resting on three feet
- 2 Gliders 300 g (red) with additional 50 g weights, spring buffers for elastic collisions and velcro strip for inelastic collisions
- 3 Helical springs, 50 mm, 1.7 N/m
- 2 Velocity flags, 10 cm
- 2 Magnets for contactless impact

U40400



Left-hand end of track with air inlet nozzles and launch mechanism for riders



Right-hand end of track with buffers and pulley

Additionally required:

- U15425-230 Air Flow Generator (230 V, 50/60 Hz)**
- or
- U15425-115 Air Flow Generator (115 V, 50/60 Hz)**

Air Track, 1.6 m

Track with triangular profile and riders for investigating frictionless linear motion. As U40400 with three feet that can be adjusted to ensure horizontal alignment.

Total length: 1.67 m
Operating range: 1.50 m

Contents:

- 1 Air track with a three-point base and adjustment screw
- 1 Glider 150 g (gold) with spring buffers
- 2 Glider 300 g (red) with spring buffers
- 3 Helical springs, 25 mm, 3.3 N/m
- 2 Magnets for contactless collisions
- 1 English operating manual for the air track

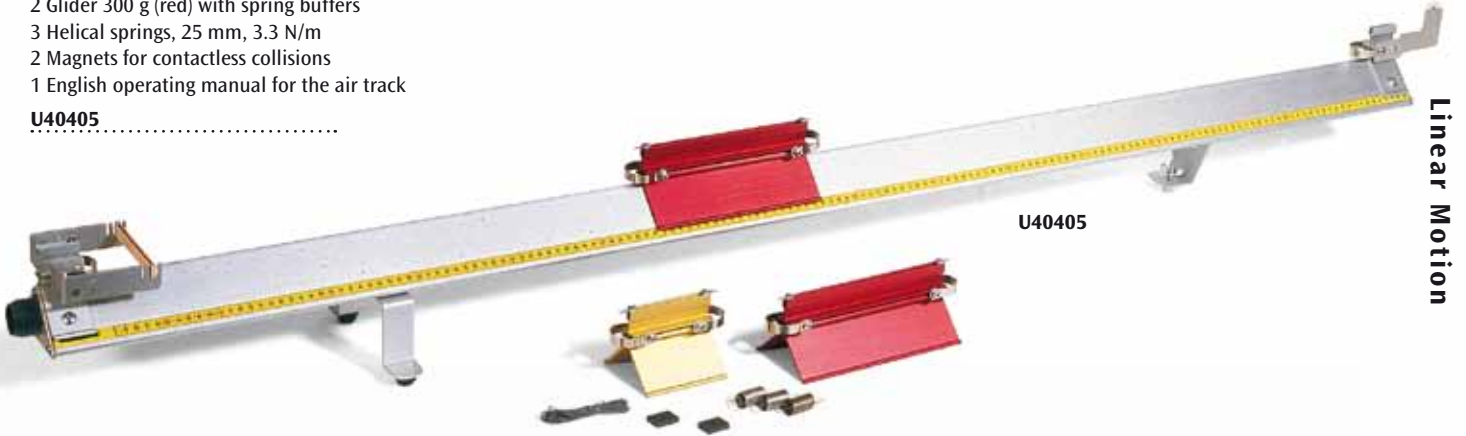
U40405

Coupled Harmonic Oscillator

Equipment set consisting of 5 150 g riders, 6 coupling springs and 5 damping magnets for modelling molecular oscillations using air tracks U40400 or U40405.

Length of springs: 75 mm
Magnets: Ceramic magnets

U40445



U40405

Linear Motion

U40445



U40405



U15425-230
U15425-115

Air Flow Generator

Fan allowing continuous adjustment of air flow. Includes a hose.

Hose length: approx. 1.5 m
Power consumption: max. 1100 W
Dimensions: 300x180x170 mm³
Weight: 4.4 kg

Air Flow Generator (230 V, 50/60 Hz)

U15425-230

Air Flow Generator (115 V, 50/60 Hz)

U15425-115

Accessories:

Art. No.	Designation	Uses
U40420	Glider 150 g (gold)	–
U40421	Glider 300 g (red)	–
U40421	Glider 450 g (blue)	–
U40423	Air Cushion Deflector	Frictionless deflection of accelerated masses
U40424	Set of 20 Bumper Springs	Investigation of elastic collisions
U40425	Set of 20 Soft Bumper Springs	Investigation of the collision process
U40426	Set of 4 Velocity Flags	Trip flags made of aluminium in widths 5 cm, 10 cm, 20 cm and 30 cm
U40427	Set of Magnets	Investigation of collisions with no actual contact
U40431	Inelastic-Collision Accessories	2 Pairs of spring buffers with velcro surface for investigating inelastic collisions
U40511	Set of 4 Riser Blocks	Aluminium base block in heights 3 mm, 6 mm, 13 mm and 26 mm

Mechanics

Experiment Topics:

- Newton's equations of motion
- Conservation of momentum and energy
- Elastic and inelastic collisions between equal and different masses
- Harmonic motion and coupled harmonic motion
- Trajectories
- Magnetic repulsion

Air-Cushion Table

The air-cushion table possesses a flat glass surface serving as a base for recording paper and carbon paper. Compressed air is supplied to the pucks via light hoses. The air emerges from the bottom of the pucks, making them hover over the recording paper. The motion of the pucks is traced by means of spark recording. The air hoses contain thin metal chains via which a connection to the spark generator is established. The sparks jump over from a contact in the centre of the puck, leaving marks on the recording paper. As the pucks weigh 550 grams, their motion is not affected by the hoses or the attached spark wire.

Contents:

- 1 Experiment table with a glass surface, 580x580 mm²
- 1 Spark generator with a footswitch
- 1 Compressor with a hose
- 2 Steel pucks, 75 mm diam., 550 g
- 2 Puck collars with velcro fastener
- 2 Springs
- 1 Auxiliary puck weight, 150 g
- 1 Edge pulley, 45 mm diam.
- 1 Centre rod with sucker
- 1 Set of plotter paper
- 1 Set of special carbon paper
- 1 Operating manual

Air-Cushion Table (230 V 50/60 Hz)

U405001-230

Air-Cushion Table (115 V 50/60 Hz)

U405001-115





U40513

U40514

Acrylic Puck

Acrylic puck for air-cushion table, for use as a second very light puck to demonstrate collisions between unequal masses. A steel puck is hardly deflected at all on collision with an acrylic puck.

Diameter: 75 mm
Weight: 90 g

U40513

Aluminium Puck

Aluminium puck for air-cushion table, for use as a second very light puck to demonstrate collisions between unequal masses.

Diameter: 75 mm
Weight: 210 g

U40514

Pair of Magnetic Pucks

A pair of pucks with extremely powerful magnets positioned such that the pucks repel each other. Intended for performing contactless collisions on the air-cushion table.

U40515

Puck Guide

Long acrylic rod with an internal spring which can be clamped between the inner edges of the air-cushion table. Intended to guide pucks for the purpose of recording harmonic oscillations.

Length: 590 mm

U40510



U40515



U40510

Set of Plotter Paper

100 sheets of printer paper for making pen plots in conjunction with an air-cushion table.

Dimensions: 510x580 mm²

U405121

Additionally required:

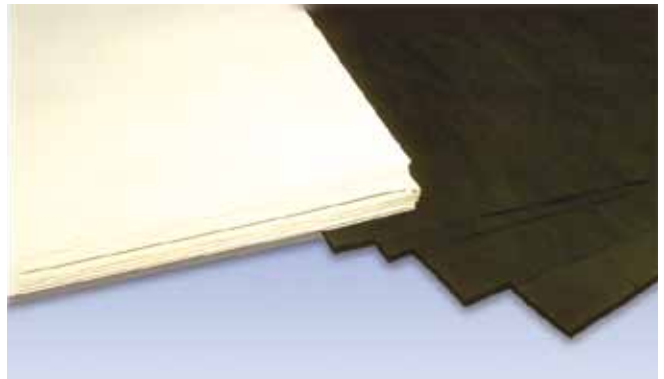
U405161 Set of Special Carbon Paper

Set of Special Carbon Paper

10 sheets of carbon paper.

Dimensions: 550x550 mm²

U405161



U405121

U405161



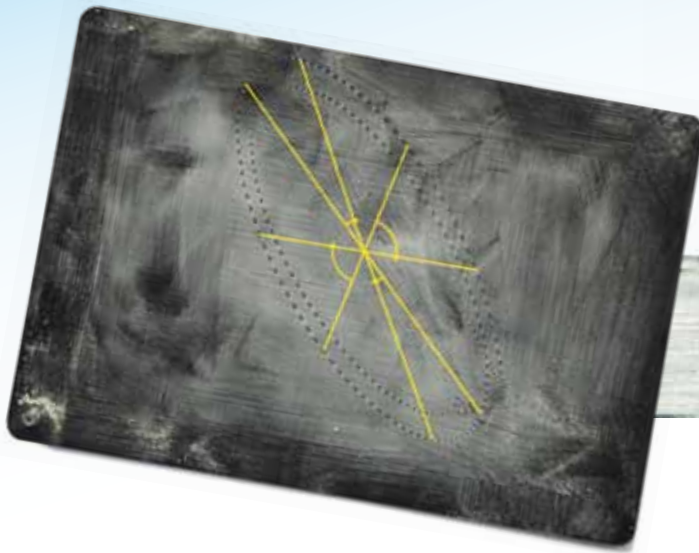
Document your experiments with the air cushion clearly with the aid of the paper sets U405121 and U405161.

Example:

Elastic collision



Measuring acceleration due to gravity



Plotting Movements in a Plane Using Powder Tracing

A plotting electrode slides over a plane counter electrode that is insulated and covered in powdered sulphur. An AC voltage across the two electrodes results in the sulphur powder being attracted or repelled depending on the polarity of the plotting

electrode. A trace thus appears in the powder with ridges that are formed at constant intervals of time. The distance between the ridges reflects the speed of the plotting electrode.

Pair of Elastic Balls with Plotting Electrode

Pair of balls with identical mass and sliding plotter electrode for experiments on elastic collisions that can be demonstrated by means of powder tracing. Made of red plastic with metal ball chain.

Diameter: 70 mm each
Weight: 300 g each

U8405630

Additionally required:

U8400870 Equipment Set for Powder Tracing



U8405630

Pendulum with Plotting Electrode

Cylindrical pendulum bob with sliding plotter electrode for experiments to confirm Kepler's law governing areas covered by a body subject to a central force that can be demonstrated by means of powder tracing.

Steel, with metal ball chain.

Dimensions: 60 mm x 40 mm Ø
Weight: 500 g

U8405640

Additionally required:

U8400870 Equipment Set for Powder Tracing



U8405640

Equipment Set for Powder Tracing

Set consisting of an insulated plate with 4-mm connector socket, a pulse generator and a transformer with two 4-mm plugs for its secondary winding, 35 g of powdered sulphur and a flat brush.

Transformer: Safety isolating transformer, short-circuit proof
Output voltage: 115 V – 230 V, safe to touch
Protective resistance: 1 MΩ
Plate dimensions: 390x270 mm²

U8400870



U8400870

Free-Fall Apparatus

Apparatus for measuring the time it takes for a ball to fall a certain distance using a digital timer. Very easy to set up and use but nevertheless highly accurate. Includes 3 steel balls. A micro-magnet holds the ball in its start position. Three contact pins under the release mechanism ensure that the start position of the ball can be reproduced and act as the contacts of a switch that opens when the ball is released, thus triggering the beginning of the timing measurement. When the ball strikes the contact plate at the bottom, the timer is stopped. The ball is also held firmly on the plate so that it does not bounce. The height through which the ball drops can be adjusted to a fraction of a millimetre and read off a scale on the column.

Height scale: 20 – 960 mm
 Scale divisions: 10 mm
 Scale precision: 0.2 mm
 Balls: Steel, 16 mm diam.
 Dimensions: 200x130x1000 mm³ approx.
 Weight: 1.6 kg approx.

U8400830

Additionally required:

1012832 Millisecond Counter (230 V, 50/60 Hz)

or

1012833 Millisecond Counter (115 V, 50/60 Hz)

or

U8533341-230 Digital Counter (230 V, 50/60 Hz)

or

U8533341-115 Digital Counter (115 V, 50/60 Hz)

U13811 Set of 3 Safety Experiment Leads for Free-Fall Experiments

Set of 3 Steel Balls (not shown)

Spare balls for the free fall apparatus (U8400830) and launcher S (U8400930).

Diameter: 16 mm

U8400735



U8408305

Maxwell's Wheel

Spoked wheel with large moment of inertia for demonstrating the conversion of kinetic energy into potential energy and vice versa. Includes suspending rod and adjustable suspension mechanism. The rotating axle is held in a horizontal position by two strings attached to a suspending rod and is moved upward by winding in the strings. If the equipment is released from its wound in position, the spoked wheel acquires kinetic energy on the way down, which can be seen by the constant increase in its speed of rotation. Two stops on the ends of the axle prevent the wheel from spinning free. At the lowest point when the strings are fully unwound, they start rewinding around the axle and the wheel rises upward again, losing its kinetic energy as it gets higher. To measure the inertial force during acceleration, the whole apparatus complete with stand is placed on a set of scales.

Moment of inertia: 10 kg cm² approx.

Diameter of wheel: 130 mm approx.

Mass of wheel: 370 g approx.

Suspending rod: 370 mm x 12 mm diam.

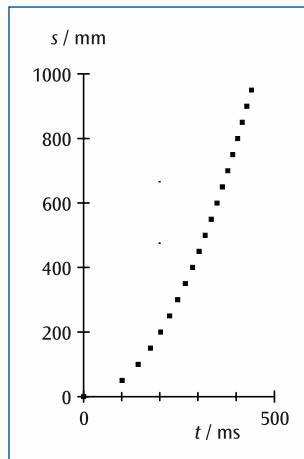
U8408305

Additionally required:

U15004 Stainless Steel Rod 1000 mm (2x)

U8611130 Stand with H-Shaped Base

U13255 Universal Clamp (2x)



**1012832
1012833**

**U8533341-230
U8533341-115**

U8400830

Free Fall

Atwood's Machine

Experiment for studying motion under constant acceleration, demonstrating Newton's second law and determining the acceleration due to gravity g . Includes an aluminium stand for affixing to a wall. A string with weights at both ends is passed over a rotating pulley. The set-up undergoes relatively slow but constant acceleration if the weights are slightly different. This motion is initiated by a tug on one string and stops when the dropping weight strikes a movable platform. To show the rotation of the pulley, it is divided into 20 segments of equal angle. It can easily be removed to measure its moment of inertia.

Axis: Mounted on ball bearing

Diameter of pulley: 152 mm

Thickness of pulley: 10 mm

Weights: 150 g each

Slotted weights: 1x 5 g, 2x 2 g, 1x 1 g each

U40550

Additionally required:

U40801 Mechanical Stopwatch, 15 min



Mechanics



Projectile Launcher

Experimental equipment for the quantitative investigation of projectile laws: vertical horizontal and angled launch, recording of flight trajectories depending on launch angle and projectile range. Three different reproducible launch speeds, continuously adjustable launch angles, constant height of trajectory at various angles since the launch point is coincident with pivot point of the cannon. Projectile is launched with almost no spin. The encapsulated design and the use of spherical plastic projectiles ensure that experiments are safe. The launcher is attached to a table via clamp (U10361) or can be used in conjunction with ballistic pendulum (U10362).

- Horizontal projectile range (Launch angle 45°): 1.1 m, 2.3 m and 4.5 m
- Launch angle: 0° – 90°
- Reproducibility at 45°: standard deviation less than 1%
- Standard deviation of launch ranges: < 1%
- Diameter of projectiles: 25 mm
- Mass of projectiles: 7 g
- Dimensions: 205x65x60 mm³ approx.
- Mass: 480 g approx.

Contents:

- 1 Launcher
- 3 Plastic projectile balls
- 1 Ramrod
- 1 Wing nut M8x20

U10360

Additionally required:

- U10361 Clamp for Projectile Launcher**
- or
- U10362 Ballistic Pendulum**
- Protective Goggles**



Photo Gate Holder for Projectile Launcher (not shown)
Holder for mounting the photo gate (U11365) at the exit of the projectile launcher (U10360).

U10363

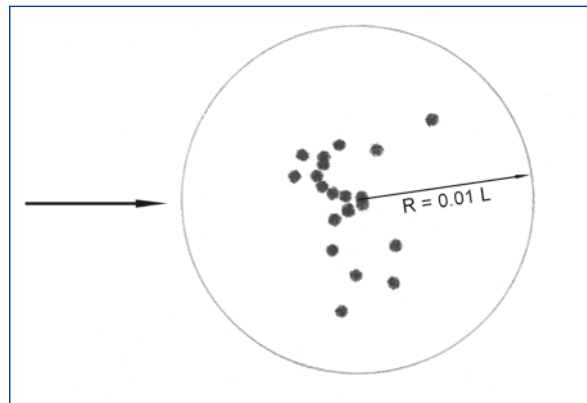
Clamp for Projectile Launcher

Table clamp for Projectile Launcher (U10360) made of anodized aluminium.
Span: 10 mm – 65 mm
Dimensions: approx. 150x70x80 mm³
Mass: approx. 710 g

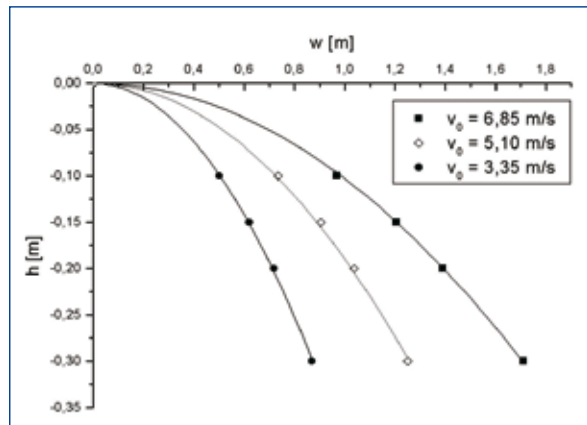
U10361

Experiment Topics:

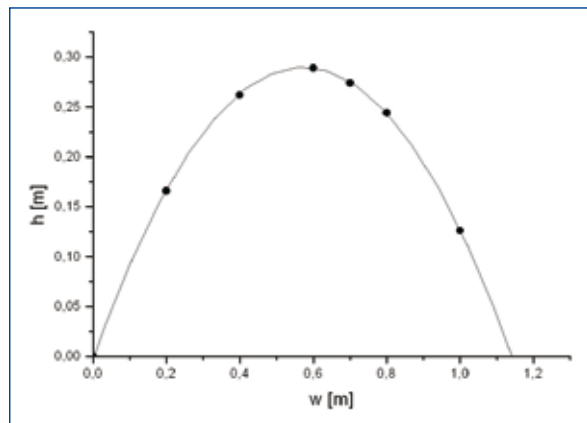
- Vertical, angled and horizontal launch
- Recording of the trajectory with an angled launch
- Determination of range and height from the projection angle
- Determination of launch speed from the range and height
- Determination of launch speed using a ballistic pendulum
- Elastic and inelastic collisions



Typical results for measurement of 20 shots. L=range.



Horizontal launch: projectile height as a function of the projectile distance



Oblique launch: projectile height as a function of the projectile distance (launch angle: 45°)

Ballistic Pendulum

Accessories for the (U10360) launcher for use in experiments on elastic and inelastic collision or to be used as a holder for experiments on trajectory. The speed of the balls as measured in launcher experiments or pendulum experiments agree to within approximately $\pm 3\%$. Additional weights can be used to investigate how pendulums behave with differing angles of deflection at the same speed. For experiments investigating trajectories, the launcher can be set to 5 different launch heights 5, 10, 15, 20 and 30 cm when it is attached to the rear of the ballistic pendulum.

Height of pendulum: 370 mm
 Extra weights: 17.5 g each
 Base plate: 130x130 mm²
 Span of bench clamp: 10 – 65 mm
 Mass: 2.1 kg

Contents:

- 1 Ballistic pendulum with table clamp
- 2 Extra weights

U10362

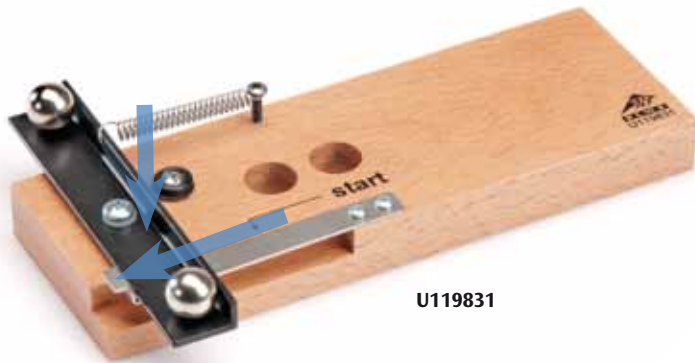
Additionally required:

U10360 Projectile Launcher



U10360

9983-1002656



U119831

Free Fall and Horizontal Launch Equipment

Equipment for demonstrating the independence of the horizontal and vertical components of motion (for projectiles). A launching rail with returning spring is mounted on a wooden base. Two steel balls are used as test bodies. Upon triggering, one ball starts to fall downwards and simultaneously the other is launched horizontally. Both balls hit the ground at the same time. Two holes in the base plate are provided for storing the balls.

Ball diameter: 15 mm
 Dimensions: 200x120x30 mm³ approx.
 Mass: 230 g approx.

U119831

Launcher S

Experimental apparatus for studying vertical and horizontal trajectories as well as trajectories starting at intermediate angles. Also demonstrates the independence of the horizontal and vertical components of motion (for projectiles). Provides for three different launch velocities. Angle of launch can be adjusted to any arbitrary angle and read off from a protractor scale with a plumb line. The projectile ball is held in place by a magnet until the moment of launch so that the height of the trajectory is independent of the launch angle. When a projectile is launched, a second ball can be released simultaneously from the other side of the launcher that then descends in free fall. The latter should strike the floor at the same time as the projectile if the launch angle is horizontal.

Launch angle: 0° – 90°
 Maximum range: 4 m
 Projectile diameter: 16 mm
 Projectile weight: 17 g
 Diameter : 280x90x90 mm³ approx.
 Total weight: 950 g approx.

U8400930

Additionally required:

- U15002 Stainless steel rods, 470 mm (2x)**
- U13260 Table clamps (2x)**

Set of 3 Steel Balls (not shown)

Spare balls for the free fall apparatus (U8400830) and launcher S (U8400930).

Diameter: 16 mm

U8400735



U8400930

Experiment Topics:

- Rotational motion: uniform and under constant acceleration
- Newton's equations of motion for rotational motion
- Moment of inertia and torque
- Moment of inertia as determined by experiment
- Simple harmonic motion of rotating objects

Rotating System on Air Bed

Apparatus for investigating frictionless rotation. A small rotating disc with a protractor scale supports a cross bar to which weights can be attached. The disc is supported by a bed of air in which its axis is centred. A driving weight is suspended from a hook at the end of a string that is passed over a single pulley on one side and a multiple pulley on the other. The rotation is very slow and can be measured using a stopwatch by hand. Alternatively, a digital timer may be used. This can be started by a mechanism that is supplied with the kit and halted by a signal from a laser reflection sensor when the wheel passes through angle zero.

Rotating System on Air Bed (230 V, 50/60 Hz)

U8405680-230

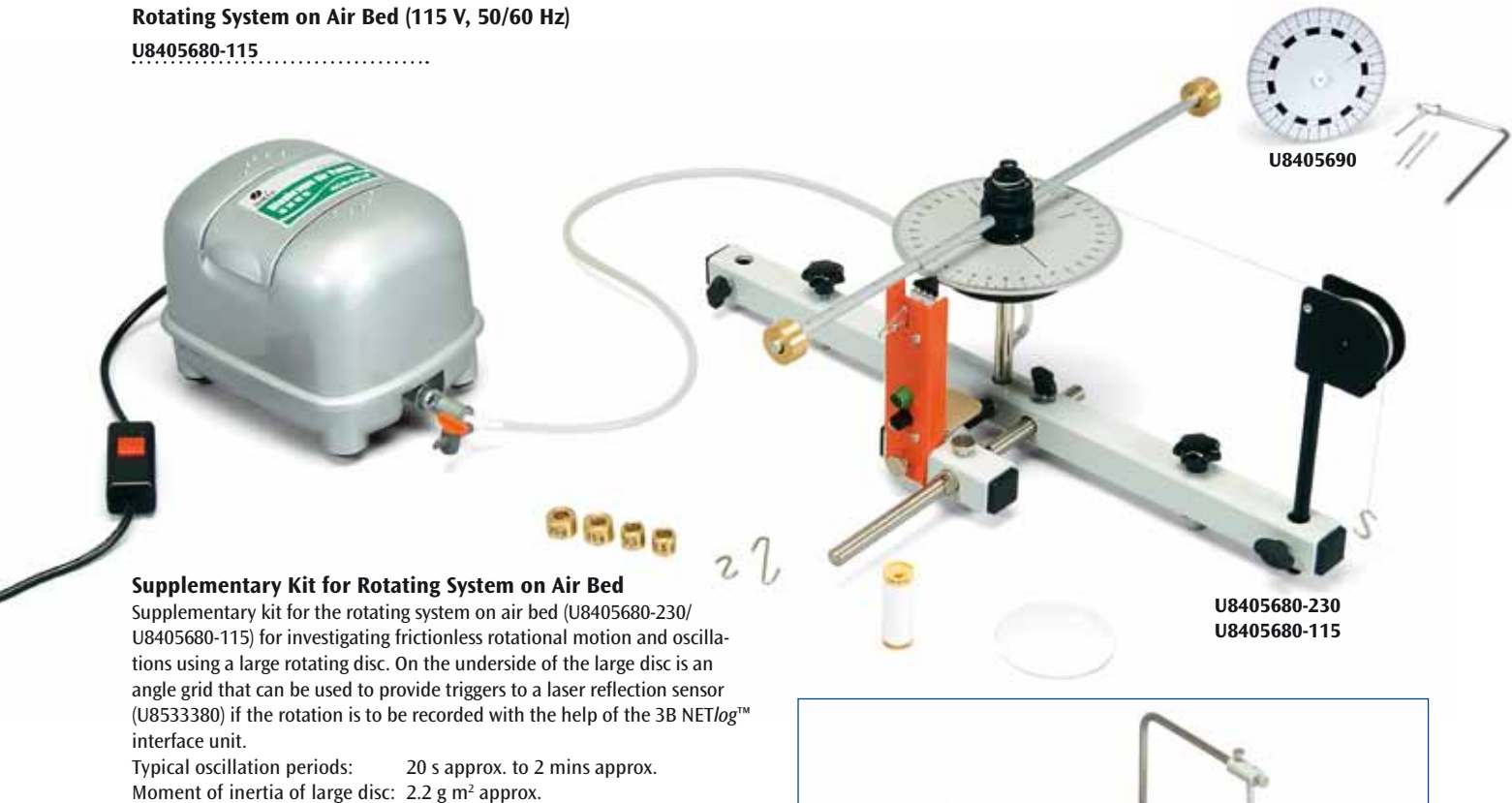
Rotating System on Air Bed (115 V, 50/60 Hz)

U8405680-115

Protractor scale:	0 – 360°
Scale divisions:	1°
Length of cross bar:	ca. 440 mm
Radii of perforations:	30 – 210 mm
Separation of perforations:	20 mm
Radii of multiple pulley:	5.0 mm/10.0 mm/15.0 mm
Moment of inertia of disc with cross bar:	0.9 g m ² approx.
Maximum moment of inertia:	7.1 g m ² approx.
Minimum driving torque:	0.05 mN m approx.
Maximum driving torque:	0.60 mN m approx.

Contents:

- 1 Air bed
- 1 Rotating disc with cross bar
- 1 Multiple pulley
- 1 Release mechanism
- 2 S-shaped hooks 1.00g
- 1 S-shaped hook 2.00 g
- 1 Set of weights (2x 12.5 g, 2x 25 g, 2x 50 g)
- 1 Compressor for connection to mains
- 1 Silicon tubing with by-pass valve (not illustrated)
- 1 Pulley
- 1 Stand rod with 3 securing screws and 2 screws for levelling
- 1 Stand rod with 2 securing screws
- 1 Stand rod, 250 mm
- 1 Levelling disc
- 1 Roll of cotton thread



Supplementary Kit for Rotating System on Air Bed

Supplementary kit for the rotating system on air bed (U8405680-230/ U8405680-115) for investigating frictionless rotational motion and oscillations using a large rotating disc. On the underside of the large disc is an angle grid that can be used to provide triggers to a laser reflection sensor (U8533380) if the rotation is to be recorded with the help of the 3B NETlog™ interface unit.

Typical oscillation periods: 20 s approx. to 2 mins approx.
 Moment of inertia of large disc: 2.2 g m² approx.

Contents:

- 1 Large disc with protractor scale, 350 mm
- 1 Scaffold stand
- 1 Cross sleeve
- 1 Set of coupling springs with magnet (1 N, 2 N, 5 N)

U8405690

Additionally recommended:

- U8533380 Laser Reflection Sensor** and
- U8533341-230 Digital Counter (230 V, 50/60 Hz)** or
- U8533341-115 Digital Counter (115 V, 50/60 Hz)** or
- U11300-230 3B NETlog™ (230 V, 50/60 Hz)** or
- U11300-115 3B NETlog™ (115 V, 50/60 Hz)**



Measuring the period of oscillation and determining the moment of inertia

Rotation Apparatus

Rotating apparatus for determining angular acceleration as a function of the torque and for determining the moment of inertia depending on mass and distance from an axis. An axle on agate bearings supports a cross bar to which weights can be attached. The force from a driving weight is conveyed to the axle via a string wrapped around the axle and passed over a pulley and a second multiple pulley on the axle itself.

- Length of crossbar: 600 mm
- Radii of multiple pulley: 4.5 mm / 9.0 mm
- Driving weights: 10 g / 20 g / 30 g / 40 g / 50 g
- Inertial mass of disc(s): 100 g / 200 g / 300 g
- Dimensions of base plate: 200x140 mm²
- Total weight: 1.3 kg approx.



1006785

Contents:

- | | |
|-----------------------------------|------------------------|
| 1 Basic apparatus | 2 Slotted weights 10 g |
| 2 100-g discs | 1 Slotted weight 20 g |
| 2 200-g discs | 1 Pulley |
| 1 Holder for slotted weights 10 g | 1 Roll of string |

1006785

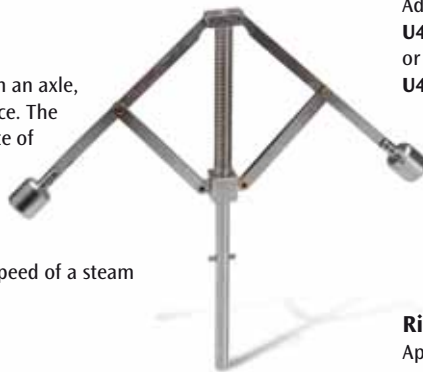
Additionally recommended:

- U40160-230 Digital Stroboscope (115 V, 50/60 Hz)
- or
- U40160-115 Digital Stroboscope (230 V, 50/60 Hz)

Watt's Governor

Symmetrical pendulum system on an axle, for demonstrating centrifugal force. The pendulum arms are held in a state of rest by a coil spring. Depending on the rotational speed, they are lifted against the force of gravity as the axle turns. This can then be used to control the speed of a steam engine.

- Rotation diameter: 350 mm
- Height: 250 mm
- Diameter of axle: 10 mm



U8403115

U8403115

Additionally required:

- U10375 Experiment Motor with Gearbox
- U13271 Stand Base, Tripod, 185 mm
- U33020-230 DC Power Supply 0 – 20 V, 5 A (230 V, 50/60 Hz)
- or
- U33020-115 DC Power Supply 0 – 20 V, 5 A (115 V, 50/60 Hz)

Rings Demonstrating Flattening of the Earth

Apparatus on axle for demonstrating and explaining flattening of the earth and other planets due to their rotation. Two steel bands crossed over and bent into a ring with a guide rod.

- Ring: 240 mm diam.
- Guide rod: 10 mm diam.

U8403120

Additionally required:

- U10375 Experiment Motor with Gearbox
- U13271 Stand Base, Tripod, 185 mm
- U33020-230 DC Power Supply 0 – 20 V, 5 A (230 V, 50/60 Hz)



U8403120

or

- U33020-115 DC Power Supply 0 – 20 V, 5 A (115 V, 50/60 Hz)

Rotary Motion Apparatus

Apparatus for studying rotary motion held in a stable frame. Designed for investigating the effect of a constant torque on a rotating body with variable moment of inertia. Rotating arm with equidistant grooves to accommodate weights of equal mass in symmetry around an axis rotating on ball bearings. For safety, the weights are fixed in place with screws. The torque is generated by a rotating plate with hooks and up to three slotted weights, acting via a string threaded over a multiple pulley with four different pulley diameters.

- Rotating arm: 600 mm x 8 mm diam.
- Groove separation: 40 mm
- Weights: 2x 50 g, 2x 100 g and 2x 200g
- Diameters of multiple pulley: 30 mm, 45 mm, 60 mm and 75 mm
- Overall weight: 7 kg

U29385

Additionally required:

- U40801 Mechanical Stopwatch, 15 min



U29385

NEW

Experiment Topics:

- Moment of inertia of a disc
- Torque
- Angular momentum
- Precession
- Nutation

Gyroscope

High quality precision made gyroscope for demonstration as well as for quantitative determination of gyroscopic laws by means of practical experiments. Experiment apparatus with a shaft that can be tilted and rotated while attached to a stand rod. On one side of the shaft there is a disc mounted on dual ball bearings, while on the opposite side there is a movable counterweight for establishing equilibrium. Fine adjustment is performed by thumb screw at the end of the shaft. To generate external torque an additional weight is provided that can also be moved along the shaft. The shaft's angle of inclination can be read from an easily readable scale. A spirit level allows the gyroscope to be adjusted to the horizontal. The disc can be set rotating by hand or by means of a cord. The dual ball bearing system ensures that rotation is nearly frictionless and that rotation continues for lengthy periods of time. The open construction of the gyroscope allows gyroscopic phenomena to be observed easily and clearly.

Scale:	- 40° to + 40°	Mass of counterweight:	1400 g
Scale divisions:	1°	Mass of additional weight:	50 g
Disc:	250 mm diam.	Total weight:	4650 g
Mass of disc:	1500 g		

U52006



Gyroscope Accessories

Accessories kit for Gyroscope (U52006) consisting of a gyroscope disc and counterweight. For demonstrating the canceling out of gyroscopic phenomena in the case of two discs rotating at the same speed in opposite directions.

U52010

Gyroscope S

Gyroscope with low-profile, dynamically balanced metal rotor in a Cardan gimbal mount. Ideal for studying gyroscopic stability phenomena, precession and nutation. Also supplied is a pendulum mounting that can be used for investigating the rolling or tipping moment. The set includes plastic Cardan discs, Cardan gimbal mount, pendulum mounting and starting cord.

Dimensions: 170x120 mm² approx.

U8556020



Bicycle Wheel Gyroscope

Spoked wheel with weighted rim for demonstrating conservation of angular momentum. Simple to use due to small wheel radius and ease of suspension.

Diameter: 500 mm

U450001

Additionally recommended:

U45001 Turn Table

U8724980 Experiment Cord

Turn Table

Intended for use with the bicycle wheel gyroscope, this rotary platform allows operation on a laboratory stool or as a base surface.

Anti-skid design.

Diameter: 300 mm

U45001

Rod Pendulum with Angle Sensor

Pendulum with low-friction pointed bearings and electromagnetic angle sensor for measuring simple harmonic motion of a weighted pendulum with movable weight. Including plug-in power supply. The deflection of the pendulum is detected by a Hall sensor that converts the angle to an electrical signal proportional to the angle so that the oscillation can be recorded using an interface unit, a Y-t plotter or a storage oscilloscope.

Length of pendulum: 1 m
 Mass of pendulum: 1 kg
 Output voltage: ± 5 V
 Output resistance: 500 Ω
 Power supply: 12 – 16 V AC
 Diameter of tube: 10 mm
 Weight: 1,4 kg approx.

Rod Pendulum with Angle Sensor (230 V, 50/60 Hz)

U8404275-230

Rod Pendulum with Angle Sensor (115 V, 50/60 Hz)

U8404275-115

Additionally required:

U13260 Table clamp
 U15004 Stainless steel rod, 1000 mm
 U13255 Universal clamp

Additionally recommended:

U11300-230 3B NETlog™ (230 V, 50/60 Hz)
 or
 U11300-115 3B NETlog™ (115 V, 50/60 Hz)

Set of 4 Pendulum Bobs

4 balls with securing eyes: made of brass, aluminium, steel and plastic for constructing a mathematical pendulum.

Diameter: 25 mm
 Weights: 71.2 g, 25.2 g, 61 g, 10.5 g

U30035

Additionally required:

U8724980 Experiment Cord
 Stand Equipment

Variable g Pendulum

Pendulum with continuously adjustable plane of oscillation for observing pendulum oscillations where the acceleration due to gravity g can appear to be varied.

Max. length of pendulum: 280 mm
 Mass of pendulum: 0.5 kg
 Angle of plane of oscillation: $0^\circ - 90^\circ$
 Dimensions: 300x250x550 mm³
 Mass: approx. 5 kg

U8403950

Additionally required:

U13271 Stand Base, Tripod, 185 mm
 U15002 Stainless Steel Rod, 470 mm

Additionally recommended:

U8403955 Photogate Holder for Pendulum
 U11365 Photo Gate
 U8533341-230 Digital Counter (230 V, 50/60 Hz)
 or
 U8533341-115 Digital Counter (115 V, 50/60 Hz)

Photogate Holder for Pendulum

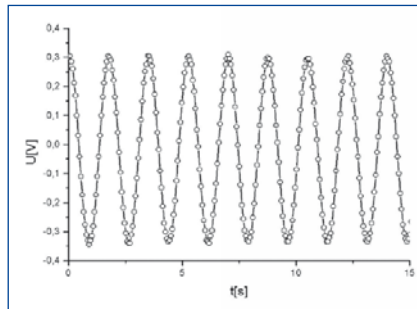
Holder for mounting the light barrier (U11365) with a variable-g pendulum, for which the plane of oscillation can be set at any angle.

U8403955

Rod Pendulum

Rod pendulum with low-friction pointed bearings as per U8404275-230 or U8404275-115 but with no Hall sensor or magnet for detecting angle.

U8404280

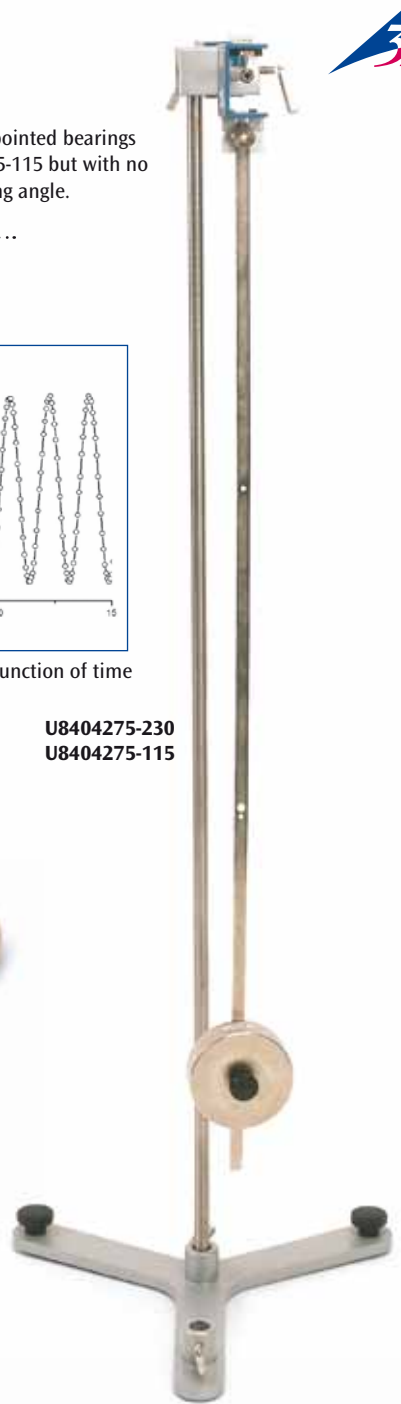


Deflection of the pendulum as a function of time

See physics experiments catalogue



U30035



U8404275-230
 U8404275-115



U8403950

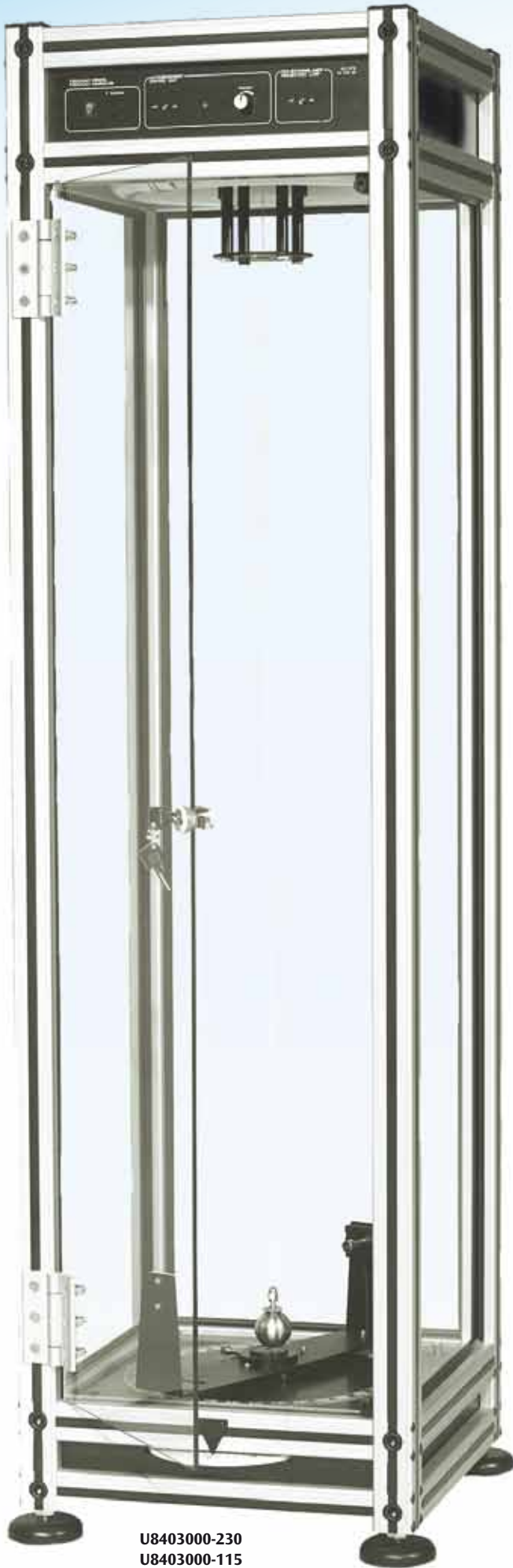
U8403955

U15002

U11365

U13271

U8533341-230
 U8533341-115



U8403000-230
U8403000-115

Experiment Topics:

- Pendulum oscillations
- Rotation of the earth
- Coriolis force

Foucault Pendulum

Pendulum for qualitative and quantitative demonstration of the rotation of the earth by means of observing the plane of oscillation. To prevent the oscillation taking an elliptical path, the thread upon which the pendulum bob is suspended impinges on a Charron ring during each oscillation. The plane of the oscillation is detected with high accuracy by projecting the shadow of the thread onto a protractor scale. The rotation of the plane can thus be identified in a very short period of time. For longer periods of observation, the gradual damping of the oscillation can be compensated for by means of an electromagnetic boost that can be adjusted to an arbitrary value. The apparatus is presented in decorative fashion inside a box with all sides made of glass, that is lit from inside to make for a very eye-catching appearance.

Length of pendulum: 1200 mm
 Mass of pendulum: 230 g
 Diameter: 38 mm
 Vertical alignment: By means of four height-adjustable feet
 Angular resolution: 0.1°
 Dimensions: 400x400x1400 mm³
 Mass: approx. 40 kg

Foucault Pendulum (115 V, 50/60 Hz)

U8403000-230

Foucault Pendulum (230 V, 50/60 Hz)

U8403000-115

UNIQUE!

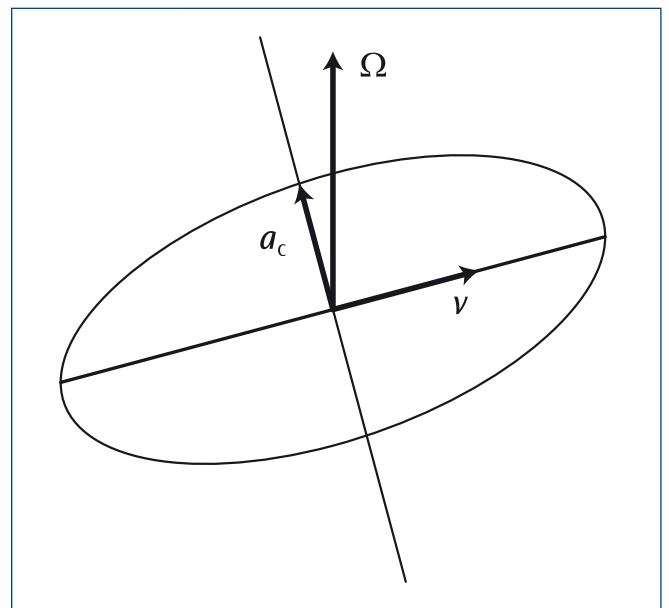


Diagram of Coriolis acceleration

Experiment Topics:

- Free rotary oscillations at various degrees of damping (oscillations with moderate damping, aperiodic oscillations and aperiodic borderline case)
- Forced oscillations and their resonance curves at various degrees of damping
- Phase displacement between the exciter and resonator during resonance
- Chaotic rotary oscillations

Plug-in Power Supply 24 V, 0.7 A

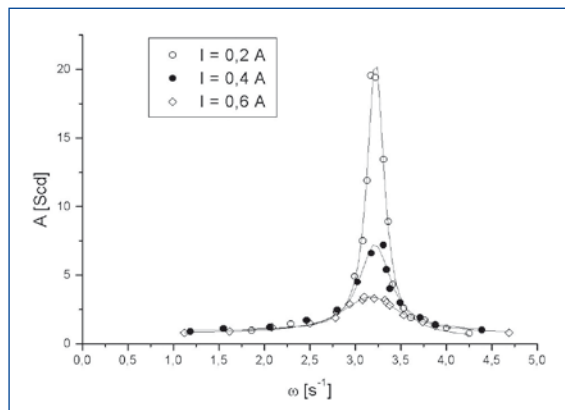
Plug-in power supply for the electric motor used with Pohl's pendulum U15040. Including cables and two safety plugs on the secondary side.
 Output voltage: 24 V, 0.7 A
 Length of cables: 1 m

Plug-in Power Supply 24 V, 0.7 A (230 V, 50/60 Hz)

U33200-230

Plug-in Power Supply 24 V, 0.7 A (115V, 50/60 Hz)

U33200-115



Resonance curve for different degrees of damping

Pohl's Torsion Pendulum

For investigating free, forced and chaotic oscillations at various degrees of damping. With slotted scale ring and pointers on resonator and exciter. An electric motor is included for exciting forced oscillations. It features coarse and fine speed adjustment and is coupled via an eccentric wheel. For damping, an electromagnetic eddy brake is used. The equipment can also be used in demonstrations involving projection of shadows.

Natural frequency: approx. 0.5 Hz
 Excitation frequency: 0 to 1.3 Hz
 Connectors: 4-mm safety sockets
 Motor: max. 24 V AC/DC, 0.7 A
 Eddy brake: 0 – 2 A DC, 20 V
 Scale ring: 300 mm diam.
 Dimensions: 400x140x270 mm³
 Weight: 4 kg

U15040

Additionally required:

U33020-230 DC Power Supply 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz)

U33200-230 Plug-in Power Supply 24 V, 0.7 A (230 V, 50/60 Hz)

or

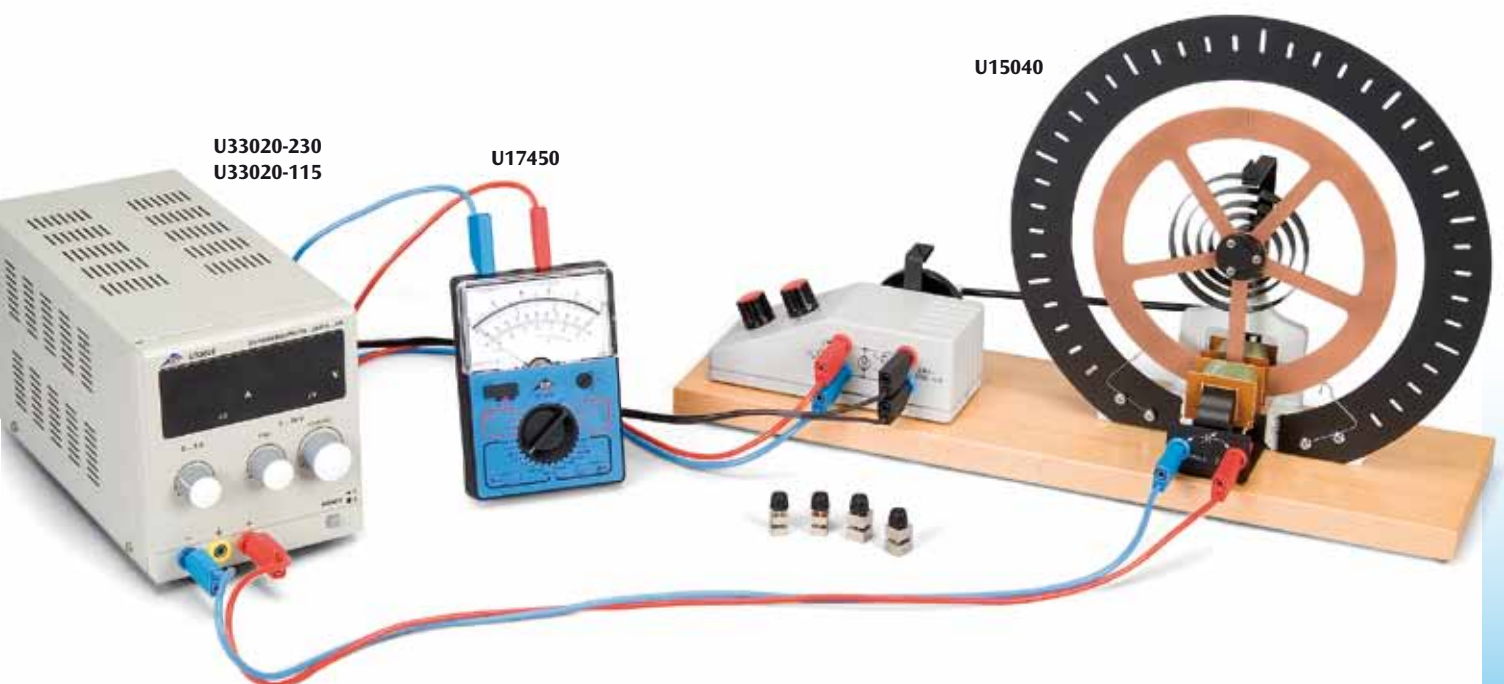
U33020-115 DC Power Supply 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz)

U33200-115 Plug-in Power Supply 24 V, 0.7 A (115 V, 50/60 Hz)

U40801 Stopwatch, 15 min

U17450 Analogue Multimeter AM50

Patch Cords



Experiment Topics:

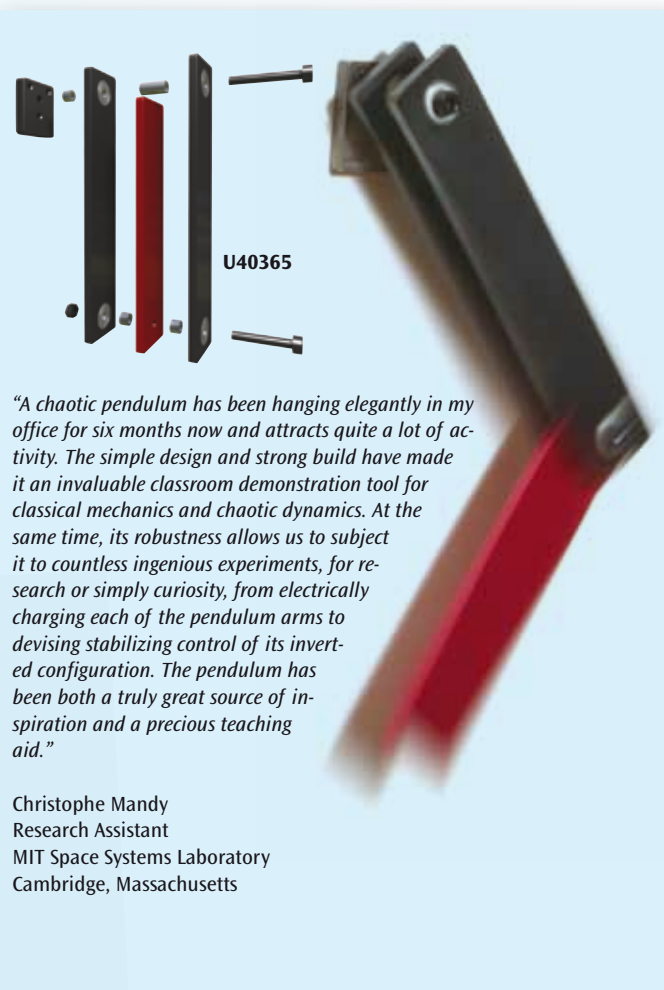
- Harmonic oscillations
- Determining unknown masses
- Gravitational mass and inertial mass

Chaotic Pendulum

Defined as an extreme sensitivity to initial conditions, chaos theory is an important field of study in modern physics. The addition of a second leg transforms the predictable pendulum into an outstanding demonstration of chaotic motion. The Chaotic Pendulum is made of Aluminium with brush-finished anodised coating. These pendulums have been manufactured to extremely high precision with a focus on fine finishing and attention to detail. The double pendulum comes packaged in a black case and includes equipment for mounting on either a wooden or concrete wall or a steel beam or structure.

Dimensions: approx. 350x38x52 mm³

U40365



"A chaotic pendulum has been hanging elegantly in my office for six months now and attracts quite a lot of activity. The simple design and strong build have made it an invaluable classroom demonstration tool for classical mechanics and chaotic dynamics. At the same time, its robustness allows us to subject it to countless ingenious experiments, for research or simply curiosity, from electrically charging each of the pendulum arms to devising stabilizing control of its inverted configuration. The pendulum has been both a truly great source of inspiration and a precious teaching aid."

Christophe Mandy
Research Assistant
MIT Space Systems Laboratory
Cambridge, Massachusetts



U30045

Inertia Balance

Inertia balance for determining inertial mass. After the apparatus is calibrated by determining the vibration frequency for objects of known mass, it can be used to determine the unknown masses. The Inertia Balance consists of two metal trays connected by stiff steel spring strips. One tray has 3 holes to hold up to three masses and the other tray may be anchored to a table edge or laboratory bench with the included table clamp.

Length of steel strip: approx. 350 mm

Masses: approx. 175 g each

Contents:

- 1 Inertia Balance
- 1 Table clamp
- 1 Cord, 1.85 m
- 3 Masses

U30045

Additionally required:

U40801 Mechanical Stopwatch, 15 min

SW Wilberforce Pendulum Set (photo p. 73)

Set for building a Wilberforce pendulum or a torsion pendulum in a space-saving table-top experiment. Adjustable rotating body for fine adjustment of moment of inertia in order to investigate couples translation and rotation oscillations as per Wilberforce's experiment. Includes components for connecting to dynamometers from the SW Sensors set in order to record and analyse oscillations using a standard oscilloscope.

Contents:

- 1 Spring, 5.25 N/m
- 1 Rotating body
- 1 Vertical plate
- 1 Body with hook
- 1 Spring set B for fitting to dynamometer

1012844

Additionally required:

1012849 SW Stand Equipment Set

Additionally recommended:

1012850 SW Sensors Set (230 V, 50/60 Hz) or

1012851 SW Sensors Set (115 V, 50/60 Hz)

1012879 USB Oscilloscope 2x40 MHz or

U33070-230 Analogue Oscilloscope 2x20 MHz

Mechanical Oscillations in a Space Saving Tabletop Experiment

SW Physical Pendulum Set

Set for building a physical pendulum with a moveable weight, a reversing pendulum or a pair of coupled pendulums in a space-saving table-top experiment. Includes components for connecting to dynamometers from the SW Sensors set in order to record and analyse oscillations using a standard oscilloscope.

Contents:

- 2 Bearing bars
- 2 Pendulum rods
- 2 Moveable weights
- 1 Spring, 2.5 N/m
- 2 Coupling spring sets C
- 2 Rings

1012853

Additionally required:

1012849 SW Stand Equipment Set

Additionally recommended:

- 1012850 SW Sensors Set (230 V, 50/60 Hz)** or
- 1012851 SW Sensors Set (115 V, 50/60 Hz)**

- 1012879 USB Oscilloscope 2x40 MHz** or
- U33070-230 Analogue Oscilloscope 2x20 MHz**



NEW

**1012853,
1012849,
1012850/
1012851,
1012879**

Oscillations / Torsion Apparatus

SW String Pendulum Set

Set for building a string pendulum and for investigating simple harmonic motion and chaotic oscillations in a space-saving table-top experiment. Features movable string pulley for setting string lengths and magnetic strips for generating chaotic oscillations. Other components are for connecting to dynamometers from the SW Sensors set in order to record and analyse oscillations with two degrees of freedom using a standard oscilloscope.

Contents:

- 1 String, 100 m
- 1 Weight, 100 g
- 1 Long magnetic strip

- 2 Short magnetic strips
- 1 Spring set A for fitting to dynamometer

1012854

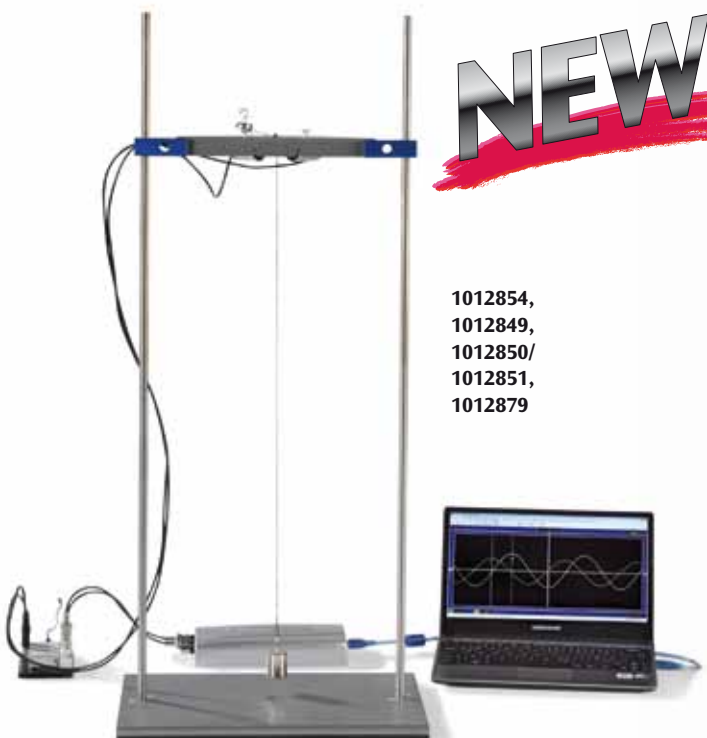
Additionally required:

1012849 SW Stand Equipment Set

Additionally recommended:

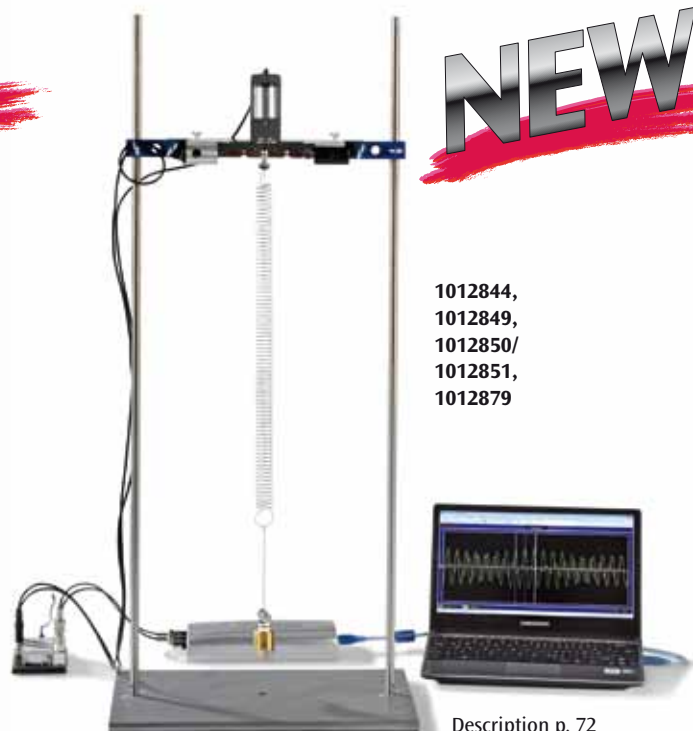
- 1012850 SW Sensors Set (230 V, 50/60 Hz)** or
- 1012851 SW Sensors Set (115 V, 50/60 Hz)**

- 1012879 USB Oscilloscope 2x40 MHz** or
- U33070-230 Analogue Oscilloscope 2x20 MHz**



NEW

**1012854,
1012849,
1012850/
1012851,
1012879**



NEW

**1012844,
1012849,
1012850/
1012851,
1012879**

Description p. 72

Mechanics

Experiment Topics:

- Rotary oscillations
- Determination of moments of inertia using the oscillation method
- Moments of inertia of various geometric bodies
- Steiner's theorem



Torsion Axle

Robust axle for investigating rotational oscillation of various test bodies and for determining their moments of inertia from the period of oscillation. With ball-bearing mounted shaft, high-quality coil spring and holding lug. Tests are undertaken on weights, which can be moved along a thin transverse rod. A circular disc, which can be used for determining moments of inertia for eccentric axes of rotation and confirming Steiner's theorem is included.

Deflecting torque of the spring: 0.028 Nm/rad.
 Height of the torsional axle: approx. 200 mm
 Transverse rod:
 Length: 620 mm
 Weight: 135 g
 Weights: 260 g each
 Disc:
 Diameter: 320 mm
 Weight: 495 g
 Boreholes: 9
 Borehole spacing: 20 mm

U20050

Additionally required:
U13271 Stand Base Tripod, 185 mm

Additionally recommended:
U11902 Digital Stopwatch
U20032 Precision Dynamometer 1 N
U20051 Set of Test Bodies for Torsion Axle

NEW



Set of Test Bodies for Torsion Axle

Accessories for the torsion axle (U20050) used to demonstrate how moment of inertia depends on the distribution of weight around the axis of rotation. Consisting of two cylinders with nearly identical weights but different weight distributions, a mounting plate for the cylinders, a wooden disc and a wooden sphere.

U20051

Hollow cylinder (metal):
 External diameter: 90 mm
 Height: 90 mm
 Weight: approx. 425 g
Solid cylinder (wood):
 Diameter: 90 mm
 Height: 90 mm
 Weight: approx. 425 g
Mounting plate:
 Diameter: 100 mm
 Weight: approx. 122 g

Wooden disc:
 Diameter: 220 mm
 Height: 15 mm
 Weight: approx. 425 g
 Moment of inertia: 0.51 kgm²
Wooden sphere:
 Diameter: 146 mm
 Weight: approx. 1190 g
 Moment of inertia: 0.51 kgm²



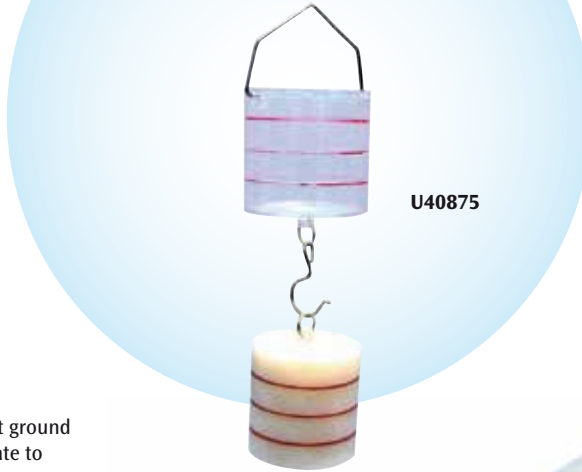
U20051

Device for Archimedes' Principle

For demonstrating Archimedes' principle of buoyancy in liquids. Consists of a hollow cylinder with a stirrup and hook, as well as a precisely fitted solid cylinder with an eyelet.

Diameter: 55 mm
Height: 53 mm

U40875



Buoyancy Apparatus

Apparatus for demonstrating buoyancy of fluids, consisting of a flat ground glass tube and a metal disc with rubber covering to form a base plate to which a long string is attached. The base plate makes a watertight connection with the glass tube and when both are immersed in water, the plate does not sink because buoyancy keeps it pushed up against the tube.

Glass tube: 200 mm x 28 mm diam.
Metal disc: 2 mm x 42 mm diam.
Length of string: 35 cm

U8410355



Free-Standing Cylinder, without Graduation

Made of Duran glass with round base and coarse ground rim, without graduation.

Height: 300 mm
Diameter: 40 mm

U14206



Cartesian Diver

For demonstrating a body floating, sinking or rising in water. A hollow figure made of coloured glass, with a narrow opening. The figure floats upright in a cylinder filled with water and can be made to float, sink or rise by applying pressure to the rubber cap. The rubber cap fits cylinder diameters of approx. 30 mm to 40 mm, e.g. free-standing cylinder (U14206).

Contents:

- 1 Cartesian diver
- 1 Rubber cap

U14090

Additionally required:

U14206 Free-Standing Cylinder, without Graduation

U14206

U14090



U8404556

Set of 5 density bodies

Set comprising five rectangular prisms made of various materials and a transparent block with a hollow body, all with the same dimensions for demonstrating Archimedes' principle. The bodies have 2-mm bores by which they can be suspended.

Materials: Wood, aluminium, iron, brass, copper
Dimensions of each body: 10x20x45 mm³

U8404556

Additionally required:

U20032 Precision Dynamometer 1N

U15036 – U15039



Immersion Blocks

Immersible block with hooks. Can be used for determining buoyancy in conjunction with a dynamometer.

Art. No.	Description
U15036	Al, 50 cm ³
U15037	Al, 100 cm ³
U15038	Fe, 50 cm ³
U15039	Fe, 100 cm ³

Additionally required:

U20035 Precision Dynamometer 10 N

Set of 3 Cylinders, Equal in Volume

Set of three cylinders of equal volume and unequal mass each with a hook.

Materials: Aluminium, iron, brass

Dimensions of cylinders: 40 mm x 20 mm diam. approx.

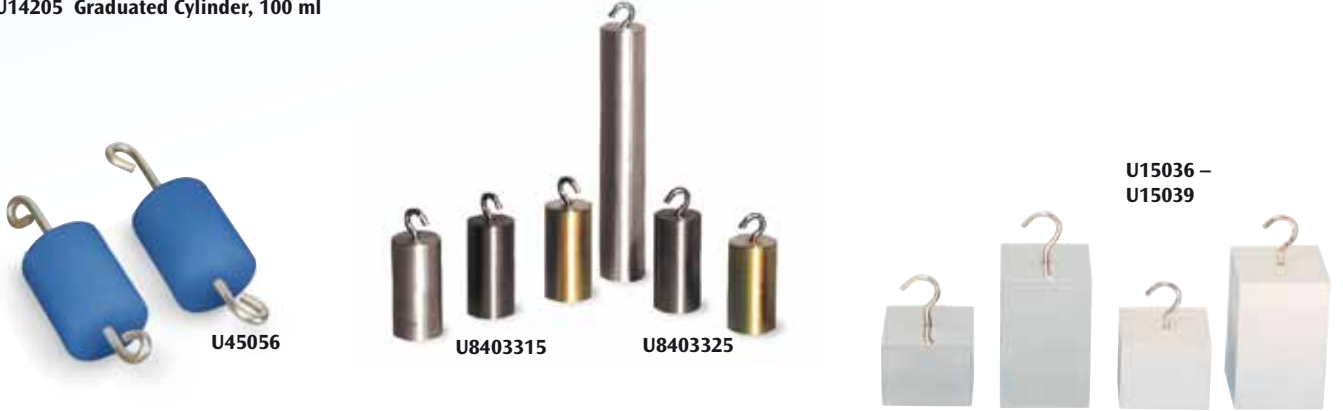
U8403315

Additionally recommended:

U42050-230 Electronic Scales 600 g (230 V, 50/60 Hz) or

U42050-115 Electronic Scales 600 g (115 V, 50/60 Hz)

U14205 Graduated Cylinder, 100 ml



Density Paradox Set

Two identical plastic cylinders with a density close to that of water. If the first is immersed in hot water, it will initially sink but will then float up to the surface after a short time. If the second one is then put into ice-cold water, it will initially float but will then sink to the bottom. The reason for this is that the density of the plastic changes more than that of the water when it is heated or cooled.

U45056

Additionally recommended:

2 Beakers from U14210

Set of 3 Cylinders, Equal in Mass

Set of three cylinders of equal mass and unequal volume each with a hook.

Materials: Aluminium, iron, brass

Mass of cylinders: 100 g

U8403325

Additionally recommended:

U42050-230 Electronic Scales 600 g (230 V, 50/60 Hz) or

U42050-115 Electronic Scales 600 g (115 V, 50/60 Hz)

U14205 Graduated Cylinder, 100 ml

Immersion Blocks

Immersible body of known volume. Can be used in conjunction with scales to determine the density of solid bodies. With hook.

Art. No.	Description
U15036	Al, 50 cm ³
U15037	Al, 100 cm ³
U15038	Fe, 50 cm ³
U15039	Fe, 100 cm ³

Additionally recommended:

U42050-230 Electronic Scales 600 g (230 V, 50/60 Hz) or

U42050-115 Electronic Scales 600 g (115 V, 50/60 Hz)

Set of 3 Areometers

Set of areometers for determining the density of liquids in g/ml at a reference temperature of 20°C / 68°F. Without thermometer, in storage container.

U16106

Measuring range	Scale division	Length
0.650 – 1.000 g/ml	0.005 g/ml	315 mm
1.000 – 1.500 g/ml	0.005 g/ml	235 mm
1.500 – 2.000 g/ml	0.005 g/ml	235 mm

Alcohol Meter

Gay-Lussac alcohol meter for determining the alcohol content in percentage by volume of ethanol/water mixtures at a reference temperature of 15°C. Without thermometer, in storage container.

Scale: 0 to 100% vol

Division: 1%

Length: 260 mm

U14290

Universal Areometer

Areometer for determining the density of liquids in g/ml at a reference temperature of 20°C. Without thermometer, in storage container.

Measuring range: 0.7 – 2 g/ml

Scale division: 0.02 g/ml

Length: 310 mm

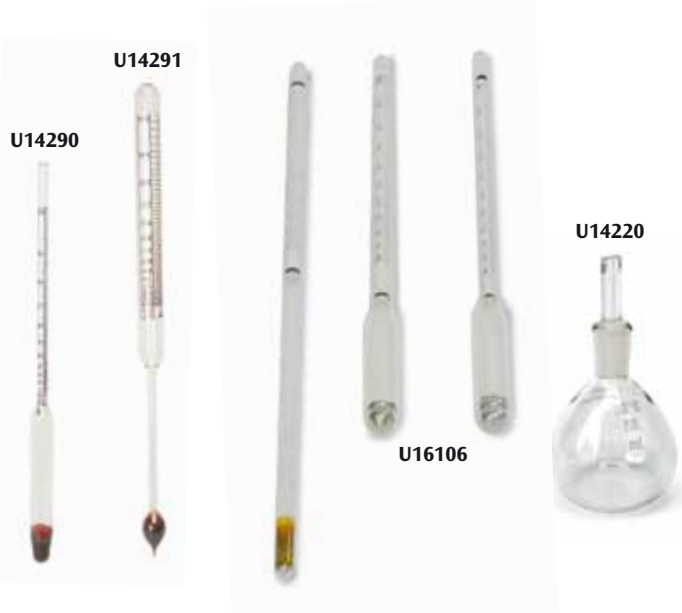
U14291

Gay-Lussac Pycnometer

Glass body with ground capillary stopper for determining the density of liquids.

Volume: 50 ml

U14220



Pressure Container for Determining Weight of Air

Airtight metal can with valve for demonstrating weight of compressed air. With bicycle valve for pumping in air. The weight of the air pumped in is determined by weighing and the volume can be determined by gauging the capacity.

Dimensions: 60x190 mm² approx.
Weight: 100 g approx.

U8412150

Additionally required:

U42049-230 Electronic Scales 400 g (230 V, 50/60 Hz) or
U42049-115 Electronic Scales 400 g (115 V, 50/60 Hz)
Bicycle Pump

Set of 7 Cubes for Determining Density

Set of seven cubes made of various materials for determining densities by weighing. Supplied in a storage case.

Materials: Wood, plastic, aluminium, iron, copper, brass, zinc
Side of cubes: 10 mm

U8404509

Additionally required:

U42050-230 Electronic Scales 600 g (230 V, 50/60 Hz) or
U42050-115 Electronic Scales 600 g (115 V, 50/60 Hz)



U8412150



U8404509



U8422050

Set of 2 Materials with 4 Different Masses Each

Two sets of test bodies made of the same material but with four different masses for deriving the concept of density in school experiments. Supplied in storage containers.

Materials: Aluminium, PVC

U45057

Additionally recommended:

U42050-230 Electronic Scales 600 g (230 V, 50/60 Hz) or
U42050-115 Electronic Scales 600 g (115 V, 50/60 Hz)
U14205 Graduated Cylinder, 100 ml

Sphere for Weighing Gases 1000 ml

Glass sphere with two taps and nozzles for attaching tubing for demonstrating the weight of air from the difference in weight between the sphere when filled with air and when evacuated.

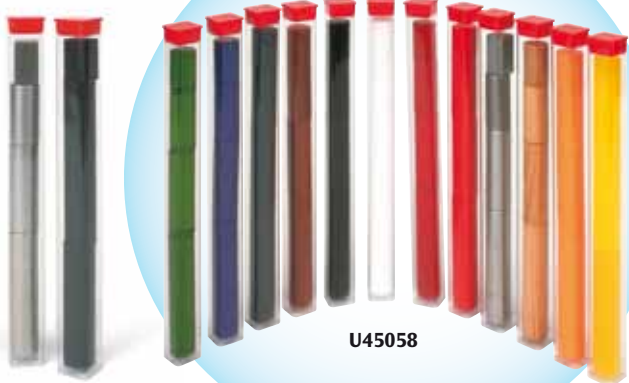
Weight: 200 g approx.

U8422050

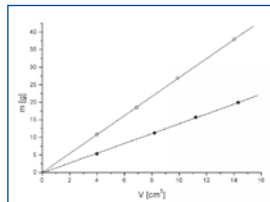
Additionally recommended:

U42049-230 Electronic Scales 400 g (230 V, 50/60 Hz) or
U42049-115 Electronic Scales 400 g (115 V, 50/60 Hz)
1012856 Vacuum Hand Pump

U45057

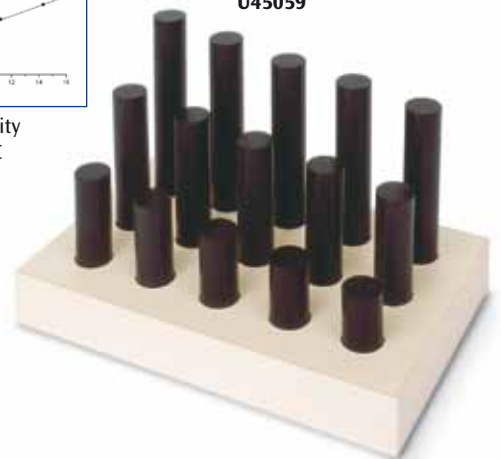


U45058



Determining the density of Aluminum and PVC

U45059



Set of 12 Materials with 4 Different Masses Each

Twelve sets of test bodies made of the same material but with four different masses for deriving the concept of density in school experiments. Supplied in storage containers.

Materials: Wood, polypropylene, polyamide, acrylic (2 colours), polyurethane, phenol, PVC (3 colours), Teflon and aluminium

Densities: 0.71 – 2.71 g/m²

Dimensions: 25 / 35 / 50 / 70 mm x 16 mm diam. approx.

U45058

Additionally required:

U42050-230 Electronic Scales 600 g (230 V, 50/60 Hz) or
U42050-115 Electronic Scales 600 g (115 V, 50/60 Hz)
U14205 Graduated Cylinder, 100 ml

Set of 15 Bodies with 2 Different Densities

Set of 15 test bodies of various masses made of two identical looking materials for deriving the concept of density in experiments at school. Supplied on a storage tray.

Materials: Plastic of density 1.41 g/cm³ and 1.15 g/cm³

U45059

Additionally required:

U42050-230 Electronic Scales 600 g (230 V, 50/60 Hz) or
U42050-115 Electronic Scales 600 g (115 V, 50/60 Hz)
U14205 Graduated Cylinder, 100 ml



U10355

Pressure Balance

Introducing the concept of pressure, for comparing pressures, for gas-compression experiments and for demonstrating overpressure and under-pressure. Two precision glass syringes of different volumes with ground piston and weight pans on stand. Includes 15 disc weights on a storage rod for adding to plunger. Connection between the syringe hoses via a tubing clamp, safety catch for the smaller piston.

- Volume of syringes: 10 ml and 50 ml
- Ratio of piston cross-sections: 10:3
- Ratio of piston masses with weight pans: 10:3
- Mass of weights: approx. 400 mN each
- Baseplate dimensions: approx. 140x100 mm²

U10355

Outlet Vessel, Glass

Glass cylinder with three outlets positioned at different heights for investigating the dependence of hydrostatic pressure on water depth through an observation of the outlet water jets.

- Height: 350 mm
- Diameter: 35 mm

U21601



U21601

NEW



U30084

Outlet Vessel, Metal

Robust metal cylinder with three outlets at various heights for the purpose of investigating hydrostatic pressure due to depth of water by observing the jets of water emerging from the outlets under pressure.

- Height: 430 mm approx.
- Diameter: 125 mm approx.

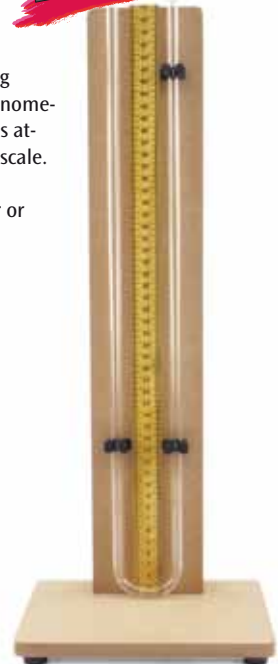
U30084

Indigo Solution

5 ml indigo solution in a flask, for colouring water in demonstration experiments.

U8410620

NEW



U30082

U-Shaped Manometer D

Demonstration manometer for measuring pressure in centimetres of water. The manometer consists of a U-tube open at both ends attached to a fiberboard (MDF) featuring a scale.

- Length of each leg: 50 cm
- Measuring range: 0 – 50 cm of water or 0 to 5 kPa
- Tubing diameter: 10 mm
- Dimensions: 200x150x530 mm³ approx.
- Weight: 820 g approx.

U30082

Additionally recommended:
U8410620 Indigo Solution

U-tube Manometer S

Manometer for measuring pressures in the range 0 to 10 hPa (cm water column). U-tube open on both sides with overflow basin on aluminium base plate with scale. Includes stand rod on the reverse for attaching to stand base.

- Length of arms: 200 mm
- Stand rod: 33 mm x 10 mm diam.
- Base plate: 210x70 mm² approx.
- Weight: 80 g approx.

U8410450

Additionally required:
U8410620 Indigo Solution

Additionally recommended:
U10146 Silicon Tube, 1 m



U8410450



U14320

Glass Cylinder with 3 Tubes

Glass vessel for demonstrating communicating tubes; also suitable as an overflow vessel. Consists of a glass cylinder with two openings and GL screw connections. Includes three differently shaped glass tubes.

Height: approx. 300 mm
Diameter: 90 mm

U14320



U8410620



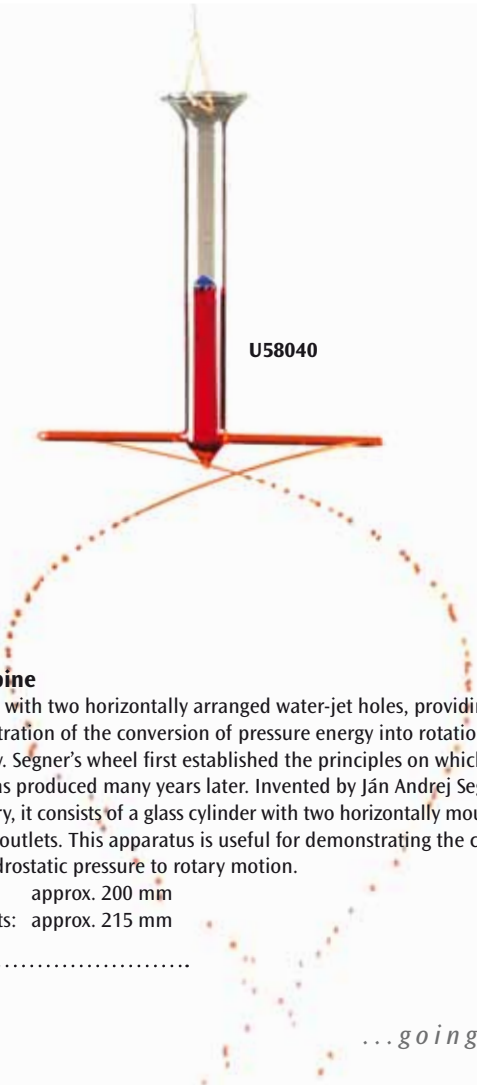
U58021

Apparatus for Investigation of Capillary Effects

A horizontal glass tube can be connected to a water reservoir through capillary tubes of different diameters. The smaller the diameter of the capillary tube, the higher the water climbs above the level of the reservoir due to the greater hydrostatic pressure.

Internal diameters of the capillary tubes: 2.0 mm, 1.5 mm, 1.0 mm und 0.5 mm
Height: 165 mm approx.

U58021



U58040

Segner Turbine

Glass cylinder with two horizontally arranged water-jet holes, providing a vivid demonstration of the conversion of pressure energy into rotational kinetic energy. Segner's wheel first established the principles on which the jet turbine was produced many years later. Invented by Ján Andrej Segner in XVIII century, it consists of a glass cylinder with two horizontally mounted curved water outlets. This apparatus is useful for demonstrating the conversion of hydrostatic pressure to rotary motion.

Height: approx. 200 mm
Span of outlets: approx. 215 mm

U58040



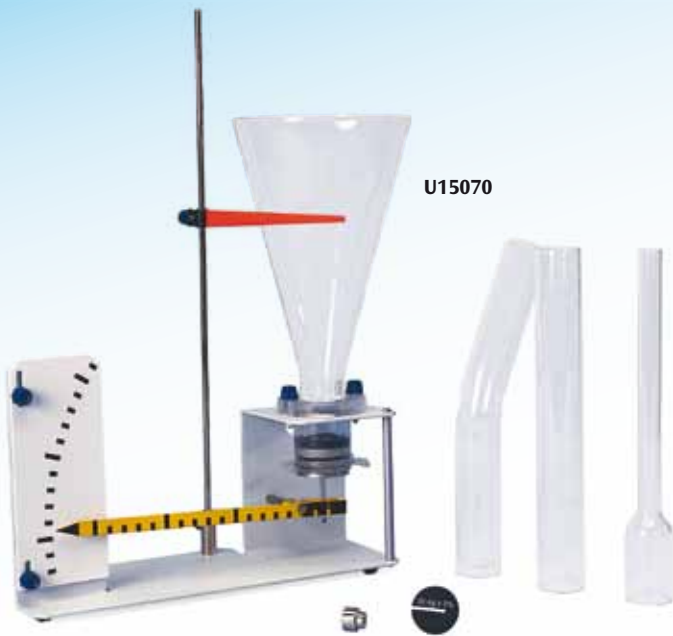
U14321

Glass Cylinder with 2 Tubes

Glass vessel for demonstrating communicating tubes. Consists of a glass cylinder with two openings and GL screw connections, as well as two differently shaped glass tubes.

Height: approx. 220 mm

U14321



U15070

Pascal's Vane Apparatus

For demonstrating the hydrostatic paradox and for quantitative measurements of ground pressure. This pressure is measured through the curvature of a membrane and indicated in magnified form with the help of a lever multiplier. Compensation for comparative measurements is possible. Includes four differently shaped vessels made of glass.

- Height of the vessels: 220 mm
- Tube diameter at the bottom: 22 mm
- Total height: 350 mm
- Base-plate area: 260x110 mm²
- Weight: 0.8 kg

U15070



U14325

Pascal's Pressure Sphere

Glass vessel with movable plungers for demonstrating equal distribution of pressure in all directions, observed by means of water jets forced out under pressure.

- Total length: 450 mm
- Diameter: approx. 75 mm

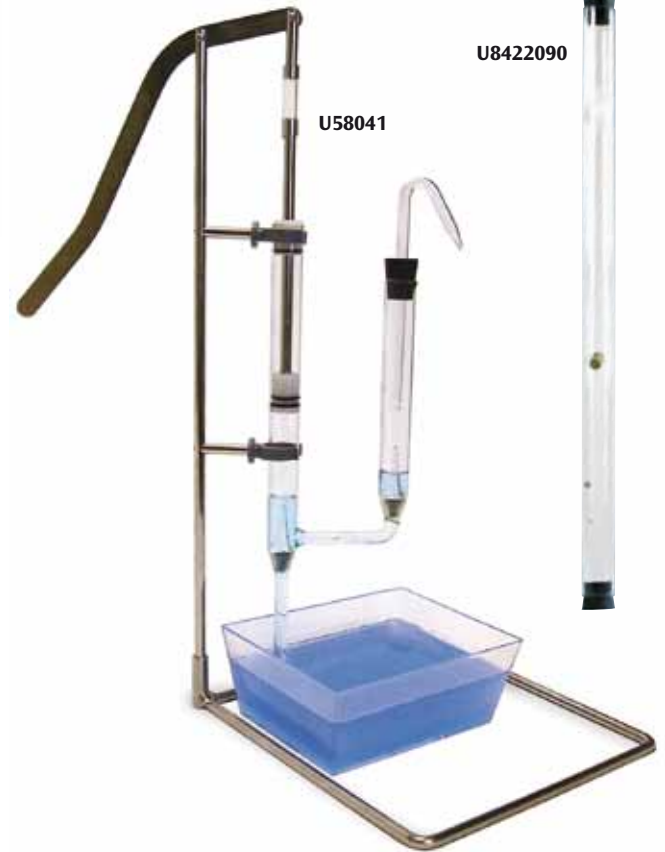
U14325

Suction and Pressure Pump

The apparatus is a working model of a reciprocating type pump that uses a piston and cylinder arrangement with integrated suction and discharge valves. The transparent model demonstrates clearly the operation of valves working within the pump. The apparatus is supplied complete with a plastic water container.

- Height: 525 mm
- Base: 240x240 mm²
- Water container: 175x135x67 mm³

U58041



U58041

U8422090

Free-Fall Tube (Guinea and Feather Apparatus)

This glass pipe can be evacuated to compare the free falling characteristics of different objects in a vacuum. A cork, duck feathers and plastic parts are included as falling objects.

- Length: approx. 800 mm
- Diameter: 36 mm diam.
- Hose nipple: 10 mm
- Weight: approx. 1 kg

U8422090

Additionally required:
1012856 Vacuum Hand Pump

Hydraulic/Pneumatic Lifting Platform

Complete equipment set for demonstration and practical training such as investigating transmission of hydraulic or pneumatic force, the relationship between force, surface area and pressure as well as verification of Boyle's law. A rugged stand holds a cylinder with piston (60 cm³ volume). The lifting platform is positioned on the piston. Various levels of pressure can be exerted on the piston using a system of tubing with 3 simple hand pumps of different volumes. A hose fitting for connection of a pressure sensor required to record measured values with a datalogger is also included.

- Dimensions: approx. 140 mm diam. x 190 mm
- Pump volumes: 3 cm³, 6 cm³, 20 cm³

U45053



U45053

Viscosity measurements using the following substances

- Light oils, machine oils, petroleum, petroleum ether, diesel (mineral oils and fuels)
- Plastic solutions, resin solutions, adhesive solutions, latex dispersions (polymer chemicals)
- Printers' ink, varnish, water-based paints, inks (inks and paints)
- Emulsions, suspensions, solutions, extracts (cosmetics/pharmaceuticals)
- Emulsions, dispersions (paper industry)
- Liquid detergents, washing-up liquid, tenside solutions (detergents)
- Honey, fruit juice, beer, milk (food industry)
- Gases and mixtures of gases

Falling Sphere Viscometer

Höppler-type falling sphere viscometer for simple but accurate measurement of dynamic viscosity of transparent Newtonian fluids. The sphere rolls and slides inside an inclined cylindrical tube filled with the fluid to be tested. The viscosity is measured in mPa s and is derived directly from the time the sphere takes to fall a specified distance through the fluid in the measuring tube. The tube can then be turned upside-down so that time the sphere takes to fall back can also be measured. The tube is situated inside a water bath, which can be filled with water at a specific temperature in order to measure how viscosity depends on temperature.

Includes:

Falling sphere viscometer with 6 spheres and 1 ball gauge
Thermometer 0 – 100° C
Cleaning set

Test certificate with accurate values for sphere constant K and density ρ for converting duration of fall to actual viscosity.

Technical data

Measuring range:	0.5 mPa s to $7 \cdot 10^4$ mPa s (as per DIN 53015) > $7 \cdot 10^4$ mPa s (for sphere fall times > 300 s)
Measurement precision	0.5 to 2% (depending on spheres used)
Spheres:	#1, #2: Borosilicate glass #3, #4: Ni-iron #5, #6: Steel
Diameter of spheres:	11.00 to 15.81 mm
Diameter of measuring tube:	15.95 mm
Fall times for spheres	30 to 450 s
Length of measured distance:	100 mm in both directions
Operating angle:	10° to vertical
Additional working angles	70°, 60°, 50° to horizontal
Volume when full:	40 ml
Permissible temperature range:	-60°C to +150°C
Dimensions:	180x220x330 mm
Weight:	3.1 kg

1012827

Additionally required:

U11902 Digital Stopwatch

Additionally recommended:

U10146 Silicon Tubing (2x)

U144002-230 Immersion/Circulation Thermostat (230 V, 50/60 Hz)

or

U144002-115 Immersion/Circulation Thermostat (115 V, 50/60 Hz)

NEW

Surface Tension Ring

Aluminium ring with a blade for determining the surface tension of liquids. Includes a hook and three threads for suspension from a dynamometer.

Diameter: 60 mm

Weight: 5 g approx.

U8412160

Additionally required:

U15020 Laboratory Jack

U20030 Dynamometer 0.1 N

U14210 Beaker, 600 ml

Stand equipment



U8412160



U58020

Communicating Tubes T

Four vertical glass tubes of different shapes linked by a horizontal glass tube demonstrate that liquid levels remain the same regardless of the shape of the vessel.

Height: approx. 195 mm

U58020

Wedge Shaped Vessel

Wedge shaped vessel made of transparent acrylic for demonstrating the surface tension of liquids and capillary forces.

Length: 100 mm

U8411130



U8411130



1012827

NEW

Vacuum



U29497

Vacuum Chamber with Hand Pump

Inexpensive, transparent plastic vacuum chamber for basic experiments with low pressure. Hand pump integrated into base plate, bleed valve and manometer for measuring pressure down to 330 hPa.

Dimensions: 200 mm diam. x 250 mm

U29497

Additionally required:
U29496 Set of 100 Balloons



U30010

1012856

Magdeburg Plates

Equipment set for demonstrations and practical teaching of Guericke's historical experiment investigating the effect of atmospheric pressure. Includes nozzle for tubing, a simple hand pump and tubing with built-in directional valves. Two transparent acrylic plates with handles that can be held together with a coarse vacuum between them. Three sealing rings of various sizes are supplied for sealing the plates. This allows the dependency of the force on the contact area to be investigated.

Acrylic plates: approx. 13 mm x 105 mm diam.

Sealing rings: approx. 65 mm, 80 mm, 100 mm diam.

U45054



U45054

Mechanics



U29496

Set of 100 balloons

Set of 100 balloons for use in vacuum chamber with hand pump.

U29496

Magdeburg Hemispheres

To demonstrate Von Guericke's historical experiment on the effect of atmospheric air pressure. Two plastic hemispheres equipped with handles can be joined vacuum-tight using the insertable rubber sealing ring. One hemisphere is equipped with a stopcock and hose connection. Including air hose.

Vacuum connection: 8 mm

Diameter: 120 mm

Hose length: 110 mm

U30010

Additionally required:
1012856 Vacuum Hand Pump

Vacuum Bell Jar

Vacuum bell jar made of glass with grip knob and polished flange to be set on top of the vacuum experiment plate (U21850).

Inner diameter: 190 mm
Total height: 220 mm

U21851



Vacuum Experiment Plate

Experiment plate for the assembly of a vacuum chamber in conjunction with the vacuum bell jar (U21851) for experiments in the coarse and fine vacuum range. Metal plate with sealing ring on a tripod, hose connection of the pump-side and ventilation cock. Includes two-pole current feed via 4-mm safety sockets and cable of approximately 1 m length with 4 mm safety plugs, plus a central bore with M12 thread for attaching experimental equipment.

Diameter: 250 mm
Height: 90 mm
Electrical limit specs.: max. 48 V, max. 12 A
Vacuum connection: 2 hose nozzles 12 mm and 8 mm diam.

U21850

Additionally required:

- U21851 Vacuum Bell Jar**
- U34000 Rotary-Vane Vacuum Pump, Two-Stage**
- U10140 Vacuum Hose 8 mm**

Vacuum Recipient

Inexpensive vacuum recipient made of transparent acrylic for experiments in coarse and fine vacuums. Comprises a base and vacuum cylinder with venting valve, manometer, inlet tap, entrance for contacts and rubber ring.

Volume: 9 l approx.
Leakage rate: < 0.5 mbars/h
Base plate: 320x320x10 mm approx.
Vacuum cylinder: 200 mm x 240 mm (diam.) approx.
Thickness of walls: 5 mm
Weight: 2.9 kg approx.

1009943

Additionally required:

- 1012830 Vacuum Tubing, 6 mm**
- U34000 Rotary-Vane Vacuum Pump, Two-Stage**

Electric Doorbell

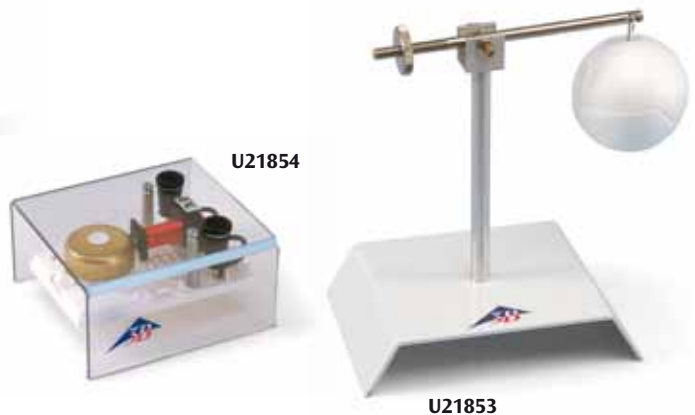
Bell for demonstrating electro-magnetic operation of apparatus and verifying that sound waves do not propagate in a fine vacuum (< 1 hPa). Open acrylic housing with 4-mm safety sockets.

Power supply: 6 V AC
Dimensions: 100x95x50 mm³

U21854

Additionally required:

- Vacuum Chamber**
- Vacuum Pump**
- U33300-230 Transformer with Rectifier 3/ 6/ 9/ 12 V, 3 A (230 V, 50/60 Hz)**
- or
- U33300-115 Transformer with Rectifier 3/ 6/ 9/ 12 V, 3 A (115 V, 50/60 Hz)**



Baroscope

Beam balance on base with suspended polystyrene ball and adjustable counterweight for demonstrating buoyancy on a body due to atmospheric pressure. At a state of equilibrium a Baroscope is placed in a vacuum bell jar under atmospheric pressure. The air in the bell jar is then evacuated, the Styrofoam sphere falls on account of the reduction in lift.

Styrofoam sphere: 50 mm diam.
Base: 120x90 mm²
Height: 125 mm

U21853

Additionally required:

- Vacuum Chamber**
- Vacuum Pump**



1009943

NEW

Vacuum Pumps with Hose Connections



1012831

1012830

U10140



U10141



U8421210

Vacuum Hoses

Vacuum hoses made of natural rubber according to DIN 12865. Colour red.

	1012831	1012830	U10140	U10141
Length	1 m	1 m	1 m	1 m
Internal diameter	4 mm	6 mm	8 mm	10 mm
Wall strength	4 mm	4 mm	5 mm	5 mm
Temperature range	-30° up to + 85°	-30° up to + 85°	-30° up to + 85°	-30° up to + 85°

Water-Jet Pump

Pump for experiments in a coarse vacuum; equipped with an integrated non-return valve to prevent water rise; can be disassembled.

- Material: Plastic
- Suction capacity: approx. 4 l/min (dependent on water pressure)
- Final total pressure: approx. 15 hPa (dependent on water temperature)
- Pump-out time for a 5 l container: 6 to 10 minutes
- Threaded joint: R 1/2" with inserts for R 3/8" and R 3/4"



U16050

U16050

Piston Vacuum Pump

Robust two-stroke piston pump for vacuum experiments, for final vacuum pressures down to 400 hPa. Air is pumped out on both the upward and the downward stroke of the piston. Includes carrying rod with handles and heavy base plus vacuum hose diam. 5 mm.

- Final pressure: 400 hPa
- Tubing nozzle: 5 mm diam.
- Dimensions: approx. 160x235x560 mm³
- Weight: approx. 1.7 kg

U8421210

Vacuum Hand Pump

Simple mechanical air pump for filling and evacuating small containers; equipped with an ergonomic handle, a manometer with a pointer that rotates through a full 360°, a ventilation valve, two hoses (long and short) and six connecting adapters.

- Final pressure: from -980 hPa to 4000 hPa
- Tubing nozzle: 8.5 mm diam.
- Hose: 850 mm x 6.5 mm internal diam. 65 mm x 4.5 mm internal diam.
- Dimensions: approx. 180x60x260 mm³
- Weight: approx. 0.3 kg

U1012856



1012856

Rotary-Vane Vacuum Pump, One-Stage

High performance, compact, one-stage, oil-sealed rotary vane pump for vacuum experiments. With thermal overload protection, handle, air valve, manometer and hose nipple. Includes pump oil.

- Suction capacity: 100 l/min
- Final pressure: 0.03 hPa
- Motor power: 245 W
- Manometer: 0 – 1000 hPa
- Hose nipple: 10 mm diam.
- Dimensions: approx. 335x138x250 mm³
- Weight: approx. 8 kg

1012855

Rotary-Vane Vacuum Pump, Two-Stage

High performance, compact, two-stage, oil-sealed rotary vane pump for vacuum experiments. With thermal overload protection, handle, air valve, manometer and hose nipple. Includes pump oil.

- Suction capacity: 100 l/min
- Final pressure: 0.003 hPa
- Motor power: 245 W
- Manometer: 0 – 1000 hPa
- Hose nipple: 10 mm diam.
- Dimensions: approx. 335x138x250 mm³
- Weight: approx. 11 kg

U34000



1012855

NEW



U34000

Mechanics

2-Way Ball Valve DN 16 KF

Connection: DN 16 KF
Length: 100 mm

U14510



U14511

U14512



U14516

Dummy Flange DN 16 KF

Connection: DN 16 KF

U14514



U14515



U14513

U14514

Crosspiece DN 16 KF

Connection: DN 16 KF
Dimensions: 80x44 mm²

U14511

Adapter Flange DN 16 KF / Shaft 12 mm

Adapter flange for connecting a vacuum hose to ISO-KF systems.

Connection: DN 16 KF
Tubing nozzle: 12 mm
Length: 40 mm

U14515

Adapter Flange DN 16 KF / NS 19/26

Adapter flange for connecting components with internally ground nozzles, e.g. gas discharge tube (U14380, to ISO-KF systems).

Connection: DN 16 KF
Core: 19/26 NS
Length: 40 mm

U14516

Ventilation Valve DN 16 KF

Connection: DN 16 KF
Dimensions: 36 mm x 26 mm Ø

U14513

T-Piece DN 16 KF

Connection: DN 16 KF
Dimensions: 50x44 mm²

U14512

Rotary-Vane Vacuum Pump, PK 4 D

Compact, two-stage rotary pump with high suction capacity. Automatic lubrication of the rotary valve and ball bearings using optimized oil pressure increases the final pressure levels achievable, stabilizes the pump temperature and prolongs the pump's working life. Includes direct drive with elastic coupling. Device exhibits good resistance to chemicals and a high degree of water vapour compatibility. A suitable mechanism prevents the oil from rising back to contaminate the recipient. Lightweight device that operates with low noise. High-quality parts make the device capable of continuous operation. The pump is complete and ready for connection with a full complement of oil, centring ring, locking ring, motor protection circuit breaker, mains switch and connection cable with mains plug

Connecting flange: DN 16 KF
Suction performance (Pneurop): 77/92 l/min at 50/60 Hz
Final pressure (without partial gas ballast): 2×10^{-4} hPa
Final pressure (with total gas ballast): 1×10^{-2} hPa
Water vapour tolerance: 60 hPa
Motor output: 200 W
Oil capacity: 530 ml
Dimensions: 415x150x235 mm³ approx.
Weight: 17.5 kg approx.

Rotary-Vane Vacuum Pump PK 4 D (230 V, 50/60 Hz)

U14501-230

Rotary Vane Vacuum Pump PK 4 D (115 V, 50/60 Hz)

U14501-115

U14511



U14518

U14517

U14512

Tension Ring DN 10/16 KF

Tension ring for mechanically secure connection of ISO-KF components.

Connection: DN 16 KF

U14517

KF External Centring Ring DN 10/16 KF

Rubber sealing ring for ISO-KF connections.

U14518

Pirani Vacuum Gauge

An easily programmable desktop device for measurement and control in fine and coarse vacuums using a Pirani vacuum gauge. Includes a clearly arranged membrane keypad, measuring line (3m) and mains cable.

Vacuum connection: DN 16 KF
Measuring range: 120 – 0.001 hPa
Measurement uncertainty: < 20% of the display value
Display: Digital LED display in mbar/torr
Digit height: 10 mm
Readout: 5 per s
Recorder output: 0 – 10 V
Threshold switch: 2x230 V, 2 A, independently adjustable

Switching accuracy/hysteresis: ± 1 digit
Permissible overload: 2 bar absolute
Power consumption: max. 15 W
Dimensions: 98x98x152 mm³ approx.
Weight: 1.2 kg approx.

Pirani Vacuum Gauge (230 V, 50/60 Hz)

U145051-230

Pirani Vacuum Gauge (115 V, 50/60 Hz)

U145051-115



U14501-230
U14501-115



U145051-230
U145051-115

Jet Nozzle (Flow Laminator)

Nozzle for emitting a near laminar air stream, e.g. for experiments with the set of drag and lift objects or experiments on recoil. Mounted on a stem. The very light air nozzle contains no moving parts and generates no spin. It spreads out the air stream from a connected fan. Air that comes out of the tubular nozzles near the plastic ring mixes with the secondary air to form an overall air stream of a large diameter. Includes a hose.

- Air inlet: 33 mm
- Air outlet: 120 mm
- Dimensions: 255x150 mm²
- Stand holder: 10 mm
- Weight: approx. 350 g

U8404250

Additionally required:
U15425-230 Air Flow Generator
 (230 V, 50/60 Hz)
 or
U15425-115 Air Flow Generator
 (115 V, 50/60 Hz)
Stand Equipment

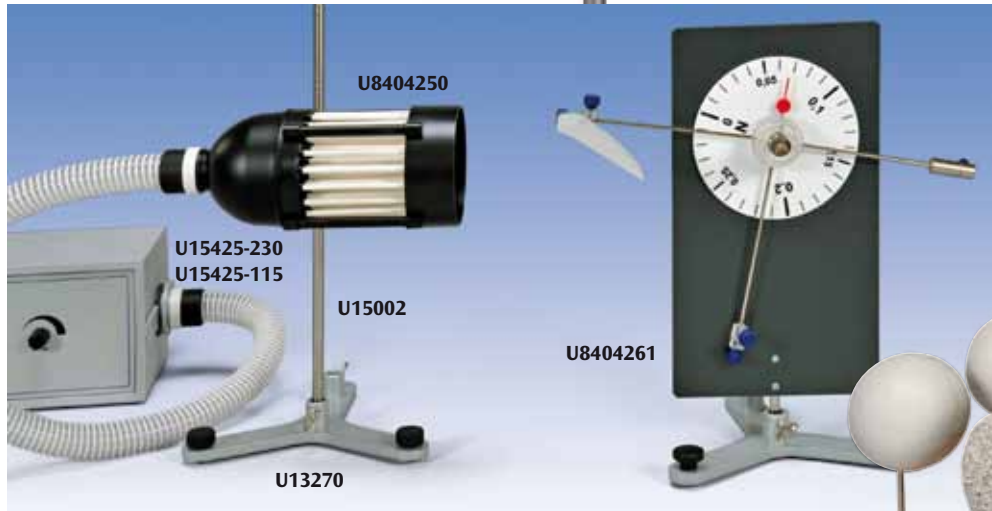


Component Balance

Scales for measuring components with holding mechanism for measuring air resistance and buoyancy of bodies from set U8404260. On rod.

- Measuring range: 0 – 0.3 N
- Diameter of the scale: 170 mm
- Dimensions: approx. 350x220 mm²
- Rod diameter: 10 mm
- Weight: approx. 0.9 kg

U8404261



Air Flow Generator

Fan allowing continuous adjustment of air flow. Includes a hose.

- Hose length: approx. 1.5 m
- Power consumption: max. 1100 W
- Dimensions: 300x180x170 mm³
- Weight: 4.4 kg

Air Flow Generator (230 V, 50/60 Hz)

U15425-230

Air Flow Generator (115 V, 50/60 Hz)

U15425-115



U15425-230
U15425-115

Set of bodies for air resistance and buoyancy experiments

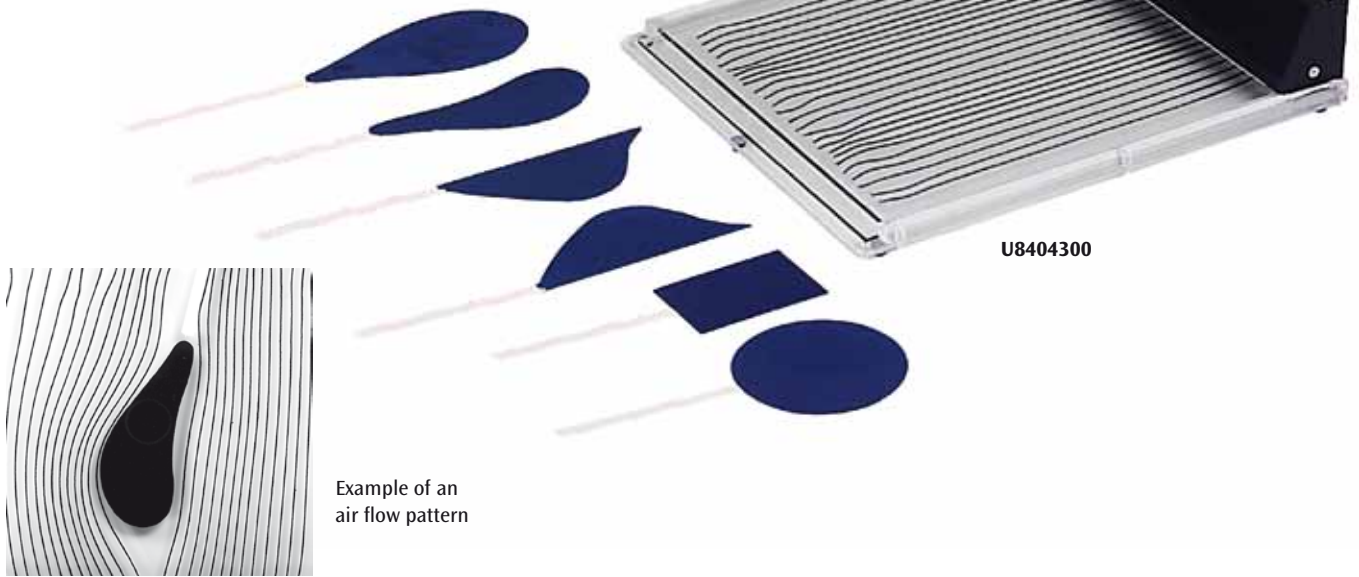
Set of 7 wooden models on stems for measuring buoyancy and fluid resistance of various bodies in laminar air flows. Including storage block.

Contents:

- 1 streamlined body, smooth, l = 120 mm
- 1 streamlined body, rough, l = 120 mm
- 1 ball, d = 50 mm
- 1 circular disc, d = 47 mm
- 1 circular disc, d = 68 mm
- 1 semi sphere, d = 50 mm
- 1 plate, 150 mmx40 mm
- 1 wing profile, l = 150 mm

U8404260

Additionally required:
U8404250 Jet Nozzle (Flow Laminator)
U8404261 Component balance



Air Flow Apparatus

Apparatus for demonstrating air flow patterns around bodies of different shapes. The air flow patterns can be projected on to a wide screen using an overhead projector. Two strings are fastened on one side at equal distances between two glass plates. The strings move according to the air currents between the two glass plates. Bodies of different shapes can be introduced in the air current. The inserted bodies can be moved to various positions in the air current from outside. Includes a hose.
 Dimensions: approx. 385x310x75 mm³
 Weight: approx. 3.2 kg

Contents:

- 1 Air flow apparatus
- 1 Circular body
- 1 Rectangular body
- 1 Streamlined body
- 1 Wing section
- 2 Bodies to demonstrate narrowing of flow
- 1 Hose

U8404300

Additionally required:

- U15425-230 Air Flow Generator (230 V, 50/60 Hz)** or
- U15425-115 Air Flow Generator (115 V, 50/60 Hz)**

Additionally recommended:

- U30150-230 Overhead Projector (230 V, 50/60 Hz)** or
- U30150-115 Overhead Projector (115 V, 50/60 Hz)**



Laminar Flow Apparatus

For demonstrating and investigating the laminar flow properties of water. The emergence of currents in water, the flow of current in the case of straight laminar flow and the overflow of differently shaped bodies can be studied. The flow of current at a narrows can also be demonstrated clearly. A rectangular piece of velour paper is placed in the apparatus consisting of an upper and lower trough. Owing to capillary forces, water from the upper trough is drawn in by the paper. The water flows down into the velour paper. The flow of water in the upper level is marked with a dye at constant intervals. Owing to the low speed of flow of approx. 2 mm/s, the development of currents can be observed with the help of the dye. After the velour paper has been dried, a lasting current pattern remains, which can be copied and evaluated.

Dimensions: approx. 220x140x240 mm³
 Weight: approx. 1 kg

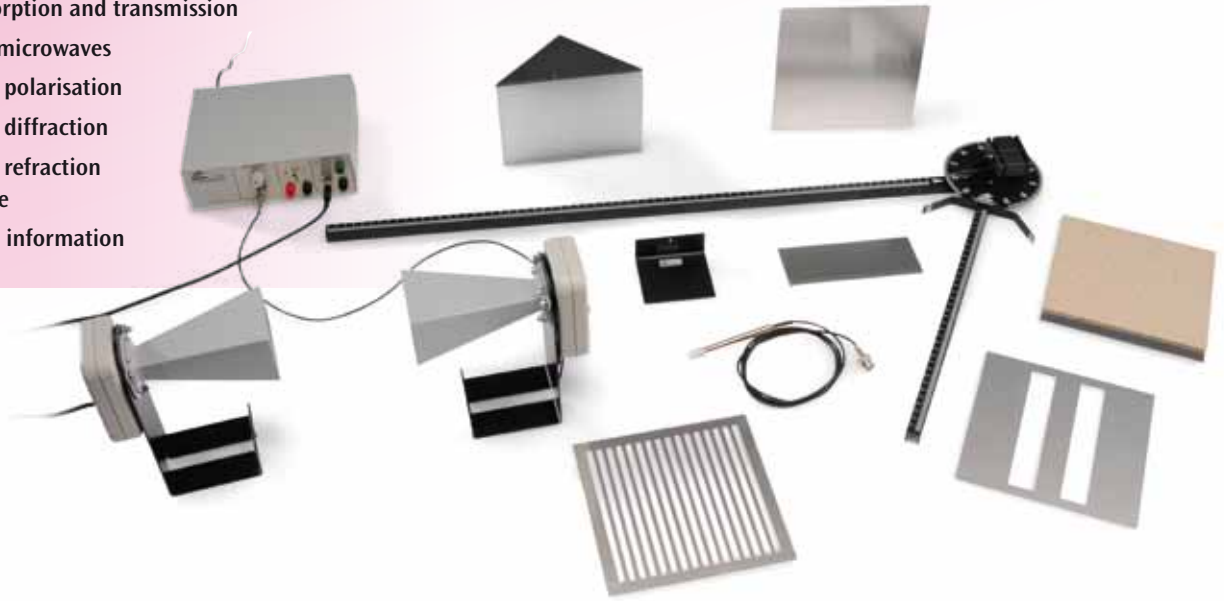
U8404248

Contents:

- 2 Acrylic glass basins
- 1 Mask
- 20 Sheets of velour paper with cut-outs
- 1 Mini-flask with dye
- Swab for dye
- Rubber gloves

Experiment Topics:

- Straight-line propagation of microwaves
- Reflection, absorption and transmission
- Shielding from microwaves
- Experiments on polarisation
- Experiments on diffraction
- Experiments on refraction and interference
- Transmission of information



Microwave Set

Equipment set for conducting wave optics experiments involving wavelengths in the cm range. A transmitter with a horn antenna radiates a narrow beam of linearly polarised electromagnetic waves with a wavelength of about 3 cm. The direction of polarisation can be altered by rotating the antenna around the axis of propagation. To detect the waves, a horn antenna receiver and a microwave sensor are provided. A control unit converts the intensity of the signal received into a proportionally large output voltage that can be measured using a voltmeter. It is also possible to switch on an acoustic signal with a volume that is proportional to the intensity of the signal.

Oscillator frequency:	9.4 GHz (1009951) 10.5 GHz (1009950)
Power of transmitter:	10 – 25 mW
Internal modulator frequency:	3 kHz approx.
Acoustic signal:	Switchable
External modulation:	100 Hz – 20 kHz, 1 V max.
Output voltage:	10 V max.
Receiver with horn antenna:	Silicon diode with resonator
Microwave sensor:	Silicon diode with resonator
Dimensions of basic apparatus:	approx. 160x200x75 mm ³

Contents:

- 1 Control unit
- 1 Transmitter with horn antenna
- 1 Receiver with horn antenna
- 1 Microwave probe
- 1 Microwave bench, 800 mm
- 1 Microwave bench, 400 mm with plate holder
- 1 Reflection plate 180x180 mm²
- 1 Polarisation grating, 180x180 mm²
- 1 Absorption plate, fibreboard, 180x180 mm²
- 1 Paraffin prism
- 1 Stand for prism
- 1 Plate with double slit
- 1 Cover plate for double slit

Microwave Set 9.4 GHz (230 V, 50/60 Hz)

1009951

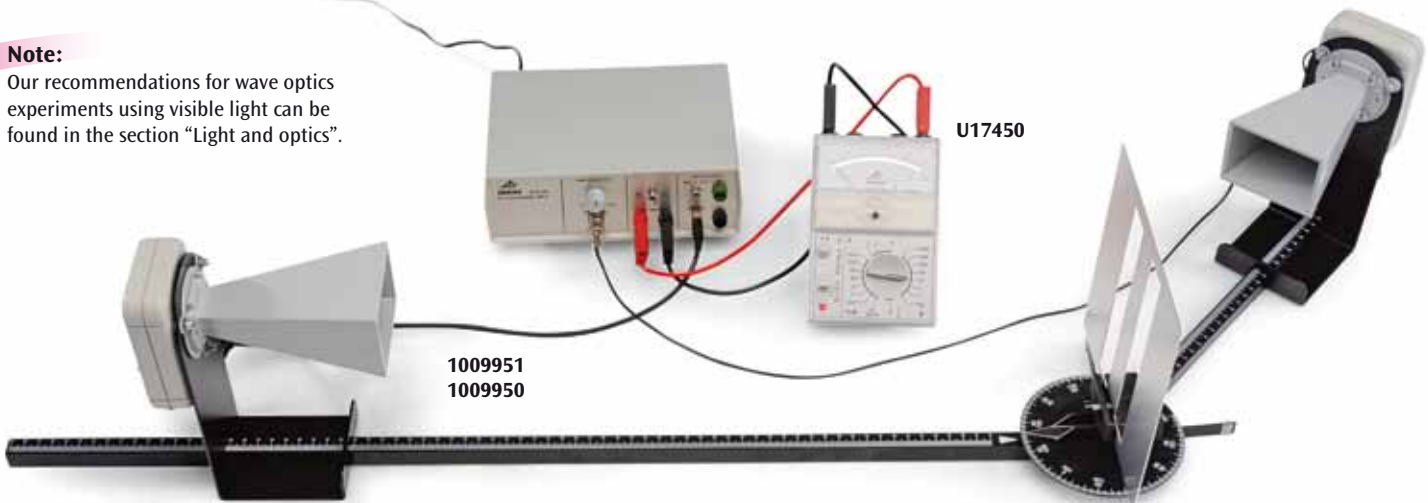
Microwave Set 10,5 GHz (115 V, 50/60 Hz)

1009950

Additionally recommended:
U17450 Analogue Multimeter, AM50

Note:

Our recommendations for wave optics experiments using visible light can be found in the section "Light and optics".



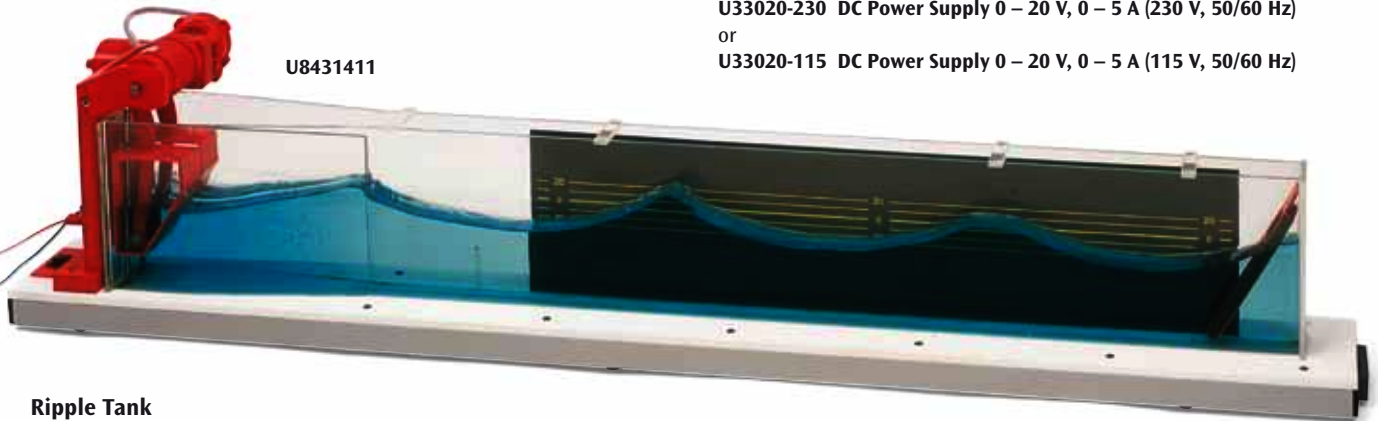
Refraction by a double slit

Experiment Topics:

- Excitement of periodic and non-periodic waveforms
- Deflection, phase and amplitude
- Frequency and wavelength
- Phase and group velocities
- In-phase and out-of phase superimposition of waves
- Reflection of a wave
- Standing waves

BEST SELLER

U8431411



Waterwave

Water Wave Channel

Wave channel for demonstrating or investigating the basic properties of waves using waves in water. A plexiglas duct is filled with water and a sinusoidal wave is generated that propagates with no reflection at the end thanks to an absorber mechanism. The frequency and thus the wavelength of the resulting movement can be varied continuously. In order to investigate reflection, the absorber at the end can be removed. Two exciting mechanisms are supplied that can be operated in or out of phase and the waves they generate can be viewed separately or superimposed. By applying a pulsed input to the exciters, non-periodic waves can be generated.

Supply voltage: 9 – 12 V DC
 Power consumption: 40 W max.
 Connectors: 4 mm safety sockets
 Frequency range: Continuously adjustable
 Dimensions: approx. 1500x150x290 mm³
 Weight: approx. 12.6 kg

U8431411

Additionally required:

U33020-230 DC Power Supply 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz)
 or
 U33020-115 DC Power Supply 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz)

Ripple Tank

Equipment set for demonstrating or investigating the basic properties of waves using waves in water. The ripple tank consists of a shallow basin with a glass bottom inside an aluminium frame. A halogen lamp operated via a stroboscope illuminates the tank from above. Underneath the tank is a diagonally aligned mirror that is used to project the waves onto a frosted glass screen. Waves in the water are produced via the oscillation of an electromagnetic vibrator, to which dippers for straight waves or up to three dippers for making concentric waves can be attached. A control unit sets the amplitude and frequency of the vibrations and the frequency of the stroboscope either synchronously or asynchronously. 4 mm safety sockets are provided for connecting a counter/timer in order to measure the frequency of the vibrations.

Frequency range: Continuously adjustable
 Supply voltage: 9 – 12 V DC
 Connectors: 4 mm safety sockets
 Lamp: Halogen lamp 12 V/35 W, GY6, 35
 Dimensions of tank: approx. 295x395x10 mm³
 Dimensions of frame: approx. 340x440x345 mm³

Contents:

- 1 Ripple tank with projection mirror; lamp and stroboscope
- 1 Control unit
- 1 Vibrator
- 1 Dipper for straight waves
- 3 Dippers for concentric circular waves
- 1 Holder for circular wave dippers
- 3 Bodies that can be laid in the tank to demonstrate reflection and diffraction (prism, bi-concave and bi-convex lenses)
- 1 Obstruction with a wide gap and four separate small gaps
- 2 Narrow covers
- 2 Wide covers
- 1 Drainage tube
- 1 Tube clamp

U21910

Additionally required:

U33020-230 DC Power Supply 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz)
 or
 U33020-115 DC Power Supply 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz)

Experiment Topics:

- Generation of circular and straight waves
- Reflection
- Refraction
- Interference
- Diffraction
- Doppler effect

BEST SELLER



U21910

Waves & Sound

Spare Halogen Lamp, 12 V, 35 W (not shown)
 Spare halogen lamp for the ripple tank (U21910).

U21911

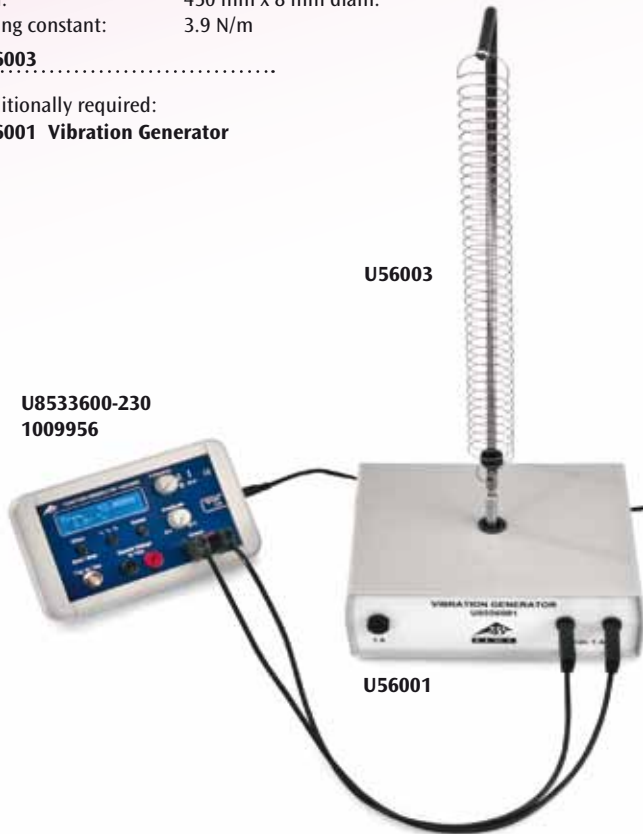
Accessories for Spring Oscillations

Accessories ideal for vibration generator U56001 for demonstrating standing longitudinal waves in a coil spring. Consisting of angled stand rod, coil spring and connector pin for attachment of the spring to the vibration generator.

Rod: 450 mm x 8 mm diam.
Spring constant: 3.9 N/m

U56003

Additionally required:
U56001 Vibration Generator

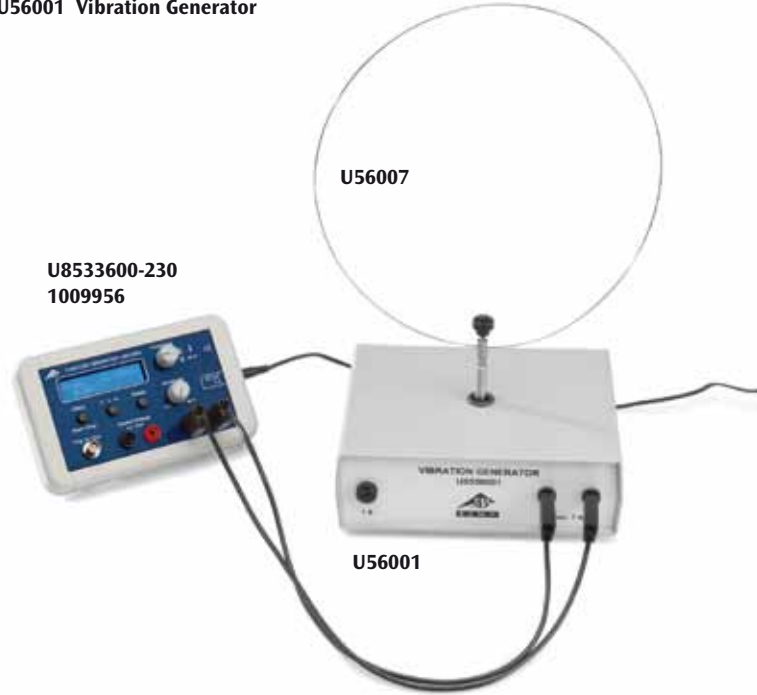


Resonance Wire, Ring Shaped

Accessories for vibration generator U56001 for demonstrating the vibration knots in determination of different frequencies. Wire ring with 4 mm plugs. Diameter: 290 mm

U56007

Additionally required:
U56001 Vibration Generator



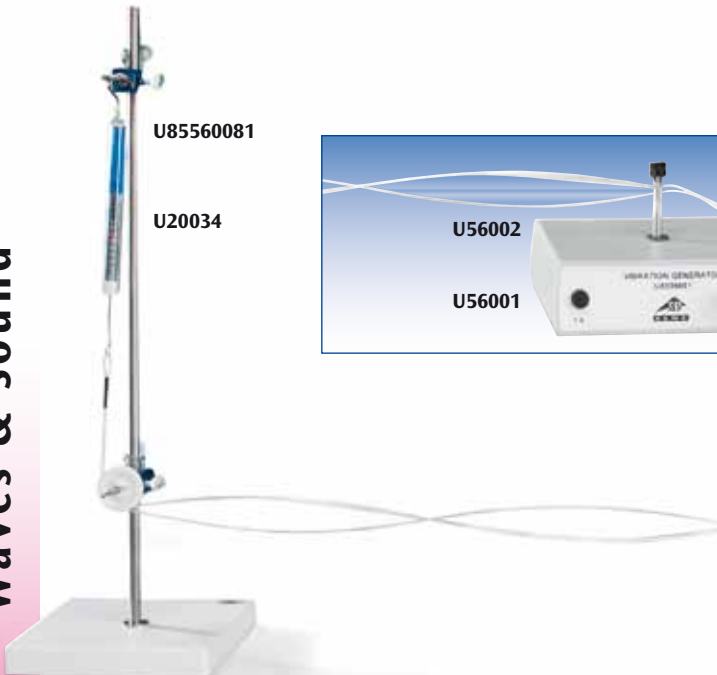
Accessories for Rope Waves

Accessories ideal for vibration generator (U56001) for the investigation of standing transversal waves and their wavelengths as a function of the rope tension and the frequency. Consisting of a base plate with stand rod, holder for dynamometer, deflection device and rubber rope.

Rope: 1 m
Base plate: approx. 180x180x25 mm³

U85560081

Additionally required:
U56001 Vibration Generator
U20034 Dynamometer 5 N



Vibration Generator

Tough vibration generator for exciting oscillations and waves mechanically, e.g. in coil springs, a rubber cord, a wire ring or a Chladni plate. In robust plastic housing including mounting pin with 4 mm socket for attaching accessories (Chladni plates, resonance wire, rubber band etc.). Including holder for stand rod (up to 8mm diam.) on the rear side of the apparatus for the demonstration of standing waves in a coil spring. The generator is equipped with overload protection.

Connection: via 4 mm safety sockets
Impedance: 8 Ω
Frequency range: 0 up to 20 kHz
Overload protection: 1 A fuse
Dimensions: approx. 200x160x70 mm³
Weight: approx. 1.4 kg

U56001

Additionally required:
U8533600-230 Function Generator FG 100 (230 V, 50/60 Hz)
or
1009956 Function Generator FG 100 (115 V, 50/60 Hz)

Rubber Band

For demonstrating stationary waves and wave propagation e.g. Using the vibration generator (U56001). Wound on a board, 25 m, 2 mm diam.

U56002

Additionally required:
U56001 Vibration Generator



Chladni's Plates

Inexpensive metal plates for generating acoustically excited figures in fine dry sand, as in the experiment by Chladni. To be used for instance in conjunction with vibration generator (U56001). With 4 mm plugs.

Chladni Plate, circular, 240 mm diam.

U56005

Chladni Plate, square, 180x180 mm²

U56006

Additionally required:

U56001 Vibration Generator

U56006



U56005



DC Motor 12 V

Compact experiment motor – can also be used as a tachogenerator, oscillation generator or for the excitation of rope waves. The motor has a coreless rotor and thus has a high starting torque at a lower moment of inertia. It is characterised by a very short starting time, smooth running and low running noise. On its axis, the motor has a threaded bush with a screw on retaining pulley. Thus, plates and levers too can be fixed on to the axis.

Nominal voltage/current: 12 V/260 mA DC

Run-up voltage/current: 0.5 V/45 mA DC

Power consumption: 3.6 W

Nominal speed: 3900 rpm

Nominal rated torque: 0.5 Ncm

Direction of rotation: reversible

Connection: via 4-mm safety sockets

Dimensions in mm: approx. 130x55 mm²

Weight: approx. 200 g

U8552330



U8552330

Band Wave Device

Robust apparatus for demonstrating transverse standing waves on a rope and investigating how wavelength depends on the tension in the rope and on the frequency.

Dimensions: 700x150x230 mm³

Weight: approx. 4.4 kg

Contents:

- 1 Chassis
- 1 Rubber cord
- 1 Pulley
- 1 Axle clip
- 2 Axle rods
- 2 Universal clamps
- 2 Stand rods, 400 mm
- 1 Dynamometer, 5 N

U8431776

Additionally required:

U8552330 DC Motor 12 V

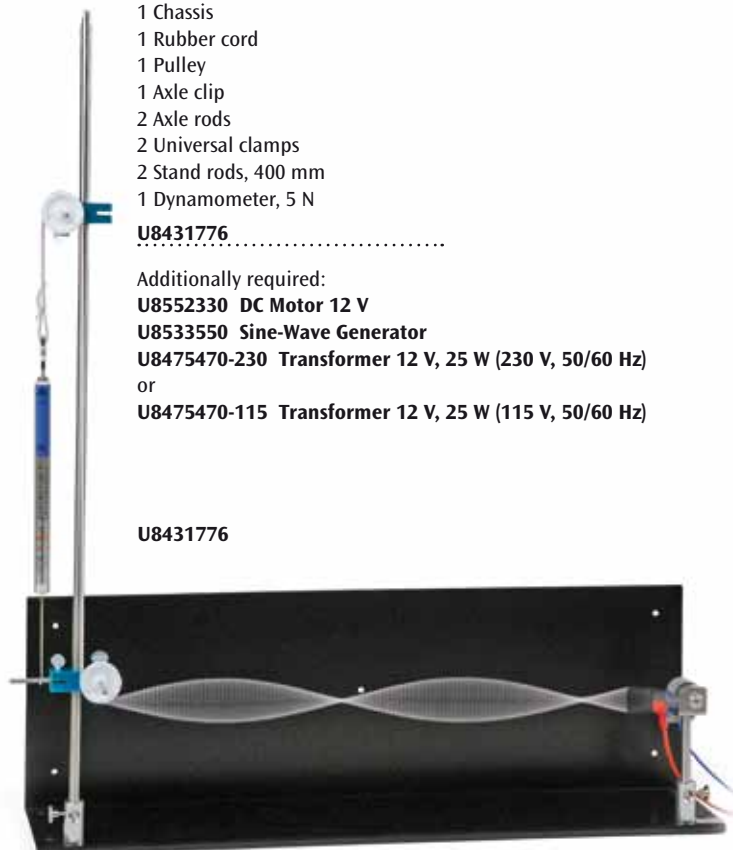
U8533550 Sine-Wave Generator

U8475470-230 Transformer 12 V, 25 W (230 V, 50/60 Hz)

or

U8475470-115 Transformer 12 V, 25 W (115 V, 50/60 Hz)

U8431776





U30034

U8405830



Helical Spring Snake

Very long helical spring for demonstrating and investigating transverse and longitudinal waves.

Length: 2 m up to 14 m
 Total number of turns: 1300
 Coil diameter: 25 mm
 Weight: 1400 g

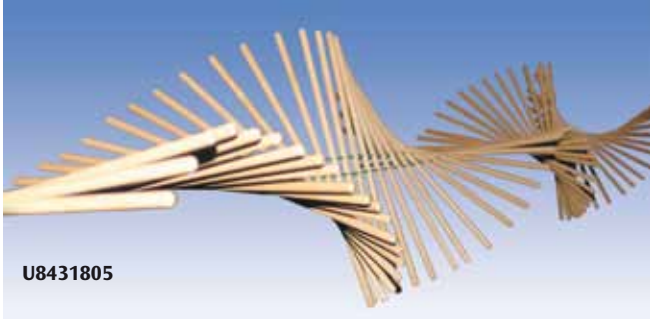
U30034

Coil Spring Slinky

Long coil spring for demonstrating the propagation and reflection of longitudinal waves.

Length: 0.2 m up to 5 m
 Total number of turns: 330
 Coil diameter: 70 mm
 Weight: 550 g

U8405830



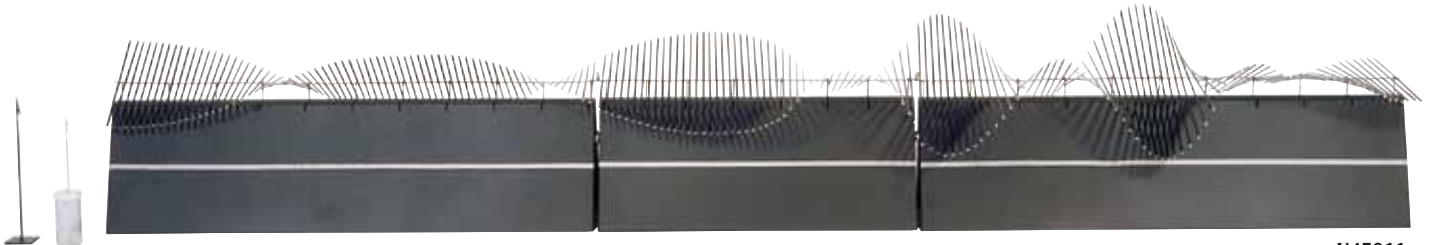
U8431805

Wave Machine, Manual

Demonstration equipment for displaying propagation, reflection, diffraction and superimposition of transverse waves. A chain of wooden double-ended pendulums joined together by a bifilar thread. Two handles allow the chain to be held by hand and excited. Pendulum weights are supplied for altering the moment of inertia.

Number of double pendulums: 79
 Length: 3 m
 Weight: approx. 0.8 kg

U8431805



U45011

Experimental topics:

- Propagation of a moving wave
- Wavelength, frequency and phase velocity
- Reflection of waves at fixed or moving ends
- Standing waves and resonance in the case of fixed or moving ends
- Constructive and destructive reinforcement of waves
- Propagation and speed of communication for a disturbance of equilibrium.
- Reflection of a disturbance of equilibrium at fixed or moving ends
- Damping of moving waves
- Reflection at a transition (experiment only possible with full set)
- Coupling at a transition (experiment only possible with full set)

Demonstration Wave Machine, Complete Set

Supplement to the demonstration wave machine comprising a module with short pendulum bars, a transition module and two module couplers. If the two models with differing bar lengths and thus differing wave velocities are coupled together, then reflections can be observed at the point where they are joined together. This can be avoided by adding the transition module.

Length of bar module 1: 460 mm
 Length of bar module 2: 230 mm
 Length of bars for transition module: 230 – 460 mm
 Total length: 2440 mm

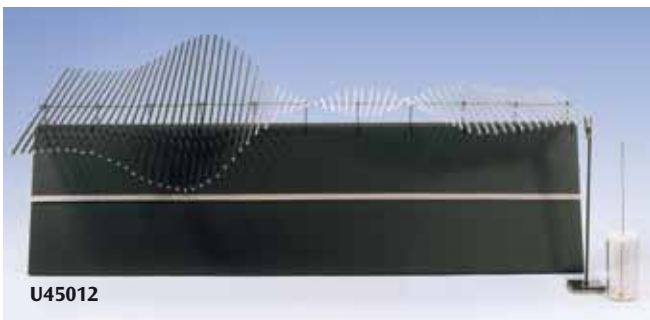
U45011

Demonstration Wave Machine, Single Module

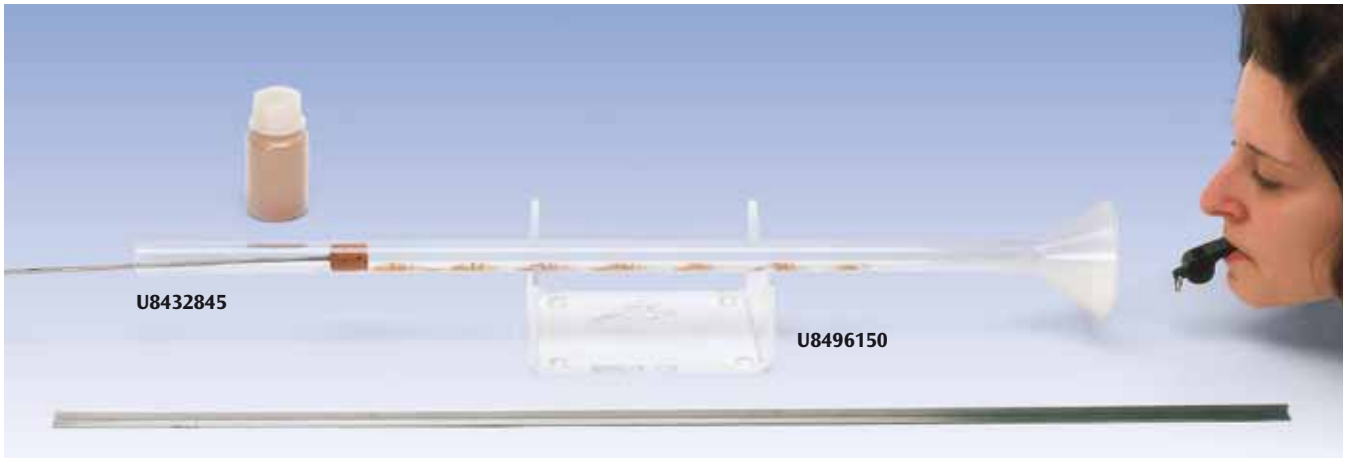
Wave machine for conducting various demonstration experiments to show the behaviour and properties of transverse waves. The motion of the wave is demonstrated by a chain of 73 steel pendulum bars each soldered at their mid-point along a rod spring that can be subjected to torsion. The ends of the bars are painted on one side in fluorescent paint and on the other side with white paint. The machine is mounted on a foldable steel base. A damping mechanism is also supplied and a retaining clamp on a stem for demonstrating reflections at a fixed end.

Number of bars: 73
 Length of bars: 460 mm
 Total length: 920 mm

U45012



U45012



Kundt's Tube

Glass tube for demonstrating standing sound waves and calculating wavelengths of sound using cork powder in a method devised by Kundt. Cork powder is spread evenly throughout the tube by means of a filler chute. Then a sound source, e.g. a whistle, a 1700 Hz tuning fork (U10115) or a horn speaker (U8432680), is used to excite the powder into a regular pattern of nodes and antinodes. The effective length of the tube can be altered by means of a piston.

Length: 600 mm
 External diameter: 20 mm
 Internal diameter: 17 mm

Contents:

- 1 Glass tube with funnel
- 1 Plunger
- 1 Filler chute
- 1 Whistle
- 1 Bottle of cork powder

U8432845

Additionally recommended:
U8496150 Plexiglass Stands

U8432850



Cork Powder, 10 g Bottle

Fine cork powder for use in Kundt's glass tube (U8432845).

U8432850

Battery Box

Accessory for probe microphone (U20601) to be used as a power supply and for connecting the microphone to a meter or oscilloscope. The equipment includes a battery compartment for one 9 V alkaline battery and a voltage regulator to output the requisite 5 V DC.

Output voltage: 5 V DC
 Input channels: two 6-pin DIN sockets (180°),
 8-pin DIN socket (270°)
 Outputs: two 5-pin DIN sockets, two 4 mm safety sockets
 Dimensions: approx. 143x84x37 mm³

U20602



Kundt's Tube with Scale

Transparent acrylic tube with scale and end plates for measuring standing acoustic waves and determining their wavelength in air or in other gases. With tubing nozzles for filling the tube with various gases, built-in speaker at one end, a bore and guide for accommodating moving piston or probe microphone (U20601) at the other end. Includes retaining clips for mounting on stands and a connector lead for the speaker.

Tube nozzle: 7 mm diam.
 Length: 1000 mm
 Diameter: 70 mm

U20600

Additionally required:

- U8611200 Barrel Foot, 0.9 kg (2x)**
- U20601 Probe Microphone**
- U8533600-230 Function Generator FG 100 (230 V, 50/60 Hz)**
or
- 1009956 Function Generator FG 100 (115 V, 50/60 Hz)**

Probe Microphone

Probe microphone for measuring changes in sound pressure in a Kundt's tube with scale U20600. A miniature microphone is attached to one end of a long stainless steel rod.

Frequency range: 20 Hz – 20000 Hz
 Dimensions: approx. 740 mm x 8 mm diam.
 Connector lead: 2 m
 Connectors: DIN plug suitable for battery box (U20602)

U20601

Additionally required:
U20602 Battery Box





U55001

Demonstration Tuning Fork

Large tuning fork for demonstrating the vibrating legs of the fork.

Length: 750 mm

U55001

21 Hz Tuning Fork with Plotter Pen

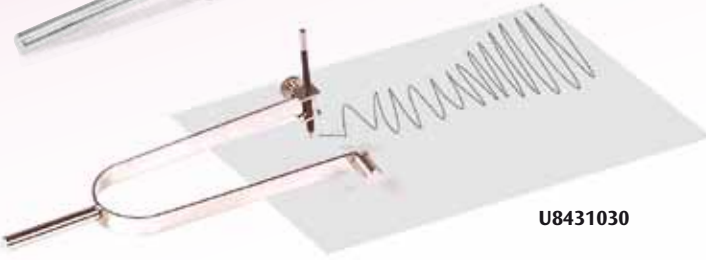
Tuning fork that allows for plotting oscillations on a sheet of paper. The oscillation is triggered by pushing the prongs of the fork together. The oscillation of the tuning fork is highly visible both with the naked eye or with the aid of a stroboscope. Includes a plotter pen with holder and a counter-weight.

Natural frequency: 21 Hz

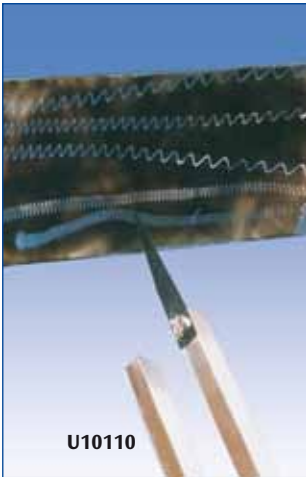
Length: 245 mm

Total weight: approx. 170 g

U8431030



U8431030



U10110

Recording Tuning Fork, c 128 Hz

For demonstrating and recording sound oscillations. For recording the oscillations on a sooted glass plate one of the two prongs is equipped with a metal tip. Complete with a glass plate.

Natural frequency: 128 Hz

Total length: approx. 280 mm

Glass plate: 120x50 mm²

U10110



U10117

Tuning Fork, 2000 Hz

Tuning fork with handle for demonstrating the Doppler Effect. The effect can be exhibited very impressively by moving the fork slowly toward and away from the audience.

Natural frequency: 2000 Hz

Length of the tuning fork: 220 mm

U10117

Additionally recommended:

U10118 **Hard Striking Hammer**



U10115



U10116

Light Metal Tuning Fork, 1700 Hz

Suitable as a source of intense, high-frequency sound, for example, for producing stationary sound waves in Kundt's tube.

Natural frequency: 1700 Hz

Length: approx. 105 mm

U10115

Light Metal Tuning Fork, 1000 Hz

Suitable as a source of intense, high-frequency sound, for example, for producing stationary sound waves in Kundt's tube.

Natural frequency: 1000 Hz

Length: approx. 115 mm

U10116

Tuning Fork, 440 Hz, on Resonance Box

Long-sustain tuning fork mounted on a resonant chamber made of clear grained fir wood. Removable, includes a soft striking hammer U10122.

Natural frequency: 440 Hz

Length of the tuning fork: approx. 170 mm

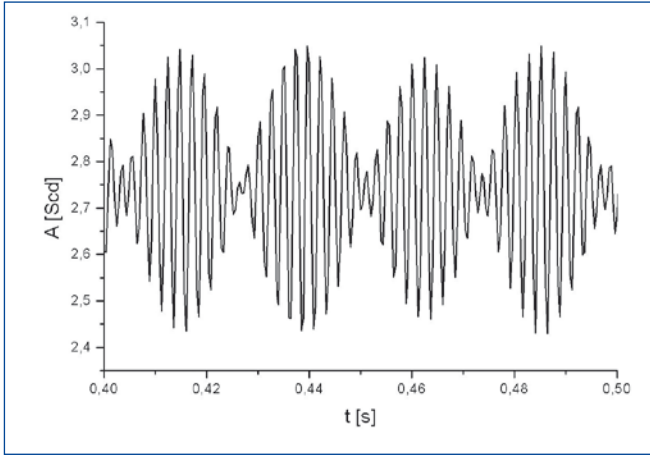
Resonance box: 180x90x50 mm³

U10121



U10121





Acoustic beats

BEST SELLER



U10120

Sound

Pair of Tuning Forks, 440 Hz, on Resonance Boxes

Pair of Tuning Forks for experiments on beats; the tuning forks are identical with (U10121). Complete with a soft striking hammer (U10122) and a pair of tuning weights (U10119).

U10120

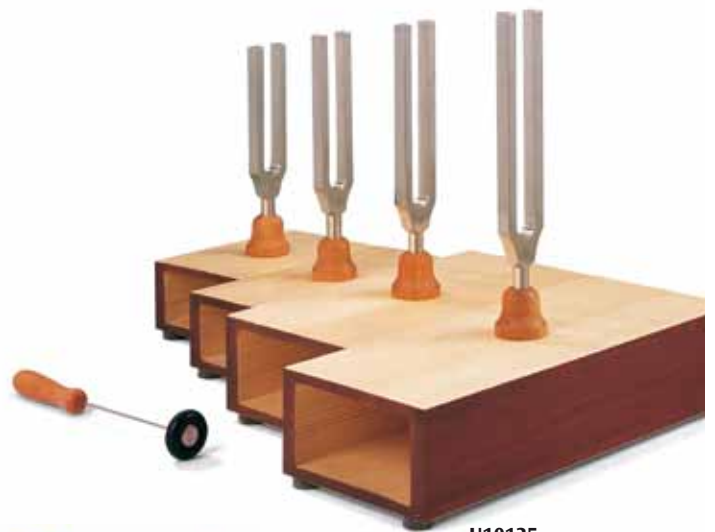
Set of Tuning Forks, C-Major Chord, on Resonance Boxes

Set of four tuning forks for demonstrating C major chord. Supplied on a sound box made of clear grained pine for especially long sustain from which the tuning forks can be removed. Includes a soft striking hammer (U10122).

Natural frequency:

c'	= 256 Hz	Internal length:
e'	= 322 Hz	300 mm
g'	= 384 Hz	240 mm
c''	= 512 Hz	190 mm
		140 mm

U10125



U10125

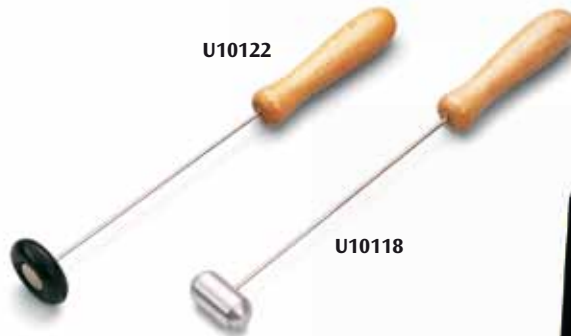
Set of Tuning Forks for the C-Major Scale

Set of 8 tuning forks in a storage case.

Frequencies:

c'	= 256 Hz
d'	= 288 Hz
e'	= 320 Hz
f'	= 341½ Hz
g'	= 384 Hz
a'	= 426½ Hz
h'	= 480 Hz
c''	= 512 Hz

U10100



U10122

U10118

Striking Hammer, Soft

Rubber beater particularly suited for striking low-frequency tuning forks, e.g. tuning forks on sound box (U10120, U10121 and U10125).

U10122

Striking Hammer, Hard

Aluminium beater particularly suited for striking high-frequency 2000 Hz tuning fork (U10117).

U10118

Pair of Tuning Weights (not shown)

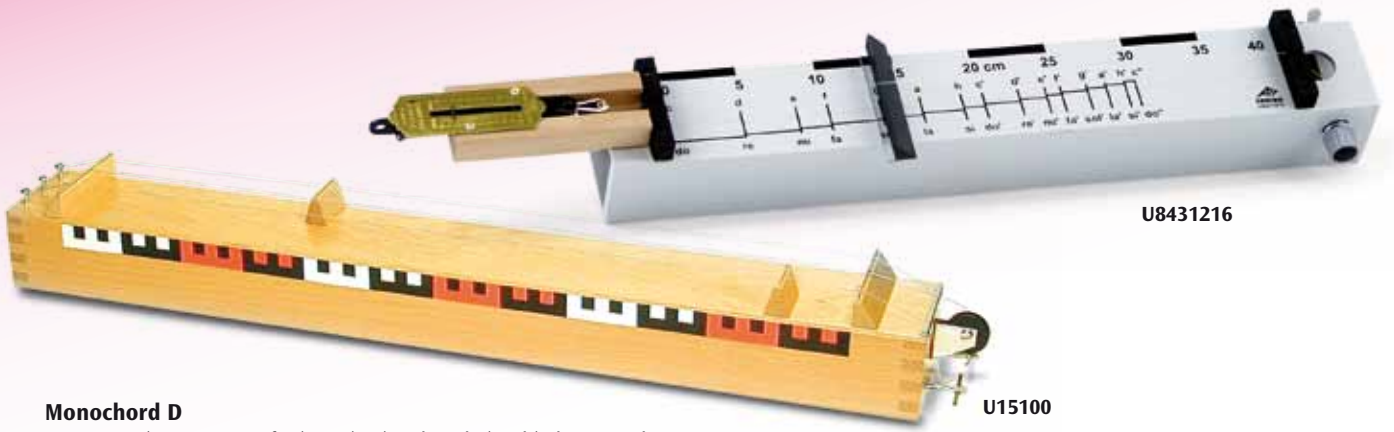
Two tuning weights for changing the frequency of tuning forks for beat experiments; intended for the 440-Hz tuning fork mounted on a resonance box (U10121).

U10119



U10100

Waves & Sound



Monochord D

Demonstration apparatus for investigating the relationship between the pitch of a sound and the length of the string making it. Also for investigating overtones formed by harmonic waves with intermediate nodes and the dependence of the pitch on string tension. Two steel strings and one nylon string are stretched over a sound box. The tension on two of the strings can be altered by tuning pegs while the other's tension can be changed by adding weights or using a dynamometer at the end of a cord passed over a pulley. The effective length of the strings can be altered by means of two moving bridges.

Scale length: 600 mm
 Scale division: cm and dm
 Dimensions of the resonance box: approx. 700x90x70 mm³

U15100

Additionally recommended:
U40815 Dynamometer 50 N

Set of 3 Monochord Strings (not shown)

Two steel and one nylon string with eyelets, fitting the monochord D (U15100).

U15101

Reed Pipe

Reed pipe with 8 valves, tuned to C major.
 Length: 37 cm
 Weight: approx. 90 g

U8430160

Helmholtz Resonator

Hollow glass bulb with a narrow tube leading out for demonstrating acoustic resonance. The fundamental oscillation is generated by blowing into the opening or tapping on the outside of the bulb. The elasticity and inertial mass of the air in the bulb cause the bulb to act as an acoustic resonator with a highly distinct resonant frequency. The frequency is dependent on the dimensions of the bulb and the tube. With a whole set of Helmholtz resonators it is possible to demonstrate how tones combine to form a tonal mixture.

Opening on the glass bulb: 14 mm diam.
 Length of tube: 15 mm
 Internal diameter of tube: 6 mm

Helmholtz Resonator, 70 mm diam.

U8430310

Helmholtz Resonator, 52 mm diam.

U8430320

Helmholtz Resonator, 40 mm diam.

U8430330

Helmholtz Resonator, 32 mm diam.

U8430340



Monochord

A wooden box open at both ends, with a clamping mechanism for a string to demonstrate the relationship between pitch and string length and the dependence of pitch on string tension. Includes an indicator for the tensioning force, as well as a steel string (tuned to B) and a nylon string. Dimensions: approx. 490x70x60 mm³

U8431216



Lip Whistle

Lip whistle for experiments on pitch as a function of resonance space. Closed wooden whistle with a round cross-section and movable piston, chromatic range from g1 (392 Hz) to g2 (794 Hz).
 Frequency range: approx. 400 Hz – 800 Hz
 Resonance space: approx. 170 mm x 20 mm diam.
 Length: approx. 250 mm

1009924

Metallophone

Metallophone for demonstrating a C major scale from c1 to g2. Note labels, frequencies and frequency ratios are printed on the instrument. With striking hammer.
 Dimensions: approx. 320x210 mm²
 Weight: approx. 510 g

U8430290

U8432680

Horn Speaker

Speaker that approximates to being a point source for excitation of Kundt's tube U8432845, for example. Without barrel foot.

Frequency range: 300 Hz – 10 kHz
 Max. load capacity: 8 W (max. 10 W)
 Impedance: 8 Ω
 Shaft: 10 mm diam.
 Weight: approx. 470 g

U8432680

Additionally recommended:

U8533550 Sine Wave Generator

U8475470-230 Transformer (230 V, 50/60 Hz)

or

U8475470-115 Transformer (115 V, 50/60 Hz)



U8611200

Wide-Band Loudspeaker

Ideal sound source for acoustics experiments in the frequency range 60 Hz to 23 kHz. Includes connecting lead with 4 mm safety plugs.

Frequency range: 60 Hz to 23 kHz (-10 dB)
 Power capacity: 100 W (as per IEC 268-5)
 Impedance: 4 Ω
 Tweeter: ½" diam.
 Woofer: 5½" diam.
 Dimensions: 225x150x142 mm³
 Weight: 1.8 kg

U8432770

Additionally recommended:

U8533550 Sine-Wave Generator

U8475470-230 Transformer (230 V, 50/60 Hz)

or

U8475470-115 Transformer (115 V, 50/60 Hz)



U8432770



Recording of ultrasonic standing waves



Ultrasound Transducer, 40 kHz, Equipment Kit

Equipment set for experiments on geometric and wave-mechanical acoustics. Based on the piezo-effect discovered by the Curie brothers, an AC voltage is applied to a piezo-electric body causing it to oscillate. Sound waves can also be used to excite the body and the oscillations can be converted into an electrical voltage signal.

Resonant frequency: 40 kHz approx.
 Band width: 6 kHz approx.
 Capacitance: 1900 pF
 Connector: BNC
 Stand rod: 145 mm x 10 mm diam.
 Dimensions: 40 mm x 20 mm diam.

Contents:

- 1 Ultrasonic transmitter, on stand rod
- 1 Ultrasonic receiver, on stand rod
- 1 Projection screen
- 1 Ruler, 1 m

1009888

Equipment:

1009888 Ultrasound Transducer, 40 kHz, Equipment Kit

U8611210 Barrel Foot, 0.5 kg (3x)

U11175 Analogue Oscilloscope, 2x30 MHz

U11261 T-Piece, BNC

U8533600-230 Function Generator FG100 (230 V, 50/60 Hz)

or

1009956 Function Generator FG100 (115 V, 50/60 Hz)



1009888



Debye-Sears Effect

In 1932, Debye and Sears for the first time demonstrated the refraction of light as it passed through a liquid being subjected to high-frequency vibrations. In this process, the density maxima and minima of a stationary ultrasonic wave act like the elements of an optical diffraction grating. The grating constant here is equal to half the wavelength and therefore dependent on the frequency and speed of the ultrasonic waves transmitted through the medium (e.g. water, glycerin, oil).



Equipment for the Debye-Sears Effect:

U100061 Ultrasonic CW Generator with Probe

U10008 Test Vessel

U10007 Laser Diode for the Debye-Sears Effect, red

U10009 Laser Diode for the Debye-Sears Effect, green

Ultrasonic cw Generator with Probe

Ultrasonic generator for producing continuous, high-powered ultrasonic waves in a wide frequency range of up to 20 MHz. Includes a multi-frequency probe with waterproof cast sound transmitting surface. The transmitter frequency can be adjusted in digital increments of 1 Hz and is indicated on a display. The acoustic power can also be adjusted by regulating the transmitter voltage of the ultrasonic converter and can be turned on and off separately. The transmitting mode is shown by an indicator lamp. The transmitter voltage is shown on an LCD display. The transmitter output supplies a sinusoidal signal with a maximum amplitude of 40 V. The transmitter frequency can also be output as a TTL signal from a monitor terminal. There is also a suitable voltage output for controlling the red and green laser diodes in the Debye-Sears experiment. This, too, can be turned on and off separately and has its own indicator light. The apparatus automatically detects any laser probe that is connected and adjusts the control voltage accordingly.

Generator frequency:	≤ 20 MHz
Multi-frequency probe:	1 – 13 MHz
Frequency increment:	1 Hz
Signal amplitude:	2 – 40 V
Output:	Transmitter signal (sinusoidal), separately switchable with indicator light, TTL (0 – 5 V, square)
Connection:	Laser diode, adjustable, separately switchable with indicator light
Display:	Voltage/frequency
Power consumption:	approx. 100 VA
Mains voltage:	90 – 230 V, 50/60 Hz
Dimensions:	approx. 256x185x160 mm ³

U100061

Test Vessel, Complete

Test vessel made of glass, for conducting the Debye-Sears experiment or projecting ultrasonic waves with divergent light. Lid with probe adjustment via three adjustment screws can be used to produce a stationary wave. A laser fixture with a lens mounting aligned vertically to the sound axis. Includes a plano-convex lens on a square mounting for the projection.

Test vessel:	100x100x120 mm ³
Testing volume:	approx. 1 litre
Laser fixture:	18 mm diam.
Lens:	Plano-convex, f = 100 mm, 16 mm diam.

U10008

Laser Diode for Debye-Sears Effect, Red

Laser diode of protection classification II with 1 m connector lead and barrel connector for connecting ultrasonic cw generator (U100061). Fits the laser holder of test vessel (U10008). All lasers have been measured to determine their wavelength specifically and the results are logged.

Wavelength:	approx. 650 nm
Power:	< 1 mW
Supply voltage:	3 V DC
Current consumption:	max. 30 mA
Dimensions:	90 mm x 17 mm diam.

U10007

Laser Diode for Debye-Sears Effect, Green

Laser diode of protection classification IIIa with 1 m connector lead and barrel connector for connecting ultrasonic cw generator (U100061). Fits the laser holder of test vessel (U10008). All lasers have been measured to determine their wavelength specifically and the results are logged.

Wavelength:	approx. 532 nm
Power:	< 5 mW
Supply voltage:	3 V DC
Current consumption:	max. 250 mA
Dimensions:	90 mm x 17 mm diam.

U10009

Ultrasonic Echoscope

Operational device for conducting ultrasonic experiments in reflection mode (pulse echo principle) or in through-transmission mode with 1 MHz (U10015), 2 MHz (U10016) and 4 MHz (U10017) ultrasonic probes. With the built-in transmission and receiving unit, time gain control (TGC), integrated analogue-digital converter and microprocessor for connection to the measuring and evaluating computer via the USB interface. Connection of the ultrasonic ultrasonic probes via robust snap-in sockets with automatic frequency recognition. Compensation on intensity losses of the transmitted ultrasonic pulse in the test bodies or test liquids using time gain control (TGC) with adjustable threshold value, starting value and location or time-dependent amplification factor. The most important function signals (trigger, TGC, AF signal (amplitude signal), RF signal) are available via BNC sockets on the front of the device. Includes measurement and evaluation software for Windows operating systems. Screen display of the receiver signal (echogram) and the simultaneous TGC signal, whereby the AF and RF signals can be recorded individually or both simultaneously in the echogram as a function of time or penetration depth. Display of all currently set system parameters (transmission power, frequency, gain etc.), Fast Fourier Analysis, depiction of 2-dimensional ultrasonic images (B-image) and the time characteristic of time motion reflection layers (Time-Motion Methods). Ultrasonic transducer not included.

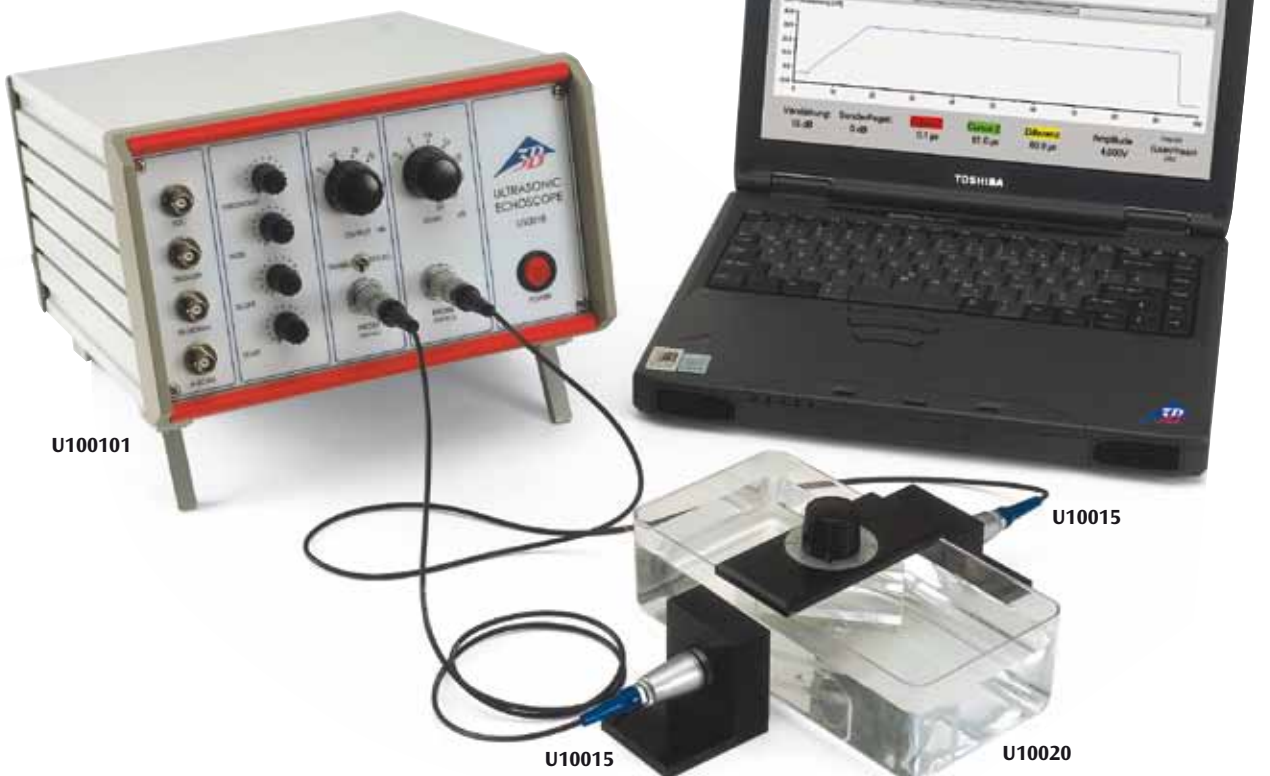
- Frequency range: 1 – 5 MHz
- Transmission signal: Dirac pulse ($< 1 \mu\text{s}$, 10 V to 300 V)
- Transmission power: 0 – 30 dB, in 10 dB steps
- Gain: 0 – 35 dB, in 5 dB steps
- TGC: Continuously adjustable threshold value, start value, rise time and gain time, Maximum gain of 30 dB
- Connections: TGC signal, trigger, low-frequency signal, high-frequency signal via a BNC socket in each case transmitter and receiver via a snap in socket
- PC connection: USB
- Scanning rate: 10 MHz per channel
- Power consumption: approx. 20 VA
- Mains voltage: 90 – 230 V, 50/60 Hz
- Dimensions: approx. 256x257x156 mm³

U100101

Experiment Topics:

- Propagation of longitudinal and transverse ultrasonic waves in solid bodies
- Determining velocity of longitudinal and transverse ultrasonic waves in solid bodies
- Determination of shear modulus, modulus of elasticity and Poisson number
- Attenuation of sound in solid bodies and liquids
- Frequency dependence of sound attenuation
- Time-dependent gain
- Frequency dependence of resolution
- Recording brightness images
- Recording ultrasonic echoes from moving boundaries (time-motion mode)
- Measurement of anomalies

- Equipment:
- U100101 Ultrasonic Echoscope**
 - U10020 Equipment Set "Ultrasound in Solids"**
 - U10015 Ultrasonic Probe 1 MHz (2x)**





Ultrasonic Probe, 1 MHz

Ultrasonic probe for tests involving large penetration depths or high acoustic power at low depth resolutions. It includes a 16-mm piezo-ceramic disc in a die-cast metal case and a 1-m long cable with a frequency-coded snap-in plug. The equipment is adapted to sound in water/acrylic glass.
 Dimensions: 65 mm x 27 mm diam.

U10015

Ultrasonic Probe, 4 MHz

Ultrasonic probe for investigations with small penetration depths and maximum depth resolution. It includes a 16-mm piezo-ceramic disc in a die-cast metal case and a 1 m long cable with a frequency-coded snap-in plug. The equipment is adapted to sound in water/acrylic glass.
 Dimensions: 65 mm x 27 mm diam.

U10017

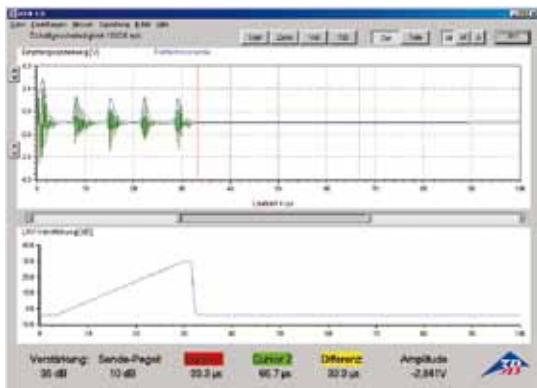
Pair of Reflection Blocks with Delay Line

These polished polyacrylate blocks are used to investigate multiple echoes and measure frequency-dependent attenuation. A 4 MHz probe (U10017) is especially suitable for such measurements. An echo pattern comprising at least 3 echoes is recorded, and the spectra of the individual echoes analysed. The result of the analysis is a shift in the average frequency toward lower frequencies, due to a stronger attenuation of the signal's high-frequency components.
 Dimensions: 80x40x10 mm³

U100251



U100251



Multiple reflections from a mirror plate

Ultrasonic Probe, 2 MHz

Ultrasonic probe for investigations at medium penetration levels and depth resolution. It includes a 16-mm piezo-ceramic disc in a die-cast metal case, adapted to sound in water/acrylic glass, a 1 m long cable with a frequency-coded snap-in plug.
 Dimensions: 65 mm x 27 mm diam.

U10016

Equipment Set "Ultrasound in Solids"

Equipment kit for the investigation of the propagation of longitudinal and transversal waves (shear waves) as well as for the determination of elastic constants (shear modulus, elasticity modulus and Poisson's ratio) in solid bodies. Further for the determination of ultrasonic attenuation in liquids by means of time dependent amplitude measurement with sliding reflector (U10022). Consisting of acoustic basin, polyacrylic test plate in holder with protractor scale and two probe holders to accommodate and precisely position two 1 MHz (U10015), 2 MHz (U10016) or 4 MHz (U10017) ultrasonic probes on the acoustic basin.

- Sound trough: 200x100x60 mm³
- Test plate: 104x75x50mm³
- Protractor scale: 360°, 5° divisions
- Polyacrylate block: 70x45x10 mm³

U10020

Additionally recommended:

- U10022 Aluminum Test Block with Protractor Scale**
- U10023 Polyoxymethylene Test Block with Protractor Scale**

Aluminum Test Block with Protractor Scale

This accessory to equipment set U10020 for longitudinal and transverse waves is used to examine the propagation of transverse waves in metals and ascertain the elastic constants of aluminum, such as its shear modulus, modulus of elasticity and Poisson ratio. The test block's very high reflectivity with high reflection coefficient in water provides sizeable signal amplitudes for measurements of attenuation in liquids (e.g. water, cooking oil or glycerine).

- Protractor scale: 360°, 5° divisions
- Aluminum block: 70x45x10 mm³
- Dimensions: 104x75x50 mm³

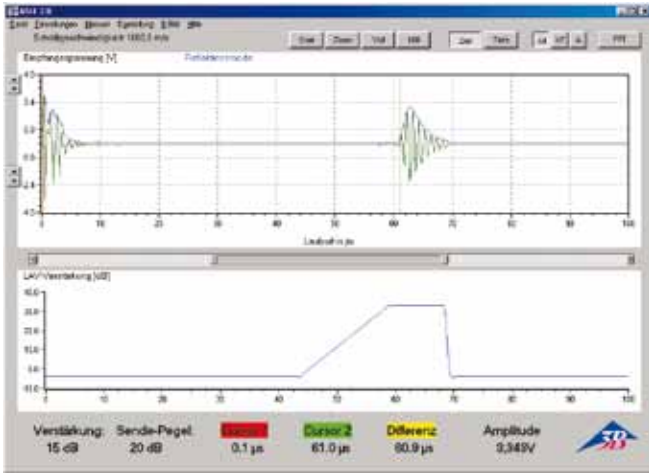
U10022

Polyoxymethylene Test Block with Protractor Scale

This accessory to equipment set U10020 for longitudinal and transverse waves is used to examine the propagation of transverse waves in plastic and ascertain the elastic constants of polyoxymethylene (POM) such as its shear modulus, modulus of elasticity and Poisson ratio.

- Protractor scale: 360°, 5° divisions
- POM block: 70x45x10 mm³
- Dimensions: 104x75x50 mm³

U10023



Pulse echo signal from a hole



U10027

Acrylic Body with Drilled Holes

Polished polyacrylic block with bores of various diameters and varying distance from the surface to determine the speed of sound and the attenuation of ultrasonic signals in polyacrylate, to localize defects, investigate aberrations resulting from acoustic shadows and ground returns, analyze frequency-dependent resolving power and display manual B-images.

Dimensions: 150x80x40 mm³

U10027

Additionally required:

U100101 Ultrasonic Echoscope

U10015 Ultrasonic Probe 1 MHz

U10017 Ultrasonic Probe 4 MHz

XP999 Ultrasonic Coupling Gel



B-image: acrylic body with drilled holes

Heart Model

This double vessel with a rubber membrane and pressure regulator is used to demonstrate movement of the cardiac wall by means of the time-motion technique. In the experiment the membrane vessel produces images similar to the cardiac wall of a beating heart during echocardiography in medical diagnostics.

Dimensions: 160x70 mm²

U10029

Additionally required:

U100101 Ultrasonic Echoscope

U10017 Ultrasonic Probe 4 MHz

XP999 Ultrasonic Coupling Gel



U10026

U10029

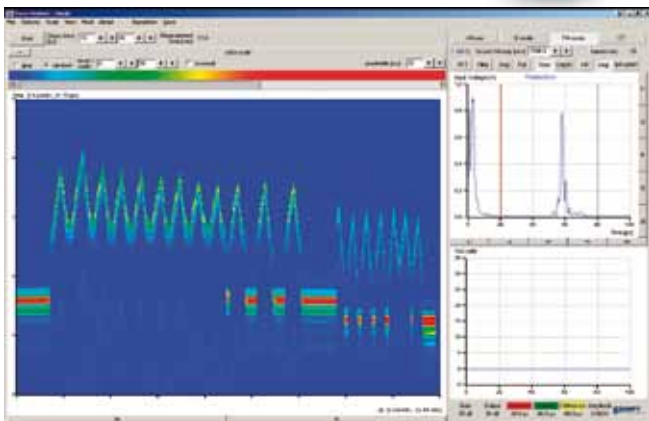
Set of 3 Cylinders

These polished polyacrylate cylinders are used to ascertain the speed of sound and the attenuation of ultrasonic waves in transparent acrylic. Measurements can be performed in reflection mode or through-transmission mode.

Length : 40 mm, 80 mm and 120 mm

Diameter: 40 mm

U10026



Time motion scan

Model Eye for Ultrasonic Biometry

Model of the human eye, enlarged to a scale of 3 to 1, including the cornea, the lens and glass bodies for demonstrating the fundamentals of ultrasonic biometry. The biometric ratios in the human eye (distance between cornea and lens, thickness of lens, distance between lens and retina) are very well suited to demonstrating measurement using a pulse-echo method with ultrasound. With the help of an ultrasonic echoscope (U100101) and a 2-MHz ultrasonic probe (U10016), typical echoes and the speed of sound can be measured. This allows the geometry of individual objects in the eye to be calculated. A lesion close to the back of the eye becomes apparent due to the diffuse nature of its echo.

Diameter: 80 mm

1012869

NEW



1012869

Additionally required:

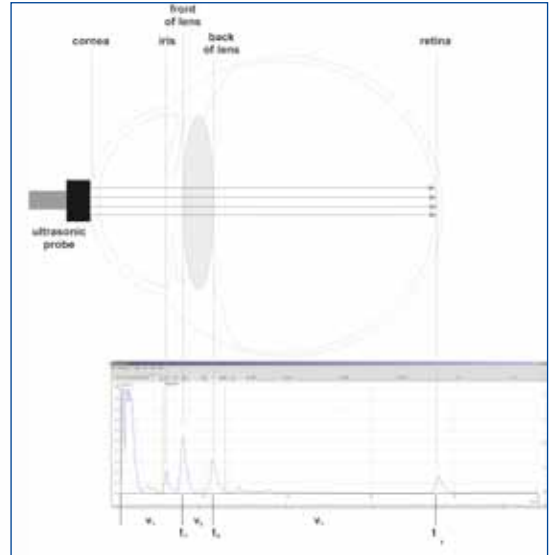
U100101 Ultrasonic Echoscope

U10016 Ultrasonic Probe 2 MHz

XP999 Ultrasonic Coupling Gel

Recommended for comparison:

F15 6-Piece, 3:1 Scale Model of the Human Eye



A-mode image and schematic diagram of the human eye



L55/1

Single Breast Model with Benign Tumor

Model of a woman's breast made of 3B SKINlike™ silicone with simulated benign tumor for the demonstration of ultrasonic B-image mode.

L55/1

Additionally required:

U100101 Ultrasonic Echoscope

U10015 Ultrasonic Probe 1 MHz

XP999 Ultrasonic Coupling Gel

Ultrasonic Coupling Gel (not shown)

To secure the ultrasonic probes to solid test objects.

Contents: 250 ml

XP999

Doppler Phantom Fluid

Phantom fluid with excellent scattering characteristics for ultrasonic waves in the frequency range from 1 – 6 MHz and viscosity calibrated for ultrasonic Doppler experiments. In plastic bottle.

Contents: 1 l

Ultrasonic scattering: 1 – 6 MHz

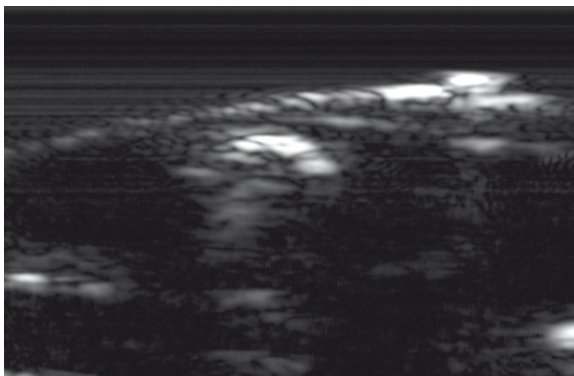
Colour: blue

Diameter of glass microspheres: 30 – 50 µm

U10004



U10004



B-image: breast model

Equipment:

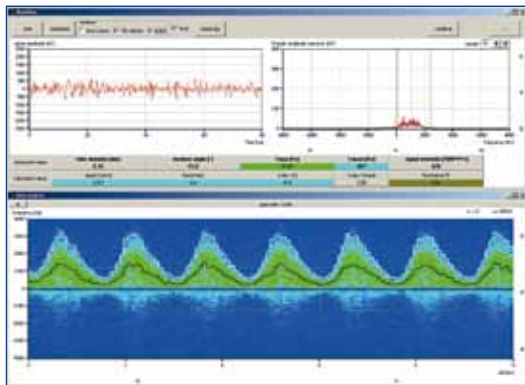
- U10001 Ultrasonic Doppler Apparatus**
- U10016 Ultrasonic Probe 2 MHz**
- U10002 Set of Doppler Prisms and Flow Tubes**
- U10003 Riser Tubes for Pressure Measurement**
- U10004 Doppler Phantom Fluid**
- U10005 Centrifugal Pump**
- XP999 Ultrasonic Coupling Gel**

Ultrasonic Doppler Apparatus

Ultrasonic device for carrying out experiments on the Doppler principle, on fluid mechanics and on Doppler sonography in the diagnosis of vascular problems using 1-MHz (U10015), 2-MHz (U10016) and 4-MHz (U10017) ultrasonic probes. Includes measurement and evaluation software for Windows operating systems in order to display the measured signals and colour-coded Doppler spectra. If the radiated waves are reflected or scattered from moving particles or bubbles in fluid flow, the Doppler shift in frequency can be detected. The equipment detects the scattered waves and generates an audio signal at a volume that reflects the amplitude of the reflected signal and a frequency that reflects the speed of the scattering. At the same time, the amplitude is also displayed on an LED bar display. Sensitivity and volume can be adjusted by means of appropriate controls. The controller can also pass on data to a PC for detailed recording and evaluation. During measurement the current LF Doppler signal is displayed. Evaluation is by means of a Fourier transformation in the frequency domain and the result can be interpreted as the distribution of velocity within the flow.

- Frequency: 1 MHz, 2 MHz and 4 MHz
- Gain: 10 – 40 dB
- Display: LED bar display and acoustic signal with volume control
- PC connector: USB
- Mains voltage: 90 – 230 V, 50/60 Hz
- Dimensions: approx. 256x185x160 mm³

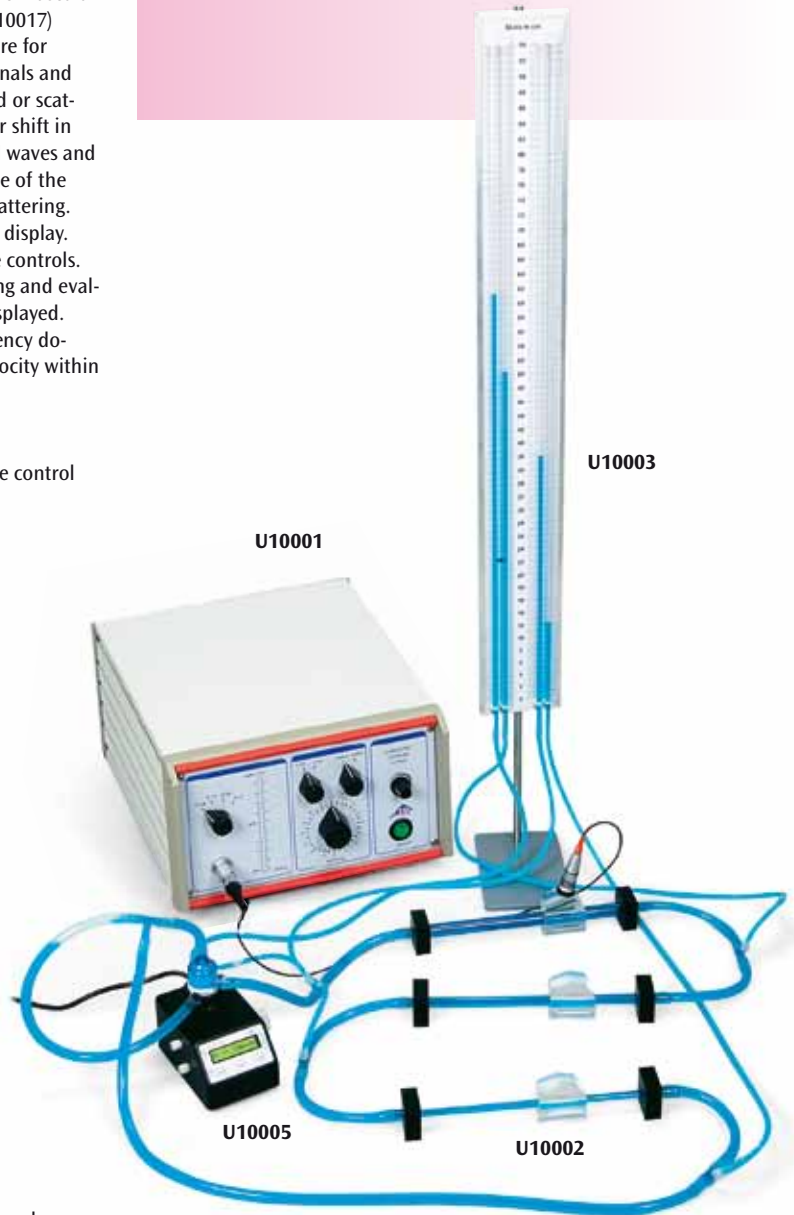
U10001



Experiment Topics:

- Investigation of flowing liquids using ultrasonic waves
- Experiments on the Doppler principle
- Measurement of flow velocities
- Demonstration of laminar and turbulent flow
- Experiments on the continuity equation, Bernoulli's equation (static and dynamic pressure) and the Hagen-Poiseuille law (resistance to flow)

Ultrasound



Centrifugal Pump

Pump for transporting liquids at a constant flow velocity which can be regulated continuously to any value and intended for the investigation of flow phenomena with laminar flow profiles. The pump has 3/8" plug-in connectors for insertion into a flow circuit (U10002) or an arm simulator (1012880). The display can be switched to show either speed or flow. The display of the flow can be calibrated to match the flow pressure. For Doppler sonographic experiments using a so-called arm phantom to simulate a real arm, the pump can be set to provide a pulsing flow (to simulate a heart beat) with a variable pulse frequency. This allows ultrasonic signals to be obtained which are typical for vascular diagnosis.

- Connectors: 2x 3/8"
- Max. flow: 6 l/min
- Display: LCD
- Mains voltage: 90 – 230 V, 50/60 HZ

U10005



Waves & Sound

Set of Doppler Prisms and Flow Tubes

Equipment set including plastic tubes and hoses of various diameters for investigating flow phenomena using ultrasonic waves. Includes Doppler prisms for connecting an ultrasonic probe to the tubes or hoses at three different angles.

Contents:

- 1 Doppler prism ¼"
- 1 Doppler prism ⅜"
- 1 Doppler prism ½"
- 1 Flow tube ¼", 300 mm
- 1 Flow tube ⅜", 300 mm
- 1 Flow tube ½", 300 mm
- 1 Hose ¼", 1000 mm
- 1 Hose ⅜", 3000 mm
- 1 Hose ½", 1000 mm
- Various hose connectors, T-pieces and accessories

U10002

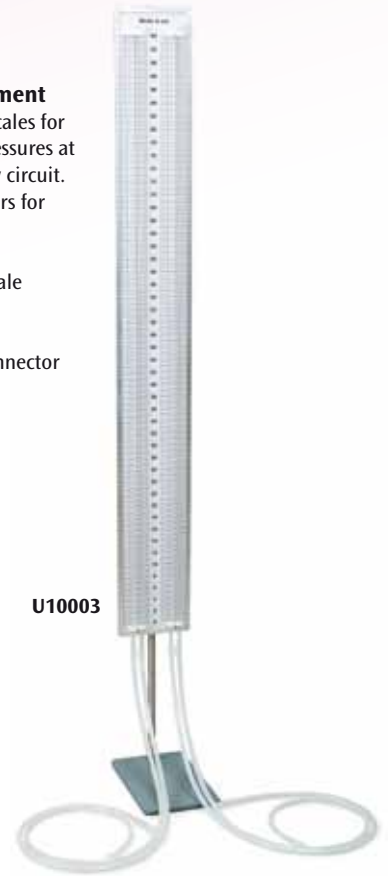


Riser Tubes for Pressure Measurement

Set of four riser tubes with millimetre scales for measuring the relationship between pressures at up to four measuring locations in a flow circuit. Includes tubing and Luer-Lock connectors for attachment to a flow circuit and stand.

- Length: 1000 mm
- Connectors: Luer Lock, male
- Length of tubing: 1200 mm
- Tubing connector: ⅜" female Luer Lock connector

U10003



Arm Phantom Set

Model of a human arm for simulating Doppler sonographic examinations of blood vessels. Includes an ultrasonic Doppler probe and so-called phantom fluid for simulating blood. The model features a variety of tubing (simulating blood vessels), including one tube which simulates a blood vessel stricture or stenosis. Using the ultrasonic Doppler apparatus (U10001) and a centrifugal pump (U10005), it is possible to simulate typical examinations used in vascular diagnosis. Doppler spectra are measured for the flow through arteries and veins with both a pulsing flow (like a heart beat) and continuous flow, allowing sounds typical of Doppler sonography to be heard.

One particularly interesting feature is the possibility of observing the change in the spectra and the Doppler sound due a stenosis (stricture) in the elbow. In addition, it is possible to calculate the flow index and resistance index from the curves measured with a pulsing flow.

- Probe frequency: 2 MHz
- Probe dimensions: 200 mm x 15 mm diam.
- Length of lead: 1 m

Includes:

- Model arm with stenosis
- Silicone tubing
- ⅜" connectors
- Ultrasonic Doppler probe
- Phantom fluid to simulate blood, 250 ml
- Funnel
- Rubber stoppers

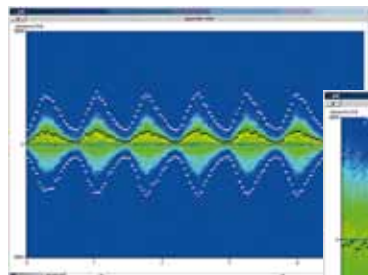
1012880

Equipment:

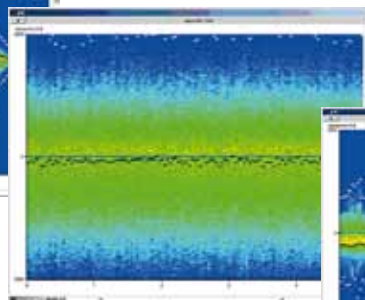
- U10001 Ultrasonic Doppler Apparatus**
- U10005 Centrifugal Pump**
- 1012880 Arm Phantom Set**
- XP999 Ultrasonic Coupling Gel**

Experiment Topics:

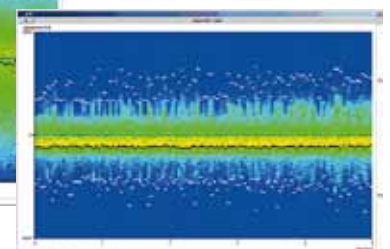
- Doppler sonographic examinations of the human arm
- Measurement of the flow velocity of blood
- Recording of Doppler spectra and pulse curves
- Diagnosis of stenosis (vascular stricture) in an arm



Doppler spectrum of arterial blood flow



Doppler spectrum of a stenosis (stricture)



Doppler spectrum of blood flow in veins

Ultrasonic Waves in a Space Saving Table Top Experiment

Experiment Topics:

- Tracing of oscillations over time from a fixed point on the wave
- Investigation of phase shifts between signals using a fixed and a moving microphone
- Recording of points on the wave front on a plane and determination of wavelength
- Relationship between wavelength and frequency and determining the speed of propagation of a wave
- Recording of circular wave fronts from a point source
- Recording of linear wave fronts after reflection from a concave semi-circular mirror
- Diffraction by a double slit
- Interference between two beams of ultrasonic waves
- Michelson interferometer using ultrasonic waves
- Absorption and reflection of ultrasonic waves
- Interference by a Lloyd mirror
- Interference between ultrasonic waves of not quite equal frequency
- Doppler effect (determination of differential frequency)

SW Ultrasonics Set

Equipment package for demonstrating the basic properties of waves using 40-kHz ultrasonic waves as an example in a space-saving, table-top experiment. Two rod-shaped microphone probes are used to record and analyse oscillations with the help of a standard oscilloscope. An ultrasonic pen can be used to record wave fronts in the plane of the table as lines of equal phase (isophases).

Contents:

- 1 Operating unit US
- 2 Ultrasonic transmitters 40 kHz
- 2 Microphone probes
- 1 Ultrasonic pen
- 1 Concave semi-circular mirror
- 2 Ultrasonic blocks/mirrors
- 1 Set for double slit
- 1 Ultrasonic semi-silvered mirror
- 1 Ultrasonic absorber
- 2 BNC cables
- 1 Cable, BNC/4-mm safety sockets
- 1 Plug-in power supply 12 V AC, 700 mA

SW Ultrasonics Set (230 V, 50/60 Hz)

1012845

SW Ultrasonics Set (115 V, 50/60 Hz)

1012846

Additionally recommended:

1012879 USB Oscilloscope 2x40 MHz

or

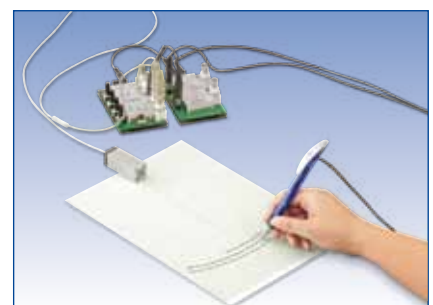
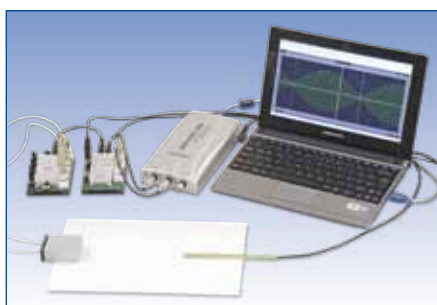
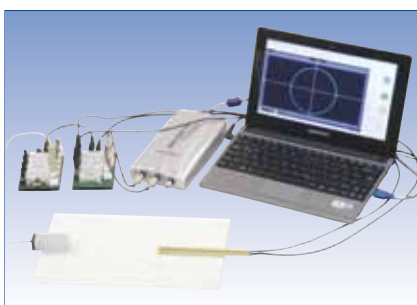
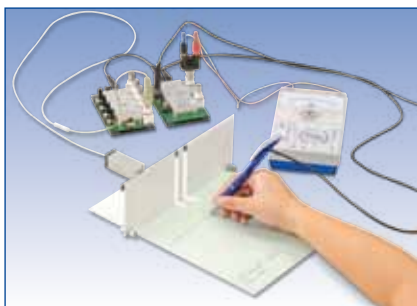
U33070-230 Analogue Oscilloscope 2x20 MHz

1006810 Multimeter Escola 10

NEW



1012845
1012846





U10974

Solar Electric Motor

Compact unit consisting of solar energy module and electric motor for demonstrating the conversion of light energy into electrical energy. Mounted on angled transparent acrylic base. A propeller is attached to the electric motor to make its rotation clearly visible. As an alternative to that, rotating discs are provided for demonstrating the phenomena of optical illusions or colour mixing effects.

- No-load voltage for solar module: 0.5 V
- Short-circuit current for solar module: 350 mA
- Starting current for electric motor: 20 mA

U10974

Halogen Lamp – 500 W

Strong light source for experiments, e.g. for use with solar energy basic kit (U8461200). With handle.

Halogen Lamp 500 W (230 V, 50/60 Hz)

U8476713-230

Halogen Lamp 500 W (115 V, 50/60 Hz)

U8476713-115

Additionally required:
U13270 Stand Base

Spare Bulbs for Halogen Lamp – 500 W (230 V, 50/60 Hz)

U8476714-230

Spare Bulbs for Halogen Lamp – 500 W (115 V, 50/60 Hz)

U8476714-115

Solar Energy Basic Kit

Set of equipment including four test bodies with different surface coating, heat insulators and covers for experiments on the utilisation of solar energy. Four series of measurements that can be completed in approximately 25 minutes elucidate the temperature characteristics and peaks of the test bodies when exposed to sunlight. The kit comes in a robust storage case.

- Storage capacity: approx. 365x310x70 mm³
- Weight: approx. 1 kg

Contents:

- 4 Solar measuring bodies, each of a different colour
- 2 Insulating housings
- 2 Mounts for the measuring bodies
- 1 Transparent acrylic plate
- 4 Thermometers, -10 – +110° C

U8461200

Additionally required:
U8476713-230 Halogen Lamp, 500 W (230 V, 50/60 Hz)
or
U8476713-115 Halogen Lamp, 500 W (115 V, 50/60 Hz)



U8476713-230



U8461200



U8461300

Bolometer

Designed to measure heat radiation from the sun, this device consists of an aluminium tube with a blackened front enclosed in a cardboard tube blackened on the inside. Includes a borehole for a thermometer.

- Aluminium tube: 30 mm x 40 mm diam. approx.
- Cardboard tube: 195 mm x 50 mm diam. approx.
- Weight: 350 g approx.

U8461300

Additionally required:

- U8451700 Thermometer, +10 – +30° C
- U13261 Universal Clamp
- Stand Equipment

Moll-Type Thermopile

Sensitive probe for measuring heat radiated by a black body or Leslie's cube, as well as for detecting visible light and ultra-violet radiation. Comprises a metal housing with a polished, conical reflector and a black surface 15 mm in diameter with 17 linked thermocouples. With two 4 mm connectors mounted on a stem.

- Sensitivity: approx. 0.28 mV/μW
- Internal resistance: approx. 1 Ω
- Setting duration: 40 s (95 %)
- Tripod: 156 mm x 10 mm diam.
- Dimensions: 94 mm x 40 mm diam.
- Weight: approx. 200 g

U8441301



U8441301

Greenhouse Effect Kit

A set of equipment permitting quick and easy experiments to demonstrate the effect of greenhouse gases on the absorption of infra-red radiation. Solar radiation received by the earth is simulated here by means of short-wave infrared radiation that is attenuated by absorption in water and visible light from a reflector lamp. Infra-red radiation emitted by the earth is simulated by heating a black metal disc. Both types of radiation are made to pass through air or butane gas in a metal tube and subsequently registered with a thermopile. Comparison of the obtained values reveals that long-wave infra-red radiation is absorbed to a high degree by butane gas. Consequently butane gas released into the atmosphere causes it to heat up, i.e. butane gas is a greenhouse gas.

Contents:

- 1 Base plate
- 1 Lamp holder with reflector lamp
- 1 Cuvette on stem
- 1 Black metal disc
- 1 Metal tube, simple
- 1 Metal tube, with taps
- 2 Mounting stems
- 1 Silicone hose
- 1 Storage case

Greenhouse Effect Kit (230 V, 50/60 Hz)

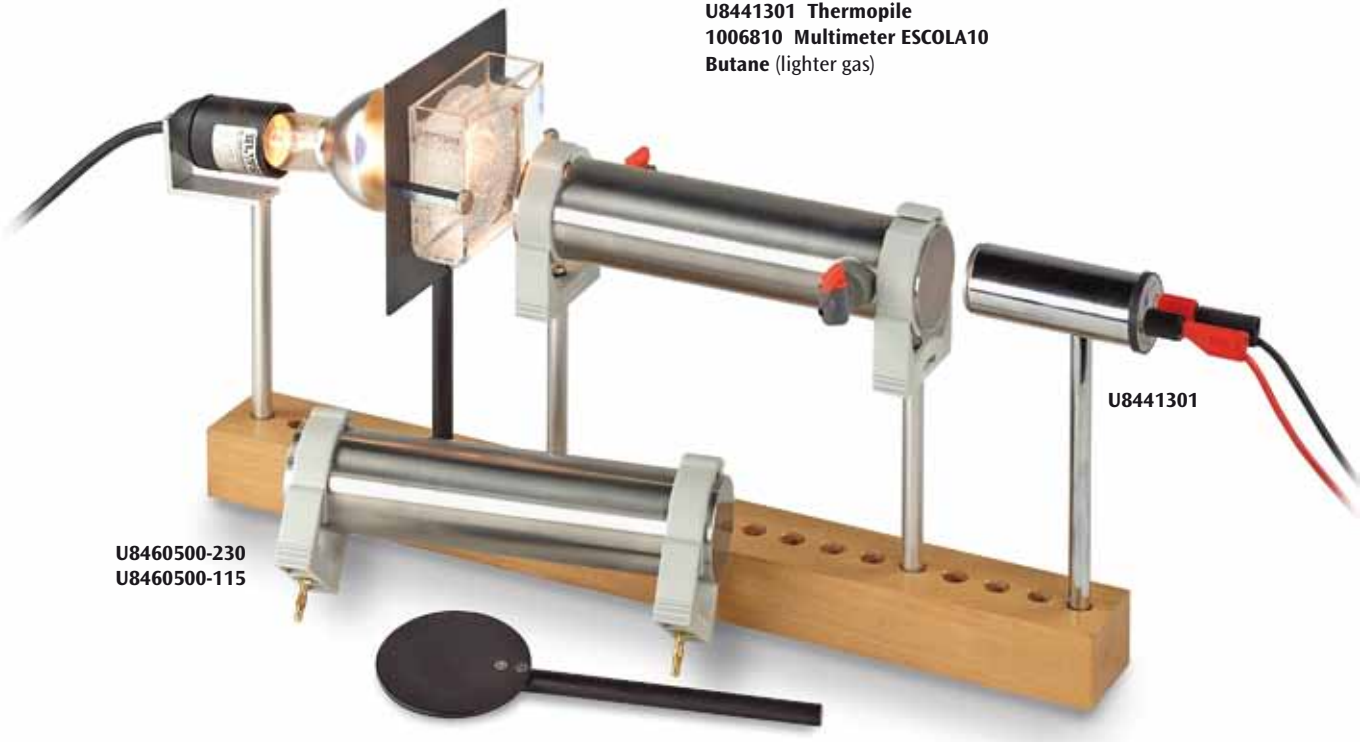
U8460500-230

Greenhouse Effect Kit (115 V, 50/60 Hz)

U8460500-115

Additionally required:

- U8441301 Thermopile
- 1006810 Multimeter ESCOLA10
- Butane (lighter gas)



U8460500-230
U8460500-115

U8441301

Tomorrow's Energy Carriers

Fuel cells, electrolyzers, solar hydrogen technology – significant contributors to a sustainable energy supply in the future: preservation of the environment and resources while maintaining today's standard of living. Now you can demonstrate the mode of operation of this fascinating technology to your students. Pure water is broken down by means of electrolysis into hydrogen and oxygen for the purpose of energy storage with the help of regenerative energy. During reconversion of the gases in a fuel cell, electricity, heat and water are formed. The resolute use of membrane technology in the training and demonstration systems does away with the use of corrosive liquids and only distilled water is required.

Fuel Cells Car

Fascinating working model of a hydrogen-fuel cell car. Designed for graphic demonstration of the practical use of hydrogen technology and a pioneering drive system.

Special features:

- Robust design guarantees long working life
- Simple to operate
- Only distilled water and no corrosive fluids required
- Acrylic glass construction permits good visibility and thus better understanding of how fuel cells actually work

Fuel cells are essential components of a sustainable energy supply of the future which will ensure that modern living standards are maintained while also preserving our environment and natural resources. To store energy for regeneration, pure water is broken down into its components, hydrogen and oxygen, by means of electrolysis. Current, heat and water are produced when the gases are recombined in the fuel cell. The power is used to drive a vehicle at a speed of approx. 20 cm/s. The hydrogen fuel cell's efficiency is about twice as high as that of a combustion engine. After being filled up with distilled water and connected to the mains via the plug-in power supply (alternatively the solar module or battery box) the vehicle is ready to drive after just two minutes.

Power: 1 W (during electrolysis), 500 mW (fuel cell operation)

Gas storage cell: 30 cm³ H₂, 30 cm³ O₂

Charging time: approx. 2 min (with plug-in power supply)

Driving time: approx. 8 min

Speed: approx. 20 cm/s

Plug-in power unit: 100 V up to 240 V, 50/60 Hz

Solar module: 2 V, 0.6 A

Battery box: 4,5 V, 0,8 A

Dimensions: approx. 100x115x260 mm³

Weight: approx. 1.3 kg

U10957

Fuel Cell Demonstration System

Model showing the function of a hydrogen solar cell consisting of:

- Solar module
- PEM electrolyser
- Hydrogen and oxygen accumulators
- PEM fuel cell
- Fan

Conveniently arranged on a baseplate.

Solar module: 2.0 V / 350 mA

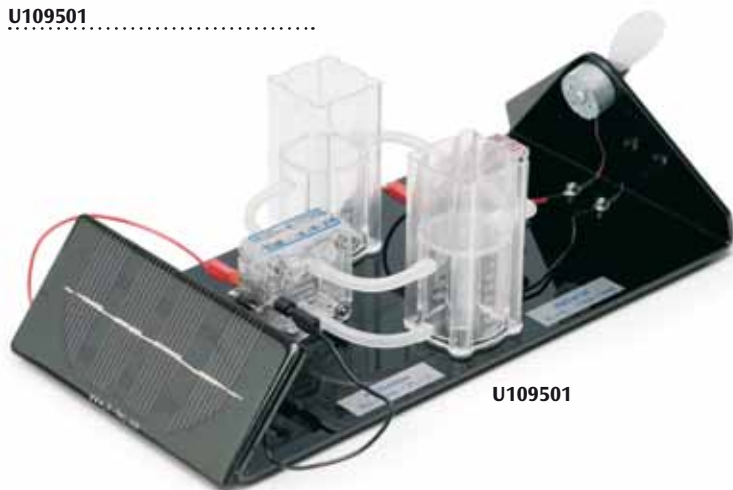
Electrolyser: 1 W

Fan output: 10 mW

Dimensions: approx. 100x300x150 mm³

Weight: approx. 600 g

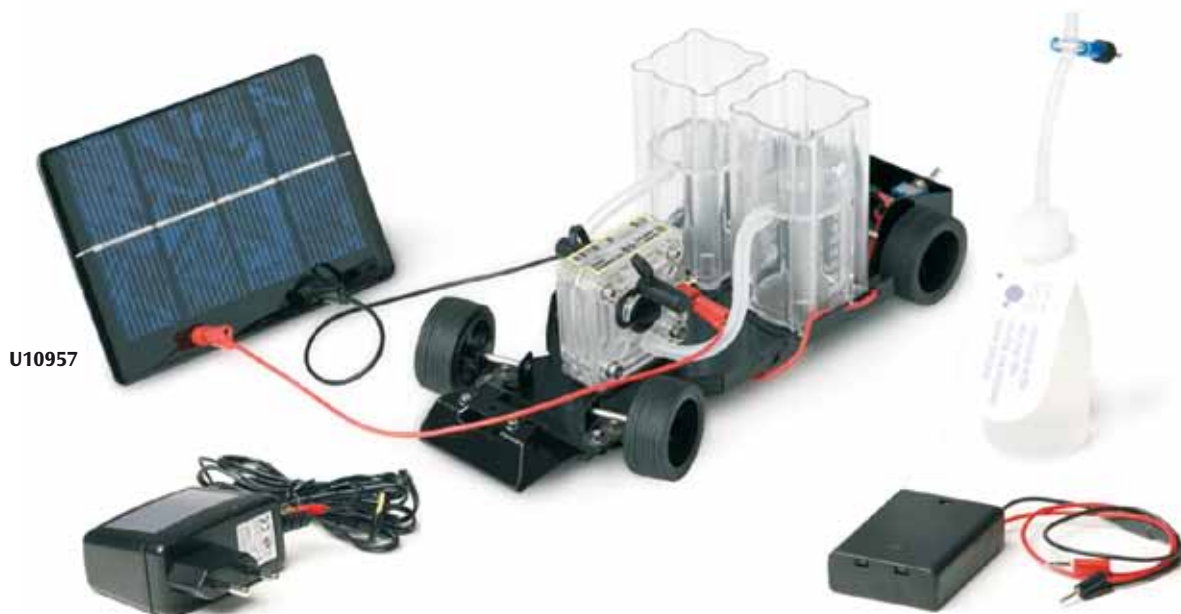
U109501



U109501

For your Safety:

Exclusive use of distilled water. No corrosive electrolytes such as potassium hydroxide (KOH).



U10957

H-Racer

Global prize winning fuel-cell racing car, reflecting in miniature the dreams of all those developing the vehicles of the future, i.e. an electric racer powered by fuel cells. The only thing needed to operate the vehicle is water, which is electrolysed by solar energy at a hydrogen fuelling station in order to generate hydrogen. Some parts of this kit need to be assembled by customers themselves.

Includes:

- 1 Car with fuel cell
- 1 Hydrogen station with solar cell and battery box for 2 1.5-V AA batteries
- 1 Remote control unit
- Connecting tubes and accessories

U40620

Additionally required:

- 2 Batteries, 1.5V AA**
- Distilled water**
- Cross-head screwdriver**



Hydrogen Car

Self-contained car with reversible fuel cell. Current to electrolyse water, in order to make hydrogen and oxygen for the fuel cell, can be provided either by the supplied solar cell or by a battery. Since the tanks are transparent, it is possible to watch the conversion process. Some parts of this kit need to be assembled by customers themselves.

Includes:

- 1 Car with fuel cell
- 1 Oxygen tank, transparent
- 1 Hydrogen tank, transparent
- 1 Solar cell
- 1 Battery box for 2 1.5-V AA batteries
- Connecting tubes and accessories

U40621

Additionally required:

- 2 Batteries, 1.5 V AA**
- Distilled water**



NEW

“Solar Hydrogen” Kit

Inexpensive set for demonstrating solar fuel-cell technology, consisting of a solar-powered fuel cell, gas reservoirs, solar module and a motor with propeller. Includes a battery box as an alternative power supply to the fuel cell. Batteries not included. Some components must be assembled by the user.

Contents:

- 1 Fuel cell
- 1 Solar cell
- 1 Motor with propeller
- 1 Gas reservoir for hydrogen
- 1 Gas reservoir for oxygen
- 2 Experiment leads, 2 mm
- 1 Battery box for 2 batteries, 1.5 V AA
- Connecting tubes and accessories

Technical data for fuel cell:

Dimensions:	54x54x17 mm ³ approx.
Weight:	70 g approx.
Electrolytic operation:	
Voltage:	1.8 V – 2.6 V
Current:	0.7 A (over 2 V)
Hydrogen production:	7 ml/min
Oxygen production:	3.5 ml/min
Fuel cell operation:	
Output voltage:	0.6 V DC
Output current:	360 mA
Power:	210 mW

Technical data for solar cell:

Dimensions:	125x155x8 mm ³ approx.
Max. output voltage:	2.2 V DC
Max. output current:	1.1 mA

U40623

Additionally required:

- 2 Batteries, 1.5 V, AA**
- Distilled water**



U29949



NEW

U14293



Hygrometer F

Hygrometer in a metallic box with indication of the relative humidity.

Measuring range: 20 to 100% relative humidity

Diameter of the dial: 98 mm

U29949

Precision Hair Hygrometer

Hygrometer for measuring the relative air humidity, consisting of a round plastic housing with a human hair as the measuring element. The specially treated hair exhibits an almost inertia free response to changes in humidity. Wall mountable.

Measuring range: 0% – 100% relative humidity

Temperature range: -35° C – +65° C

Reading accuracy: ±5%

Diameter: 100 mm

U14293

U11819



U16102



Digital Hygro-Thermometer

Digital measuring device for displaying exterior and interior temperature and humidity. With min/max function and acoustic signal if exterior temperature drops to or below zero, switchable between °C and °F, on/ off button, eyelet for hanging up and fold-out stand.

Measuring range:

Temperature (interior): 0° C – 50° C / 32° F – 122° F

Temperature (exterior): -50° C – 70° C / -58° F – 158° F

Humidity: 20% – 99%

Divisions: 0.1° C/F, 1%

Accuracy (temp.): ±1° C / ±2° F

Accuracy (humidity): ±3%

Exterior temperature

sensor: Cable length 3 m

U16102



U10260

U14294



Infrared Temperature and Humidity Gauge

Digital measuring device for contact-free temperature measurement from large distances, e.g. of hot or moving objects or inaccessible points of measurement, and for simultaneous humidity display. With laser diode as detection aid, integrated in the measuring probe, illuminated LCD display, max and data-hold function, switchable between °C and °F, automatic switch-off. Includes pouch and battery.

Measuring range,

temperature: -50° C – +500° C; -58° F – +932° F

Divisions: 0.1° C/F

Accuracy: ±2% of measured value ±2° C / 4° F

Measuring range,

humidity: 5% – 95%

Divisions: 0.1%

Accuracy: ±3.5%

LCD dual-function

display: 3½-digit, 21 mm with backlighting

Voltage supply: 9 V battery

Dimensions: approx. 90x170x45 mm³

Mass: approx. 360 g

U11819

Demonstration Aneroid Barometer

Barometer for measuring air pressure and demonstrating how an aneroid barometer operates. The measurement system consists of two flat, highly-evacuated metal cans which deform in response to changes in the air pressure. This deformation is indicated by a pointer. The pointer mechanism and metal cans are situated behind a glass cover for easy observation. By pumping the attached rubber ball the action caused by the air pressure changes can be demonstrated.

Measuring ranges: 955 mbar up to 1070 mbar, scale division 1 mbar

715 mmHg up to 800 mmHg, scale division

1 mmHg

Scale diameter: 120 mm

Housing diameter: 130 mm

Weight: 650 g

U10260

Maximum-Minimum Thermometer

Reading of maximum, minimum and instantaneous temperature. In plastic housing with reset button and hanging strap. Mercury filling.

Measuring range: -38° C – 50° C

Divisions: 1° C

Dimensions: approx. 230x85 mm²

U14294

Digital Pocket Anemometer

Waterproof anemometer for measuring wind speed. Indication of wind chill temperature based on the combination of air temperature and wind speed. Indication of mean and maximum speeds. Wind curves on the Beaufort scale. Supplied with closeable cover.

Wind speed: 0,2 ... 30 m/s
 Accuracy: $\pm 5\%$ of mean wind speed
 Units: km/h, m/h, m/s or knots
 Temperature: -30° to $+59^{\circ}\text{C}$
 Battery: 3.0 V (CR2032)
 Dimensions: 137x50x18 mm³

W13623



Aneroid Barometer F

Aneroid Barometer in a metallic box with altitude adjustment screw at the rear. Graduations in mm of mercury and hPa.

Diameter of the dial: 98 mm

U29948



Wireless Weather Station

Weather station with wireless detection of external temperatures from up to three sensors situated at distances of up to 25 m. Display of internal temperature and humidity. Features switchable $^{\circ}\text{C}/^{\circ}\text{F}$ display, min/max function, weather forecasting, trend displays for air pressure and radio-controlled clock with date function. Supplied with one external temperature sensor, two 1.5-V AA batteries and two 1.5-V AAA batteries. Silver/grey housing. Can be suspended or set up on a surface.

External temperatures: -30°C ... $+70^{\circ}\text{C}$

Internal temperatures: 0°C ... $+60^{\circ}\text{C}$

Humidity: 1 ... 99%

W13620

W13620



NEW

Noise: the World's no. 1 Pollutant

Noise

- Damages hearing
- Makes it more difficult to hear genuinely important signals
- Impedes both physical and mental work
- Disturbs and adversely affects well being
- Disturbs relaxation and sleep
- Can cause chronic stress, physical ailments and illness



1012741

Noise Level Indicator SPL

Handy and easy-to-use noise level meter with digital display in decibels (dB) and an arbitrarily adjustable trigger threshold for use as a traffic-light style noise indicator with a happy green face and a sad red face. Can be mounted on a wall or set up on a table top. Its well-conceived compact design makes it easy to transport. Automatically switches to electricity-saving stand-by mode when noise is low for a long period. The brightness of the display can also be adjusted. Includes a stand base, USB/miniUSB cable, USB power supply and transport case.

Display: 100 mm diam, with LED
 Measuring range: 40 dB to 130 dB
 Resolution: 1dB
 Thresholds for colour display: Adjustable to any level in steps of 1 dB
 Power supply: 5 V DC via miniUSB socket
 Power consumption: 150 mA (normal operating mode)
 <1 mA (stand-by)
 USB power supply: 100 – 240 V, 50/60 Hz
 Dimensions: 130x145x12 mm³
 Weight: 400 g approx.

1012741





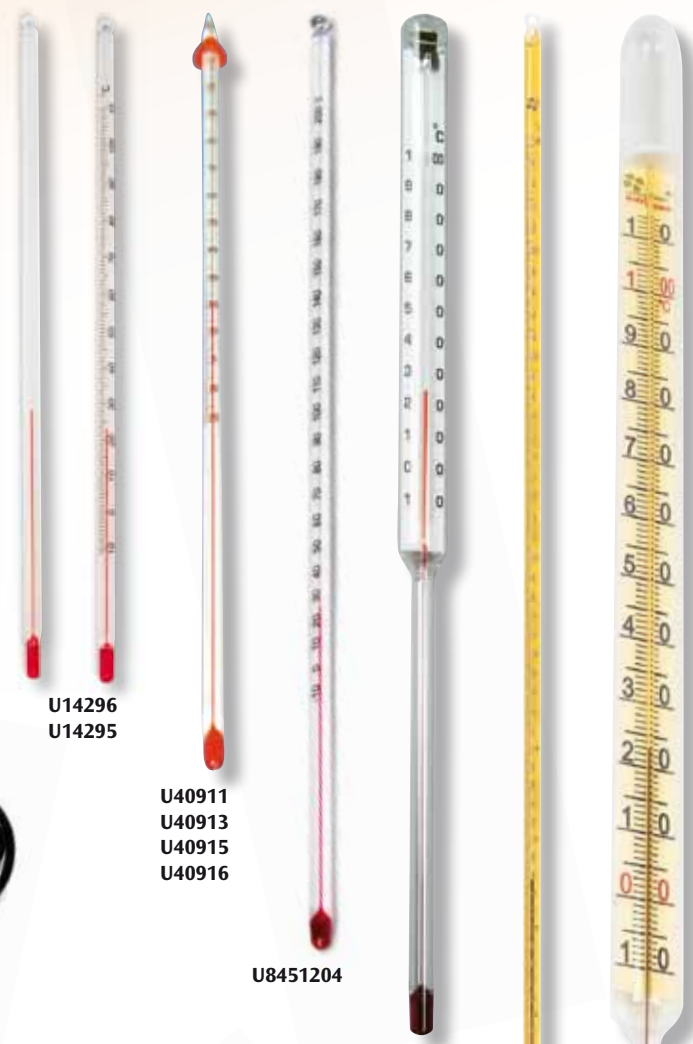
Thermometer Clip
Stainless steel clip for holding thermometers in beakers.

U8452570



U8451700

U14297



U14296
U14295

U40911
U40913
U40915
U40916

U8451204

U8451310



U11331

U11330

Temperature Sensor, Pt100

Temperature sensor for the measurement of temperatures in organic liquids, solutions of salts, acids, and bases. The stem and tip of the temperature sensor are of stainless steel. Can be used in conjunction with 3B NET/og™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes connector lead with 8 pin miniDIN plugs.

- Measurement range: -50°C – 150°C
- Resolution: 0.1° C
- Accuracy: 0.1% of measured value plus 0.25°C
- Sensor cable: 1 m, with silicone insulation
- Sensor type: Pt100 thermocouple

U11330



U11854

U11855

U16115

U16120

Temperature Sensor, TC – K

Temperature sensor for the measurement of extremely low and extremely high temperatures, for example in liquid nitrogen or liquid oxygen, or inside a flame. With room temperature compensation. The immersible NiCr-Ni sensors (U11854 and U11855) can also be connected to the sensor box. Can be used in conjunction with a 3B NET/og™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes connector lead with 8 pin miniDIN plugs.

- Measurement range: -270°C to 400°C
- Accuracy: 0.2% plus 3°C (-270°C – 0°C)
0.1% plus 2°C (0°C – 400°C)
- Resolution: 1°C
- Sensor type: NiCr-Ni (type K)
- Sensor length: 60 cm approx.

U11331

Digital Quick-Response Pocket Thermometer

For instantaneous measurements on surfaces, in liquids, soft plastic media, air/gases, very small objects. For connection to a K-type NiCr-Ni measurement sensor. Sensor not included in scope of supply.

- Measuring range: -65° C – 1150° C / -85° F – 1999° F in 2 ranges
- Division: 0.1° C / 1° C/F
- Accuracy in lowest range: 0,05% of measured value ±0,2% FS
- Display: 3½-digit LCD display, 13 mm in height
- Dimensions: 106x67x30 mm³
- Mass: approx. 135 g

U11853

Additionally required:

U11854 K-Type NiCr-Ni Immersion Sensor, -65° C to 550° C

or

U11855 K-Type NiCr-Ni Immersion Sensor, -200° C to 1150° C

Art. No.	Scale division	Measuring range	Scale division	Dimensions	Remarks
U8451700	Thermometer	+10° – 30°C	0.2°C	140 mm x 6 mm diam.	Tube type, white coated capillary, red alcohol filling.
U14297	Pocket Thermometer	-10° – 110° C	1° C	165 mm x 10 mm diam.	Tube type, scale on white background, special red filling, in yellow plastic protective case with clip.
U14295	Tube Thermometer, graduated	-10° – 110° C	1° C	260 mm x 6 mm diam.	Glass thermometer with eyelet, scale on white background, special red filling, in transparent square plastic case.
U14296	Tube Thermometer, not graduated	–	–	260 mm x 6 mm diam.	For demonstrating function and mode of operation of thermometers. Like U14295 but without scale.
U40911	Thermometer	-20° – 110° C	1° C	295 mm x 6.3 mm diam.	Tube type with anti-roll design, white coated capillary, red alcohol filling, packed in a plastic tube.
U40913	Thermometer	-10° – 150° C	1° C	295 mm x 6.3 mm diam.	Tube type with anti-roll design, white coated capillary, red alcohol filling, packed in a plastic tube.
U40915	Thermometer	20° – 110° C / 0° – 230° F	1° C/F	295 mm x 6.3 mm diam.	Tube type with anti-roll design, white coated capillary, red alcohol filling, packed in a plastic tube.
U40916	Thermometer	-20° – 150° C / 0° – 300° F	1° C/F	295 mm x 6.3 mm diam.	Tube type with anti-roll design, white coated capillary, red alcohol filling, packed in a plastic tube.
U8451204	Thermometer	-10° – 200° C	1° C	300 mm x 6 mm diam.	Rod-shaped general-purpose thermometer, white-coated capillary, red indicator liquid, total immersion depth.
U8451310	Rod Thermometer	-10° – 100° C	1° C	350 mm x 8 mm diam., Length of rod: 150 mm	Rod thermometer with internal scale made of frosted glass, prismatic capillary tube and red liquid.
U16115	Stable Tube Type Thermometer	-1° – 101° C	0.2° C	460 mm x 7 mm diam.	Stable tube type thermometer with biodegradable special blue filling, scale on yellow background, with eyelet.
U16120	Demonstration Thermometer	-10° – 110° C	1° C	650 mm x 30 mm diam.	Extra-large tube type thermometer with biodegradable special blue filling, easy-to-read scale on yellow background.

K-Type NiCr-Ni Immersion Sensor, -65° C to 550° C

Temperature measurement sensor with stainless steel (V4A)-tube, spring-mounted (rigid) and silicone cable.

Measuring range: -65° C – 550° C

Response time: approx. 3 s

Tube: 130 mm x 1.5 mm diam.

U11854

K-Type NiCr-Ni Immersion Sensor, -200° C to 1150° C

Sheath thermocouple with stainless steel (Inconel) tube, flexible and silicone cable.

Measuring range: -200° C – 1150° C

Response time: approx. 3 s

Tube: 150 mm x 1.5 mm diam.

U11855

U11853



NEW

Thermometers



U29627

Insertion Thermometer

For measuring the temperature in air, liquids and soft materials. Temperature sensor made of stainless steel with protective case, switchable between °C and °F, On/Off switch and automatic switch-off.

Measuring range: $-50^{\circ}\text{C} - 150^{\circ}\text{C} / -58^{\circ}\text{F} - 302^{\circ}\text{F}$
 Division: $0.1^{\circ}\text{C}/\text{F}$
 Accuracy: $\pm 1^{\circ}\text{C} / \pm 2^{\circ}\text{F}$
 Temperature sensor: $130\text{ mm} \times 4\text{ mm diam.}$
 Mass: 29 g

U40170



U40170

Insertion Thermometer F

Waterproof digital thermometer with a 125 mm long sensor to measure the temperature of liquid, pulverulent and soft substances. With memory function, min/max function, reversible °C/°F. Plastic casing, clip and LR 44 button battery included.

Measuring range: $-40 - +200^{\circ}\text{C}$
 Accuracy: $\pm 0.8\text{ degree (from } 0 - 100^{\circ}\text{C)}$,
 $\pm 1\text{ degree (from } -20 - 0^{\circ}\text{C)}$,
 $\pm 1.5\text{ degree (others)}$

Measurement interval: 1 s
 Dimensions: $205 \times 20 \times 17\text{ mm}^3$
 Mass: 56 g

U29627

Digital Thermometer, Min/Max

Insertion thermometer with Hold and Min/Max function in robust plastic housing and temperature sensor made of stainless steel. Switchable between °C and °F, On/Off switch, hanging strap and folding angled support.

Measuring range: $-50^{\circ}\text{C} - 200^{\circ}\text{C} / -58^{\circ}\text{F} - 392^{\circ}\text{F}$
 Division: $0.1^{\circ}\text{C}/\text{F}$
 Dimensions: $95 \times 65 \times 20\text{ mm}^3$
 Cable length: 1400 mm
 Measurement probe: 120 mm

U16101



U16101

Digital Pocket Thermometer

Temperature sensor made of stainless steel with protective case, watertight, switchable between °C and °F, Min/Max/Hold function, automatic switch-off.

Measuring range: $-40^{\circ}\text{C} - 200^{\circ}\text{C} / -40^{\circ}\text{F} - 392^{\circ}\text{F}$
 Division: $0.1^{\circ}\text{C}/\text{F}$
 Accuracy: $\pm 1^{\circ}\text{C} / \pm 2^{\circ}\text{F}$
 Dimensions: $150 \times 20 \times 18\text{ mm}^3$
 Mass: 20 g

U40173



U40173

Heat and Thermodynamics

Infrared Thermometer

Surface thermometer for contactless temperature measurement from a safe distance, e.g. in inaccessible places, hot or moving objects. With laser diode for laser sighting, illuminated LCD display, range overflow display, measured value storage function, selection between Celsius and Fahrenheit, automatic switch off. Includes bag and battery.

	U118152	U118161
Designation	Infrared Thermometer, 800° C	Infrared Thermometer, 380° C
Measuring range	-50° C – +800° C -58° F – +1472° F	-50° C – 380° C -58° F – 716° F
Division	0.1° C/F	1° C/F
Accuracy	±1% of measured value ±1° C / 1.8° F	2% of measured value +2° C / 4° F
Response time	150 ms	< 1 s
Optical resolution	20:1	12:1
Max. temperature display	yes	–
Alarm function	high/low	–
Voltage supply	9 V battery	9 V battery
Dimensions	146x43x104 mm ³	160x82x45 mm ³
Mass	approx. 170 g	approx. 180 g



U118152

U118161

	U11817	U11818
Designation	Digital Thermometer, 1 Channel	Digital Thermometer, 2 Channels
Measuring range	-50° C – +1300° C -58° F – +2000° F 223 K – 2000 K	-50° C – +1300° C -58° F – +2000° F
Division	0.1° C/F, 1 K	0.1° C/F
Accuracy	±0.5% +1° C / +2° F ±1% +2 K	±0.5% +1° C / +2° F
Display	3½-digit illuminated LCD	3½-digit illuminated LCD
Digit size	21 mm	21 mm
Voltage supply	9 V battery	9 V battery
Dimensions	approx. 90x170x45 mm ³	approx. 90x170x45 mm ³
Mass	approx. 350 g	approx. 350 g



U11823

Thermometers

Digital Thermometer Type K/IR

Digital two channel thermometer with two K-type inputs and additional external infrared sensor. Can also be used for measurements at low temperatures. With automatic shut off, maximum value storage and data hold function. Includes case, 2 K-type thermocouple sensors, infrared temperature sensor, 9 V battery and instruction manual.

- Measurement inputs: 2x K-type, external IR input
- Measuring functions: T1, T2, T3, T1-T2, T1-T3, T2-T3
- Measuring range: -200 – 1372°C (type K), -30 – 550°C (IR)
- Measurement error: ±0.5% + 2°C (type K), ±2.5% + 2°C (IR)
- Resolution: 0.1°C
- Unit of measurement: °C or K
- Emission factor: 0.95 fixed
- Digital display: 3½ digit LCD
- Background lighting: blue
- Operating voltage: 9 V battery
- Dimensions: 75x200x50 mm³ approx.
- Mass: 280 g approx.

U11823

Digital Thermometer

Versatile digital thermometer for type-K temperature sensors with single or dual input (U11818) for measuring instantaneous or differential temperature (T1 – T2 U11818). With storage of maxima and Data-Hold function. Includes type-K temperature sensor (U11818 2x), battery, holster and carrying bag.



U11817 / U11818

Heat and Thermodynamics

Heat Equivalent Apparatus

Apparatus for determining the specific heat capacity of aluminum and for confirming the energy conservation law. The robust heat equivalent apparatus consists of a shaft with ball bearings at both ends, an integrated counter for measuring the number of revolutions performed and an attached table clamp for securing the device. The aluminum calorimeter body heats up as a result of frictional work or electrical energy from the integrated heating element. An NTC thermistor, acting as a temperature sensor and located in an aluminum case, determines the temperature. The calculation can be performed easily using the temperature calibration table printed on the apparatus.

- Length: 230 mm
- Span of the table clamp: 10 – 65 mm span
- Cord length: approx. 1.80 m
- Calorimeter body: 50 mm x 48 mm diam.
- Electric heater power: 10 V, 1 A
- Heating element connection: via 2 mm sockets
- Weight calorimeter: 250 g
- Total mass : approx. 1200 g

Contents:

- 1 Basic unit
- 1 Aluminum calorimeter
- 1 Temperature sensor
- 1 Pair of adapter cables with 4 mm safety plugs/2 mm plugs
- 1 Friction belt
- 1 Bucket, 5 l
- 1 Counterweight

U10365

Additionally required for temperature measurement:

U11806 Digital Multimeter

Additionally recommended:

U33020-230 DC Power Supply, 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz)

or

U33020-115 DC Power Supply, 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz)

U10366 Copper Calorimeter



Immersion Heater, 12 V

Sheathed heater suitable for the metal block calorimeters (from U30070).

- Operating voltage: max. 12 V
- Power: max. 50 W (nominal)
- Tubing: 150 mm long
- Heated section: 70 mm
- Electrical connection: 4 mm sockets

U30075

Additionally required:

U33020-230 DC Power Supply Unit 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz)

or

U33020-115 DC Power Supply Unit 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz)



Copper Calorimeter

Calorimeter body for the heat equivalent device for determining the specific heat capacity of copper. With borehole for holding temperature sensor and with integrated heating element.

- Electric heater power: 10 V, 1 A
- Heating element connection: via 2 mm sockets
- Dimensions: 50 mm x 48 mm diam.
- Mass: 750 g

U10366

Additionally required

U10365 Heat Equivalent Apparatus



U10366

Set of 4 Calorimeter Cylinders

Four cylindrical metal calorimeter blocks, each of mass 1 kg, for determining the specific thermal capacities of aluminium, brass, copper and steel. Each calorimeter cylinder has two holes for inserting a heating element (U30075) and a thermometer or temperature sensor.

- Hole for heating element: 12.5 mm diam.
- Hole for thermometer: 8 mm diam.

U30070

Additionally required:

U30075 Immersion Heater, 12V

Thermometer or Temperature Sensor

Art. No.	Material	Height	Diameter	Specific heat J/(kg*K)
U30071	Aluminium	84 mm	75 mm	896
U30072	Brass	84 mm	44 mm	377
U30073	Copper	85 mm	43 mm	385
U30074	Steel	92 mm	44 mm	452



U8441020



U8451310



U8441010

U8441050

Calorimeter with Heating Coil, 150 ml

For determining the specific heat capacity of solids and liquids and for measuring the electric heat equivalent. Two mutually insulated aluminum beakers, lid with rubber stopper with boreholes for thermometer and stirrer, with heating coil.

Capacity of insulated container: 150 ml
 Connection sockets: 4 mm
 Electric heater: 6 V/2 A max.

U8441020

Additionally required:

U14295 Tube Thermometer, -10 ... +110°C

Additionally recommended:

U8442610 Aluminium Shot, 100 g
U8442620 Copper Shot, 200 g
U8442640 Glass Shot, 100 g

U33020-230 DC Power Supply, 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz)
 or

U33020-115 DC Power Supply, 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz)

Calorimeter, 200 ml

For determining temperatures of mixtures, specific heat capacities, conversion energies of substances and heat of fusion of ice. Designed for simple experiments for students. Plastic container with styrofoam inlay.

Capacity of insulated container: approx. 200 ml
 Weight: approx. 80 g

U8441050

Additionally required:

U8451310 Tube Thermometer, -10 – +100° C

Additionally recommended:

U8442610 Aluminium Shot, 100 g
U8442620 Copper Shot, 200 g
U8442640 Glass Shot, 100 g



U8442640

U8442610

U8442620

Calorimeter with Heating Coil, 1,200 ml

Calorimeter for determining specific heat capacities, conversion energies of materials, mixing temperatures as well as measurement of electrical equivalents of heat. Consists of a double-walled, heat-insulating plastic container with an insulating vessel inside made of reflecting glass, with heating coil and stirrer. Also includes a lid with an opening for a thermometer and two 4 mm plugs for connecting the power supply for the heating coil. The calorimeter is equipped with a heating filament, electrically insulated to avoid decomposition of filament and terminals due to electrolytic processes.

Max. heater voltage: 25 V
 Max. heating power: approx. 160 W
 Contents of insulated container: approx. 1200 ml
 Dimensions: approx. 240 mm x 120 mm diam.
 Weight: approx. 0.8 kg

U8441010

Additionally required:

U8451310 Tube Thermometer, -10 – +100° C

Additionally recommended:

U8442610 Aluminium Shot, 100 g
U8442620 Copper Shot, 200 g
U8442640 Glass Shot, 100 g

U33020-230 DC Power Supply, 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz)

or

U33020-115 DC Power Supply, 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz)

Graduated Cylinder, 100 ml

Duran glass, tall form with spout, hexagonal base.

Scale: 100 ml
 Divisions: 1 ml

U14205

Pellets

Granules for filling calorimeters.

Aluminium Shot, 100 g

U8442610

Copper Shot, 200 g

U8442620

Glass Shot, 100 g

U8442640

U14205





U8442150

Tyndall's Bar Breaker

U-shaped clamping set up with a metal rib and fastening screw for demonstrating the linear expansion of metals on heating, as well as the tremendous forces which can be exerted in the process. The set includes 10 cast-iron bolts for breaking in the course of the experiment.

Diameter for bolt hole: approx. 11 mm
 Length of clamping fixture: approx. 285 mm
 Weight: approx. 1400 g

U8442150

Ball and Ring

Brass ball and brass ring with plastic handles for demonstrating the thermal expansion of solid bodies. After heating in a burner flame, the ball no longer fits through the cold ring. Length: approx. 250 mm

U409001



U409001



U8442120



Cast Iron Bolts, Set of 10 Bolts

Spare bolts to be used with Tyndall's bar breaker (U8442150) or the ice bomb (U8442120).

U8442110



U8442110

Ice Bomb

Clamping set up for demonstrating volumetric expansion of water on freezing, as well as the tremendous forces which can be exerted in the process. Comprises a steel cylinder with a clamping rib and plastic lid. The set includes 10 cast-iron bolts for breaking in the course of the experiment.

Diameter for bolt hole: approx. 11 mm
 Dimensions: approx. 40x30x75 mm³
 Weight: approx. 620 g

U8442120



U8442500

Ball with Ring

An arrangement for demonstrating the expansion of solids on heating. After heating in a burner flame, the ball no longer fits through the bore in the bracket. Steel ball with chain and handle.

Dimensions of the bracket in mm: approx. 40x50x40 mm²
 Diameter of ball: approx. 22 mm
 Length of handle with shaft: approx. 225 mm
 Weight: approx. 175 g

U8442500

Linear Expansion Apparatus with Three Pointers

Apparatus for measuring the linear expansion of different kinds of solids simultaneously. The set includes three sample tubes (brass, aluminium and glass) which are heated by passing steam through them. Linear expansion is indicated on a mirror scale by three differently coloured pointers mounted on rollers. Includes silicone tubing.

Dimensions of the tubes: 700 mm x 6 mm diam.
 Dimensions: approx. 830x80x70 mm³
 Weight: approx. 1.2 kg

U8442200

Additionally required:

U8624650-230 Steam Generator (230 V, 50/60 Hz)
 or
U8624650-115 Steam Generator (115 V, 50/60 Hz)

Steam Generator

Device for generation of steam, e.g. in experiments on thermal expansion. Aluminum vessel with cork lid and retainer on an adjustable hot plate with a thermal circuit breaker.

Hotplate: 90 mm diam.
 Power consumption: 550 W
 Vessel volume: 250 ml
 Dimensions: 170 mm x 180 mm diam.
 Hose connection: 6 mm diam.
 Total mass: approx. 1 kg

Steam Generator (230 V, 50/60 Hz)

U8624650-230

Steam Generator (115 V, 50/60 Hz)

U8624650-115



Gauge with Adapter

Analogue gauge for measuring minimal changes in length plus an adapter for fitting a gauge dial as an enhancement to the extension apparatus D (U15400).

1012862

Linear Expansion Apparatus S

A device for measuring the linear expansion of solids as a function of length and material. Includes three sample tubes (iron, copper and glass) which are heated by passing water vapour through them. Consists of a base strip with a clamping spring, pointer, scale and hose nipple.

Pointer ratio: 1:50
 Tube length: approx. 630 mm
 Dimensions: 530x60x240 mm³
 Weight: 0.6 kg

U15405

Additionally required:

U8624650-230 Steam Generator (230 V, 50/60 Hz)
 or
U8624650-115 Steam Generator (115 V, 50/60 Hz)
U10146 Silicone Tubing, 1 m

Linear Expansion Apparatus D

A device for measuring the linear expansion of solids as a function of length and material. Includes three sample tubes (steel, brass and glass) which are heated by passing water vapour through them. Consists of a base strip with a fixed bearing, pilot bearing, pointer and projectable scale.

Scale dimensions: 140x200 mm²
 Measuring range: 1 mm
 Reading accuracy: 0.05 mm
 Tube length: approx. 650 mm
 Dimensions: approx. 730x50x200 mm³
 Weight: approx. 2 kg

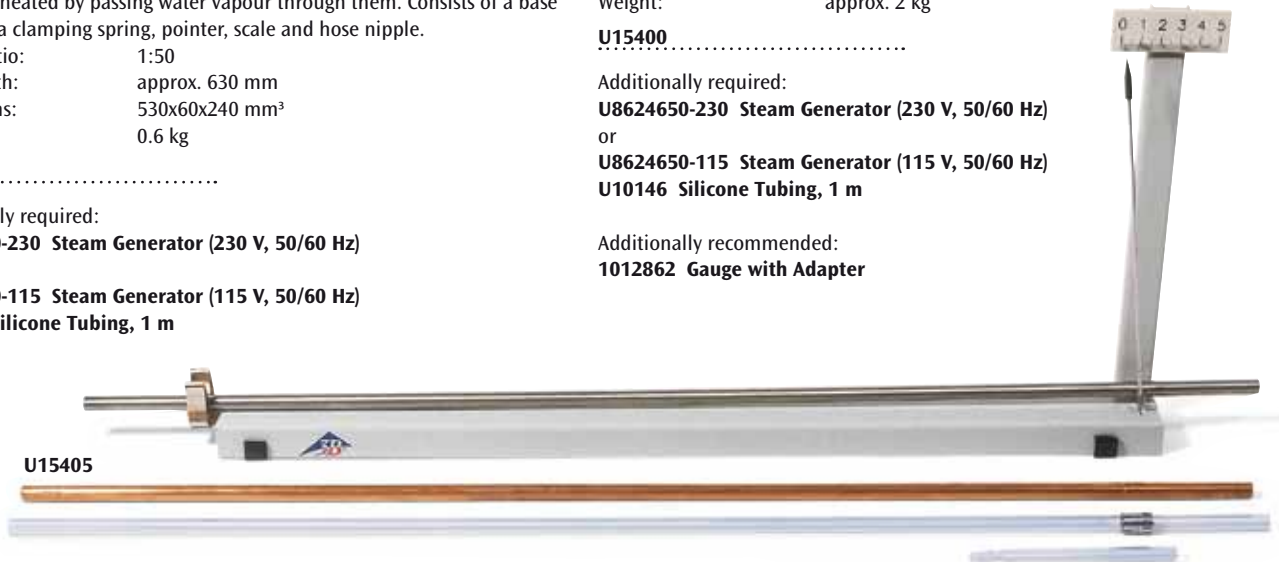
U15400

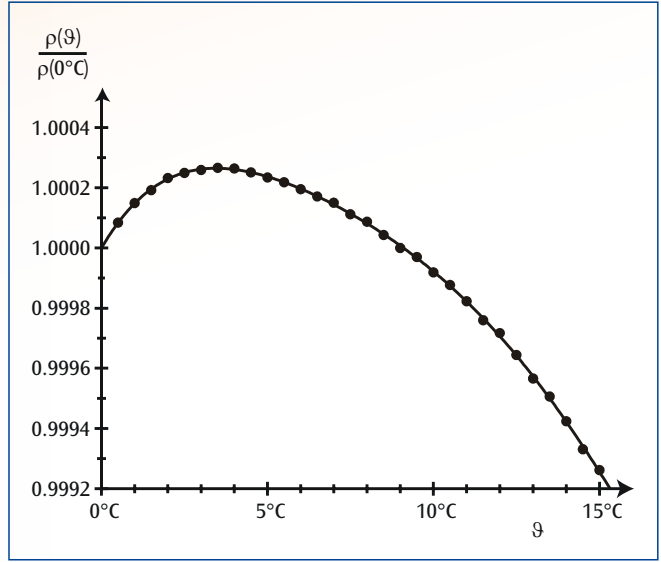
Additionally required:

U8624650-230 Steam Generator (230 V, 50/60 Hz)
 or
U8624650-115 Steam Generator (115 V, 50/60 Hz)
U10146 Silicone Tubing, 1 m

Additionally recommended:

1012862 Gauge with Adapter





Determining the maximum density of water

Gas Expansion Apparatus

Glass vessel with ground-glass sealing joints for demonstrating the expansion of air when heated. The U-tube is filled with water at room temperature and the water levels are marked. Even the heat from a hand is enough to cause the air in the flask to expand so that the water levels in the U-tube change visibly.

Height: approx. 230 mm

U58030



Device for Demonstrating the Anomaly of Water

Apparatus for demonstrating the thermal anomaly of water, measuring its thermal expansion and determining its maximum density. Comprises a Duran glass vessel with an inlet tube and two GL screw connections for mounting the riser tube with a mm scale and a temperature sensor or thermometer. Includes stirring rod.

- Volume: 250 ml
- Riser tube: 400 mm
- Capillary: 1.5 mm diam.
- Hose nipple: 8 mm
- Overall height: approx. 500 mm

U14318

Additionally required:

- T52006 Plastic Trough
- U11876 Magnetic Stirrer
- U16115 Tube Thermometer
- or
- U11817 Digital Thermometer
- and
- U11854 K-Type NiCr-Ni Immersion Sensor, -65°C – 550°C

Heat-Flow Device

Stable glass flask with rectangular bends for demonstrating the flow of heat in a liquid that is heated non-uniformly. With GL18 screw fitting and side-limbs for filling with water, and a small quantity of potassium permanganate for colouring.

Dimensions: 420x420 mm²
 Tube diameter: 30 mm

U14340

Additionally required:

- U13271 Tripod Stand, 185 mm**
- U15002 Stainless Steel Rod, 470 mm**
- U13255 Universal Clamp**
- U13261 Universal Jaw Clamp**
- U8621240 Spirit Lamp**
- Potassium permanganate for use as a colouring agent**



U20020



U14340

Heat Conduction / Heat Flow



U58031

Vane Wheel

Device for demonstrating air and heat flows generated by a burning candle, water vapor or other heat sources. Made of aluminum and mountable on a long needle.

U20020

Additionally required:

- Long needle**

Heat Conductivity Device

A device with five metal bars for comparing the thermal conductivity of aluminium, brass, steel, zinc and copper – by melting wax balls at the rod ends. The five rods extend in a star-shaped configuration from a brass hub. Each rod has a notch for holding wax.

Length: 340 mm

U409051



U409051

Heat-Flow Device S

Stable glass flask on a stand for demonstrating the flow of heat in a non-uniformly heated liquid. With filling hole for filling with water and a small quantity of potassium permanganate crystals for colouring.

Glass flask: 300x150 mm²
 Tube diameter: 14 mm
 Height: 250 mm

U58031

Additionally required:

- U8621240 Spirit Lamp**
- Potassium permanganate for use as a colouring agent**

Thermal Conductivity Equipment Kit

Kit for the qualitative investigation of the heat conductivity of aluminum (extremely high thermal conductivity) and expanded polystyrene (very low thermal conductivity). Even at room temperature the varying material temperatures are evident to the touch. In the experiment ice cubes are placed on the plates. The ice cube on the seemingly colder aluminum plate melts much more quickly (in 1–2 minutes), while there seems to be no melting at all of the ice cube on the seemingly warmer plastic plate. Two rubber rings which prevent the ice cubes from slipping off the plates complete the experiment kit.

Plate dimensions: approx. 95x95x13 mm³

U45055



U45055

Heat and Thermodynamics



Accessories for Kinetic Gas Theory

Accessories for vibrator (U56001) for simulating particle motion in an ideal gas. Differently coloured spheres (gas model) are set in motion by mechanical vibrations.

Contents:

- 1 Plexiglas cylinder, length 300 mm
- 1 Circular disc
- 1 Set of spheres of different colours

U56004

Additionally required:

- U56001 Vibration Generator**
- U8533600-230 Function Generator FG 100 (230 V, 50/60 Hz)**
- or
- 1009956 Function Generator FG 100 (115 V, 50/60 Hz)**

U8533600-230
1009956

U56001

Crookes Radiometer

Device for demonstrating the conversion of radiation energy into kinetic energy. Rotary-vane wheel mounted on a metal tip and equipped with four plates, each coloured black on one side; housed in an evacuated glass bulb.

- Height: 210 mm
- Ball diameter: 80 mm

U14300



U14300

Moll Type Thermopile

Sensitive probe for measuring heat radiated by a black body or Leslie's cube, as well as for detecting visible light and ultraviolet radiation. Comprises a metal housing with a polished, conical reflector and a black surface 15 mm in diameter with 17 linked thermocouples. With two 4 mm connectors mounted on a stem.

- Sensitivity: approx. 0.14 $\mu\text{V}/\mu\text{W}$
- Internal resistance: approx. 1 Ω
- Setting duration: 40 s for 95 % of the measured value
- Rod: 156 mm x 10 mm diam.
- Dimensions: 94 mm x 40 mm diam.
- Weight: approx. 200 g

U8441301

Additionally required:

- 1006810 Multimeter ESCOLA 10**
- U8611210 Stand base**
- 2 Experiment leads**



U8441301

Leslie's Cube

A hollow aluminium cube for investigating heat radiation from a hot body as a function of its temperature and surface. With a removable lid for pouring in hot water and 2 openings for inserting a thermometer or thermal sensor and a stirrer. One side each is polished, matt, black and white.

- Dimensions: 100x100x100 mm³
- Weight: approx. 360 g

U8442835

Additionally required:

- U8441301 Moll Type Thermopile**



U8442835

Experiment Topics:

- Thermal motion of atoms and molecules in various states of aggregation
- Electrical conduction processes
- Models of atomic physics
- Mechanical motion

Air-Cushion Plate

An ideal device for demonstrating a series of experimental models intended to study the motion of atomic particles:

- Objects hovering on the air cushion experience near-zero friction and are used to simulate particle motion. The set contains five different transparent, coloured plastic or aluminium elements with round ceramic magnets fitted to them to ensure elastic collisions.
- Magnetic barriers can be used to modify the plastic-bordered experimentation surface. This allows elastic collisions between the hovering bodies and the borders.
- A lattice model with a fixture is available for emulating crystal lattices in experiments on electrical conductivity in semiconductors, for instance. Comprises a height-adjustable plexiglass plate from which 25 ceramic magnets are freely suspended.
- Two rod-shaped metal electrodes can be positioned in parallel with the experimentation surface in order to generate an electrical field. The effect of electrical fields on charged particles can also be simulated by inclining the experimentation surface.

The equipment system is characterized by a clear and simple design, minimum preparatory adjustment requirements, clear visibility of all experiments through overhead projection, simple operation and high reliability. The device consists of a robust frame with a pressure chamber whose cover plate is furnished with 1089 fine perforations and serves as an experimentation surface. Air is supplied to the pressure chamber by a blower via a hose, causing the coloured bodies to hover. An additional air stream from an impulse valve makes it possible to alter the motion of the hovering bodies. The air-cushion table is equipped with two adjustment screws. With two adjustable screws for horizontal alignment.

Dimensions: 350x350x75 mm³

Contents:

Air-cushion plate

Magnetic hovering bodies:

- Red, 16 mm diam. (30x)
- Green, 16 mm diam. (25x)
- Aluminum, 21 mm diam. (5x)
- Orange, 28 mm diam. (25x)
- Blue, 48 mm diam. (1x)

Magnetic barriers:

- 253 mm (2x)
- 233 mm (1x)
- 233 mm with a recess (1x)
- 233 mm with an opening, flat, with 4 magnets (1x)

Magnetic piston

Lattice model

Fixture for lattice model

Pair of electrodes

Plexiglass plate

Manipulation rod

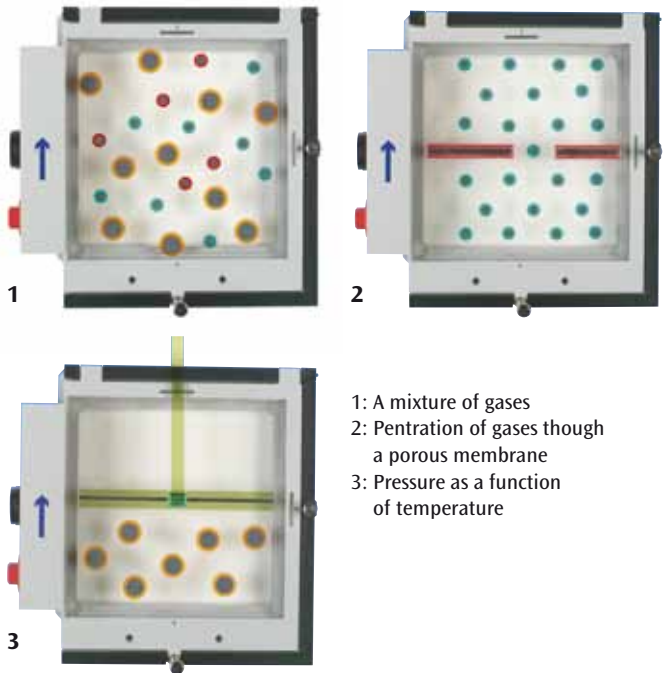
Tweezers

Experiment manual

Wooden storage box

Tube

U15420



- 1: A mixture of gases
- 2: Penetration of gases through a porous membrane
- 3: Pressure as a function of temperature

Additionally required:

U15425-230 Air Flow Generator (230 V, 50/60 Hz)

or

U15425-115 Air Flow Generator (115 V, 50/60 Hz)

Qualitative Observations

- Liquid and gaseous states
- Dynamic compression and expansion
- Critical opalescence
- Formation of the transition point at various temperatures

Quantitative Measurements

- Display of the critical point and temperature
- Recording of isotherms in p-V (Clapeyron) diagrams
- Recording of isotherms in pV-p (Amegat) diagrams
- Pressure curves for a saturated vapour
- Differences between real gases and ideal gases

Critical temperature:	318.6 K (45.5°C)
Critical pressure:	3.76 MPa (37.6 bars)
Critical volume:	197.4 cm ³ /mol
Critical density:	0.74 g/mol
Temperature range:	10 – 60°C
Maximum pressure:	6.0 MPa (60 bars)
Maximum volume:	15.7 cm ³
Manometer diameter:	160 mm
Bore for temperature sensor:	6 mm diam.
Temperature control connections:	7 mm diam.
Reducing valve connection:	1/8" diam.
Standard gas connection:	3.5 mm diam.
Dimensions:	380x200x400 mm ³
Weight:	7 kg approx.

Contents:

- 1 Critical point apparatus filled with hydraulic (castor) oil but without test gas (SF₆). Includes built-in safeguarded connection nozzle for MINICAN® gas canisters
- 1 Oil filling device
- 1 Angled 1.3-mm hexagonal spanner (for grub screw on rotary scale)
- 1 Plastic hose, 3 mm internal diameter
- 1 1/8" pipe screw connection (SW 11)
- 1 Grease gun

U104001

Additionally required:

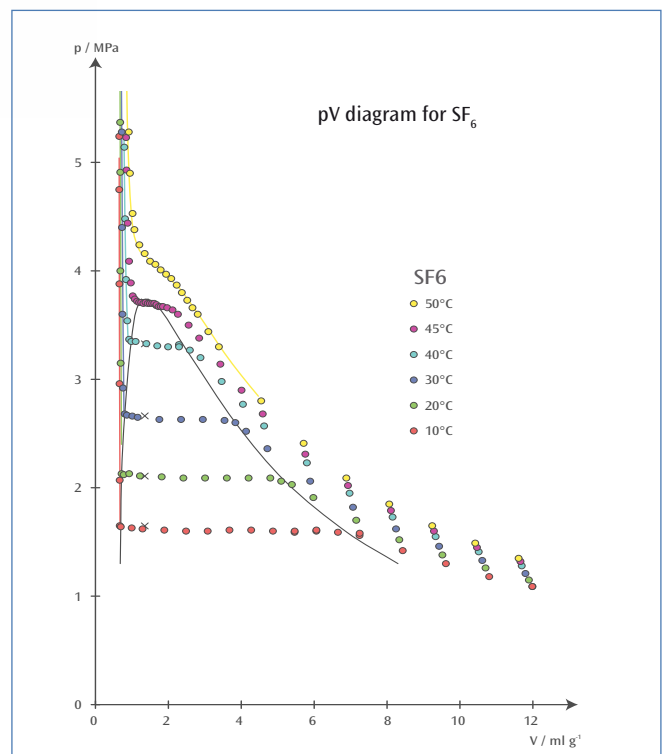
- U144002-230 Immersion/Circulation Thermostat (230 V, 50/60 Hz) or
 - U144002-115 Immersion/Circulation Thermostat (115 V, 50/60 Hz)
 - U10146 Silicone Tubing, 1 m (2x)
 - U11853 Digital Quick-Response Pocket Thermometer
 - U11854 Immersion Sensor, NiCr-Ni, type K, -65°C – 550°C
- Sulphur hexafluoride SF₆

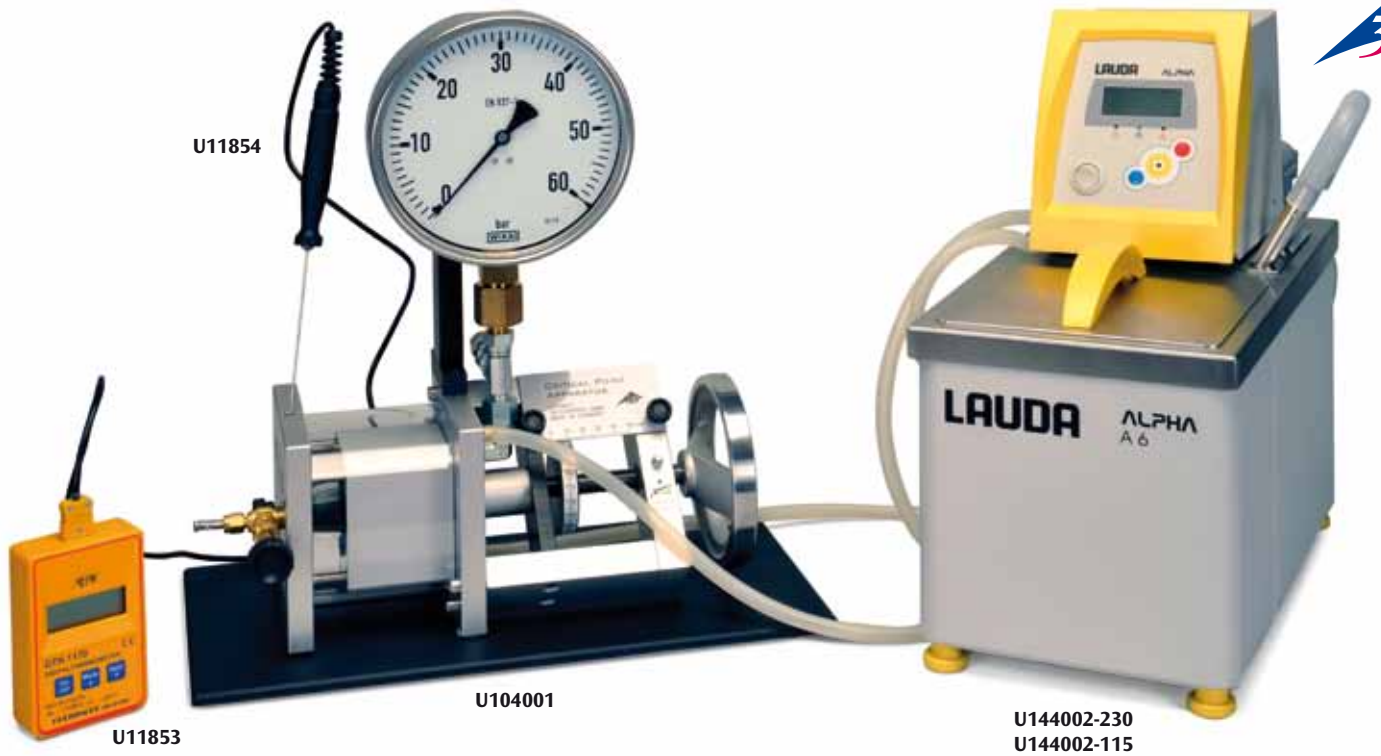


U104001

Critical Point Apparatus

A high-precision apparatus for studying the compression and liquefaction of a gas, determining the critical point and recording isotherms in p-V (Clapeyron) diagrams. The test gas is sulphur hexafluoride (SF₆), which has a critical temperature of 318.6 K (45.5°C) and a critical pressure of 3.76 MPa (37.6 bars), allowing for a simple experiment set-up. The apparatus includes a transparent measuring cell that is highly resistant to leakage and compression. The volume inside the cell is changed via a finely adjustable handwheel, the change being indicated by a combination of a fixed and a rotary scale to an accuracy of 1/1000 of the maximum volume. The pressure is generated by a hydraulic system containing castor oil of medically approved quality. The measuring cell and hydraulic system are separated by a cap seal which rolls in as the volume increases. This design means the pressure gradient between the measuring cell and oil chamber is negligible. A manometer measures gas pressure instead of oil pressure without taking up any dead space inside the measuring cell. During transitions from the gaseous to the liquid phases and vice versa, it is therefore possible to observe the formation of the first drops of liquid and disappearance of the last gas bubbles. The measuring cell is enclosed in a transparent water chamber. A circulation thermostat allows the temperature to be maintained at a highly constant value, which can be monitored by means of a thermometer. Practical indications of the volume, pressure and temperature permit easy recording of p-V or pV-p diagrams providing qualitatively correct results. Pressure and temperature-dependent volumetric corrections also provide quantitatively accurate results comparing favourably with standard reference values.




Note:

In accordance with good laboratory practice, it is advisable to obtain gas via a fixed pipeline if the critical-point apparatus is used frequently. In case of occasional usage, it is more expedient to obtain the test gas from MINICAN® canisters. A MINICAN® gas connection is designed similarly to the valve on a common spray can, i.e. it is opened simply by fitting the MINICAN® on the gas connection nozzle.

Additionally required in case of degassing hydraulic oil:

U10401 Castor Oil

High-Power Vacuum Pump

Set of Seals (not shown)

Set of spare seals for critical point apparatus (U104001). Includes a rubber cap seal, round rubber seal of diameter 60 mm, square rubber seal 78x78 mm², a sealing ring of diameter 30/20 mm, four copper sealing discs and a threaded bush made of POM (Polyoxymethylene).

U10402

Castor Oil (not shown)

250 ml of DAB approved castor oil for filling critical point apparatus (U104001).

U10401

Immersion/Circulation Thermostat

Immersion circulation thermostat for setting the temperature of a bath or external apparatus with non-flammable liquids at temperatures up to 95°C. The fully electronic continuous regulator and the powerful circulating pump ensure that the water in the bath is optimally stirred so that the temperature remains highly constant. The user-friendly menu and simple three-button operation guarantee that the equipment is easy to use. A single-row LED display indicates the desired temperature and the actual temperature. Excess temperature protection is set to a fixed value of 95°C and features both audible and visual alarms to enhance operating safety. Also included is the possibility of connecting a water cooler or heat exchanger to provide cooling by means of tap water.

Operating-temperature range: 25°C – 85°C
 Temperature constancy: ±0.05°C
 Heating power: 1.5 kW
 Pump pressure: max. 0.2 bar
 Delivery rate: max. 15 l/min
 Bath volume: max. 5.5 l
 Bath area / depth: approx. 145x161x150 mm³

Immersion / Circulation Thermostat (230 V, 50/60 Hz)

U144002-230

Immersion / Circulation Thermostat (115 V, 50/60 Hz)

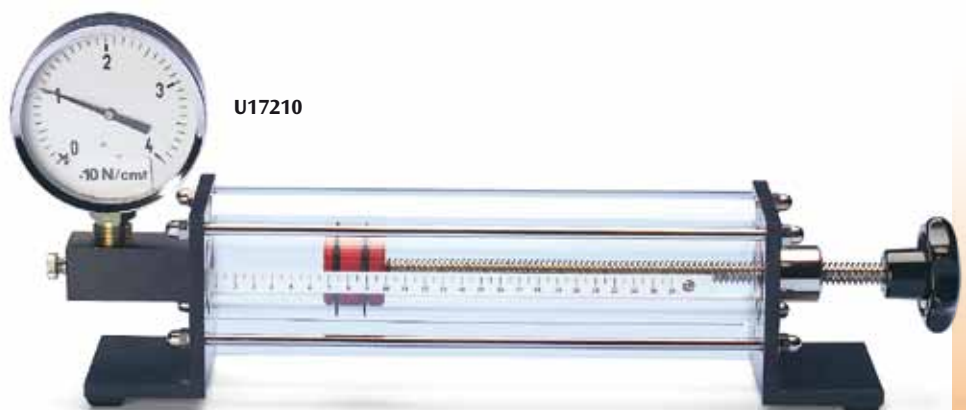
U144002-115

Boyle-Mariotte Apparatus

Device for experiment based determinations of the dependence between the volume and pressure of a gas at constant temperature (Boyle's law). Consists of a plexiglass cylinder with graduations for volume measurement, piston, manometer and air inlet/outlet valves. Turning the handle moves the piston via a thread in the plexiglass cylinder. This allows a generation of overpressures and underpressures. For safety reasons, the power cylinder is enclosed in another plexiglass cylinder.

Length: 300 mm
 Internal diameter: 40 mm
 Piston: 30 mm x 40 mm diam.
 Piston seal: 2 O-rings
 Manometer diameter: 100 mm
 Pressure range: 0 N/cm² – 40 N/cm²

U17210





1012870

NEW

Jolly's Bulb and Gauge
 Palm-sized, hollow metallic ball with a manometer connected to it for demonstrating change of pressure in a closed volume of air when heated or cooled. Immersing the ball in a water bath at a specific temperature allows the relationship between pressure and temperature of the enclosed air to be investigated in order to demonstrate the behaviour of an ideal gas.
 Hollow ball: 60 mm diam.
 Manometer: 840 ... 1240 hPa
1012870

Oscillation Tube

For determining adiabatic exponent c_p/c_v of air by Rüchardt's method, used in conjunction with Mariotte flask (U14327). Precision glass tube with precisely fitting aluminum cylinder. If the glass tube is placed vertically on a glass flask of 10 l volume and the aluminum cylinder is allowed to slide into the glass tube, it can be made to undergo harmonic oscillations on the air cushion resulting from the enclosed volume of air. c_p/c_v can then be calculated from the period.
 Dimensions: 600x16 mm diam.^{internal}
 Aluminum cylinder: 15.2 g

U14328

Additionally required:
U14327 Mariotte Flask
U11902 Digital Stopwatch

U14328

Additionally recommended:
1012856 Vacuum Hand Pump

Mariotte Flask

Duran glass flask with discharge opening at base and two rubber stoppers with boreholes.
 Volume: 10 l

U14327

Additionally recommended:
U14328 Oscillation Tube



U14327



U8741180

U30046

Pneumatic Lighter

Device for demonstrating the ignition of diesel. By swiftly pressing down the piston, the compressed air in the transparent tube is heated so strongly that a piece of paper placed at the bottom of the tube very clearly ignites. Similarly, a cotton-wool pad soaked in ether also catches fire.
 Length of compression tube: approx. 150 mm

U8741180

Spare Glass Tube (not shown)

Spare glass tube for pneumatic lighter (U8741180).
U8741185

Boyle-Mariotte Apparatus S

This apparatus is ideally suited to demonstrating Boyle's Law to groups of students. Coloured oil is gradually pumped from a reservoir into a tube containing air. Whilst the volume of air is read from a scale clearly visible behind the tube, pressure is measured by a Bourdon gauge. The glass tube is extra strong and additionally protected by a plastic safety screen. The Bourdon gauge is fitted with a transparent plastic back to allow students to see its working parts. The apparatus is supplied complete with red oil.
 Hose nipple: 10 mm diam.
 Dimensions: approx. 350x200x760 mm³

U30046

Additionally required:
1012856 Vacuum Hand Pump

Experiment Topics:

- Recording and evaluating a pV diagram
- Operation of a Stirling engine as a heat pump or refrigerator
- Operation of a Stirling engine as a classical heat-engine

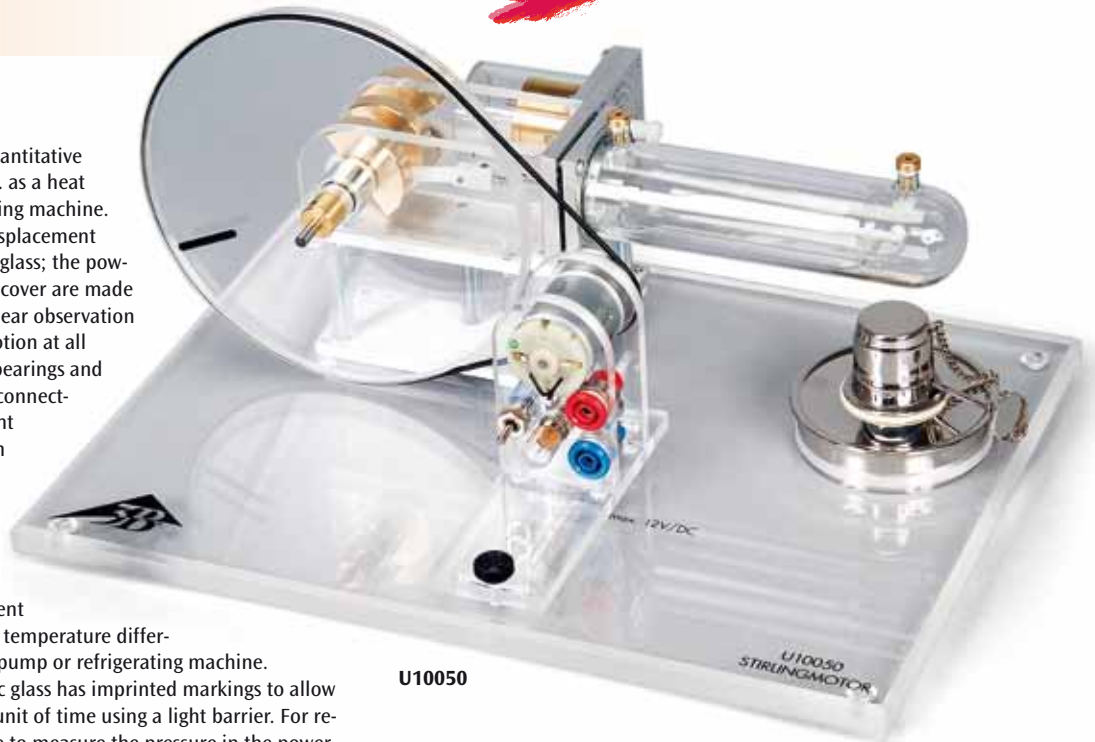
BEST SELLER

Stirling-Engine G

Transparent Stirling engine for quantitative investigations of the Stirling cycle, as a heat engine, heat pump and refrigerating machine. The displacement cylinder and displacement piston are made of heat resistant glass; the power cylinder, flywheel and gearbox cover are made of acrylic glass. This allows very clear observation of the individual sequences of motion at all times. The crankshafts have ball bearings and are made of hardened steel. The connecting rods are made of wear resistant plastic. Includes spirit burner with adjustable wick for use as a heat source. The glass of the displacement cylinder is also equipped with recessed temperature measurement sockets before and behind the displacement piston, to allow measurements of temperature differences during operation as a heat pump or refrigerating machine. The large flywheel made of acrylic glass has imprinted markings to allow measurement of revolutions per unit of time using a light barrier. For recording pV-diagrams, it is possible to measure the pressure in the power cylinder via a hose connection; the string included in the scope of delivery can be fastened to the power piston to measure the stroke in order to determine the volume. The integrated engine generator unit with a two stage belt pulley allows a conversion of the produced mechanical energy into electrical energy. Equipped with a switchover option for operating an integrated lamp or external loads, or feeding electrical energy for operation as a heat pump or refrigerating machine, in accordance with the direction of rotation of the Stirling engine.

Power of the Stirling engine: 1.5 W
 Idling speed: 1000 rpm
 Flywheel: 140 mm diam.
 Power cylinder: 25 mm diam.
 Stroke of the power piston: 24 mm
 Gas volume: 32 cm³ – 44 cm³
 Motor generator unit: max. 12 V DC
 Belt pulley: two stage (30 mm diam., 19 mm diam.)
 Dimensions: 300x220x160 mm³
 Weight: 1.6 kg

U10050



U10050

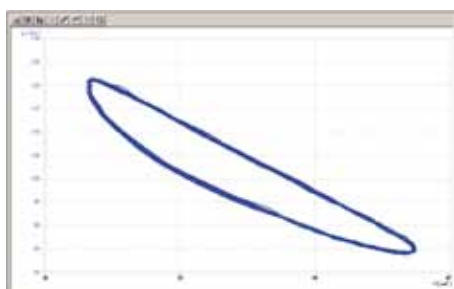
Additionally recommended:

- U11323** Relative Pressure Sensor ±1000 hPa
- U11371** Displacement Sensor
- U11372** Sensor Holder for Stirling Engine G
- U11310** 3B NETlab™
- U11300-230** 3B NETlog™ (230 V, 50/60 Hz)
- or
- U11300-115** 3B NETlog™ (115 V, 50/60 Hz)

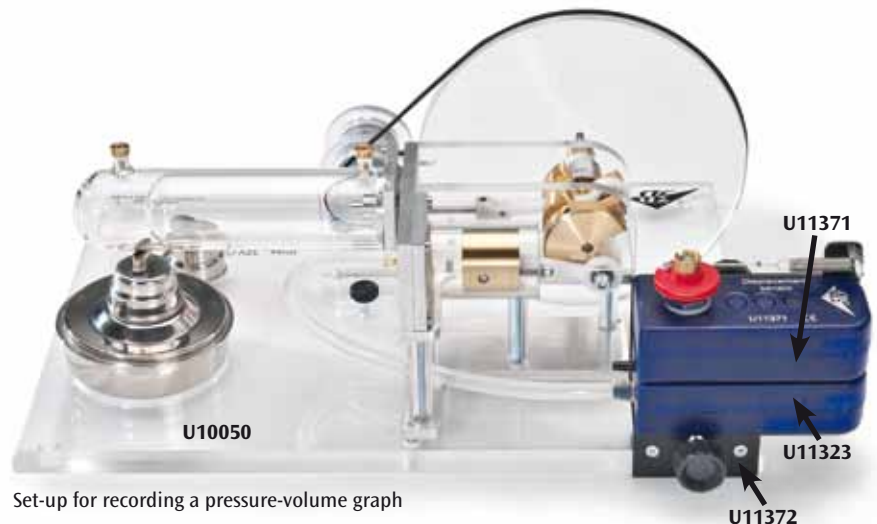
Sensor Holder for Stirling Engine G

Holder for a relative pressure sensor (U11323) and a displacement sensor (U11371) for use with the G-series Stirling engine (U10050).

U11372



Pressure-volume diagram of Stirling engine G



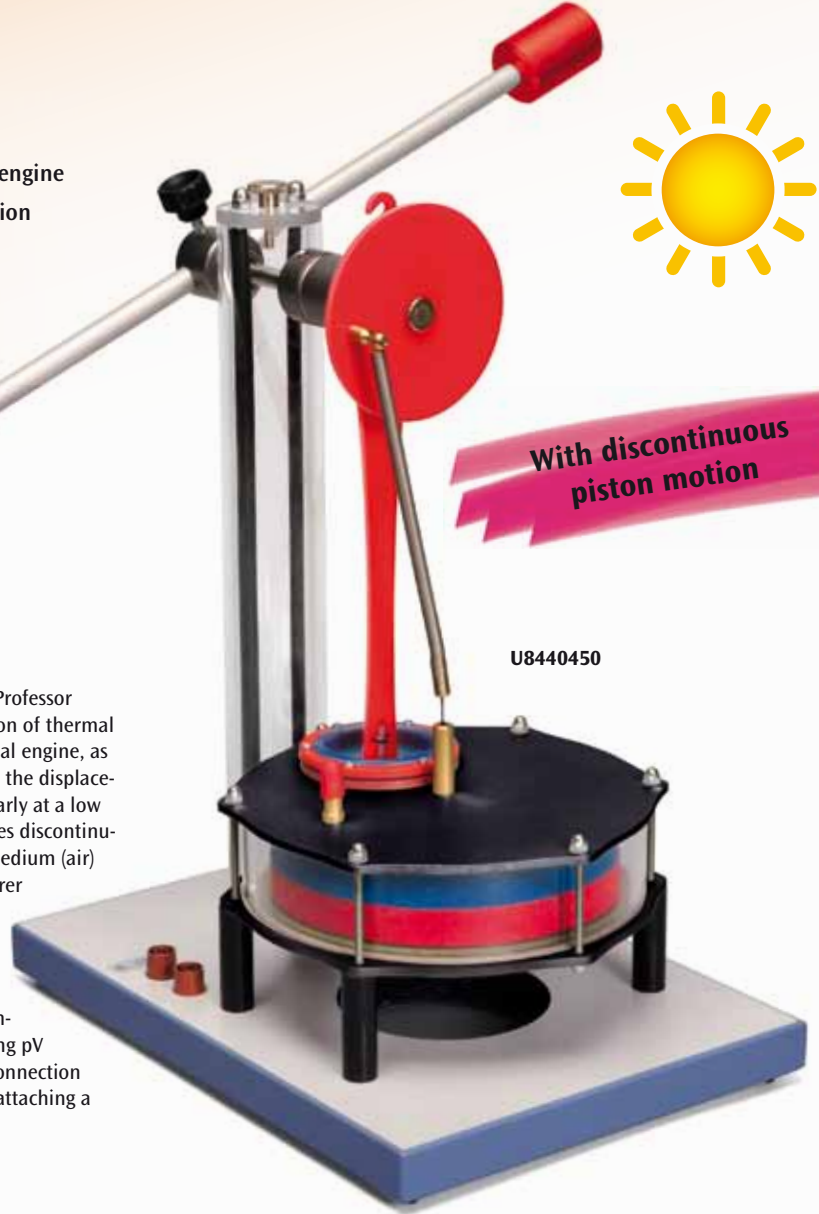
Set-up for recording a pressure-volume graph

Experiment Topics:

- Operation of a Stirling engine as a classical heat-engine
- Measurement of the no-load (idling) rate of rotation as a function of the heat input
- Recording and evaluating a pV diagram



With discontinuous piston motion



U8440450

Stirling Engine D

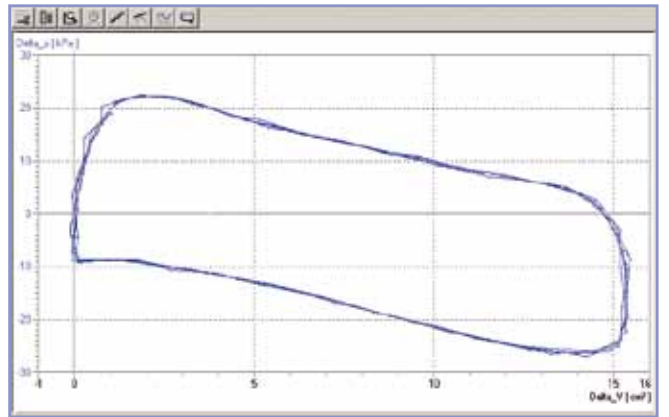
A functional model of a Stirling engine based on an idea by Professor Wilcke optimised for demonstrating to students the conversion of thermal energy into mechanical energy and the operation of a thermal engine, as well as investigating the Stirling cycle. The interplay between the displacement piston and the power piston can be seen especially clearly at a low rate of rotation. In this version the displacement piston moves discontinuously, with a dwell time during the heating of the working medium (air) and a second dwell time during its cooling. This offers a clearer demonstration of the ideal Stirling cycle than is possible with continuous piston movement. The heat source can be provided by an integrated electric hotplate, a candle flame, or focused radiation from the sun or from a lamp. In the latter case the direction of rotation will depend on whether the heat is applied from above or from below. For recording pV diagrams, the pressure can be measured via a rubber hose connection on the power cylinder, and the volume can be measured by attaching a thread to the power piston to follow its movement.

- Heater voltage: 8 – 12 V, 1.5 A
- Gas volume: 330 cm³ – 345 cm³
- Flywheel rod: 400 mm
- Dimensions without flywheel rod: 260x185x330 mm³
- Weight: 2.2 kg

U8440450

Additionally recommended:

- U11321 Relative Pressure Sensor ±100 hPa
- U11371 Displacement Sensor
- U8440455 Supplementary Set for Stirling Engine D
- U11310 3B NETlab™
- U11300-230 3B NETlog™ (230 V, 50/60 Hz)
- or
- U11300-115 3B NETlog™ (115 V, 50/60 Hz)



Pressure-volume diagram of Stirling engine D

Supplementary Set for Stirling Engine D

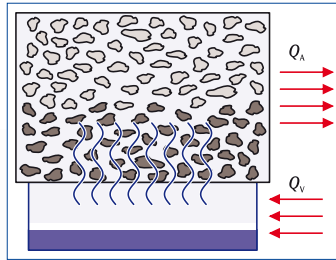
Set of equipment for adding a displacement sensor (U11371) and a relative pressure sensor (U11321) to the D-series Stirling engine (U8440450). The set consists of the following components:

- 1 Base plate to accommodate the pressure sensor
- 1 Knurled screw for fastening the base plate to a stand rod
- 1 Stem with magnetic base for displacement sensor
- 1 Silicone tubing for connecting ±100-hPa relative pressure sensor (U11321)
- 1 Set of threads with suction pad
- 2 Weights with hook, 20 g each

U8440455



U8440455



Adsorption Cooler Ice-Quick

Demonstration instrument for illustrating the principle of adsorption cooling. Consists of an evacuable cartridge filled with zeolite and a high quality hand-operated vacuum pump interconnected via rubber tubing, plus a plastic beaker. By means of the Ice-Quick it is possible to freeze a small quantity of water in a very short time. This is done by placing the cartridge on the plastic beaker containing some water then pumping the air out of the system. After a few strokes of the pump the water begins to boil at the ambient temperature. The zeolite adsorbs the water vapour by binding it into its crystal structure, and is thereby heated. Thus, heat is extracted from the boiling water; after a short time it is cooled sufficiently to freeze, with ice formation beginning at the surface. The process can be repeated several times, allowing pauses in between for the zeolite to cool, until the zeolite becomes saturated with water. The contents of the cartridge can be regenerated by heating at about 250°C for a short time in an oven. After cooling, the sequence can be repeated until the zeolite again becomes saturated.

U13150



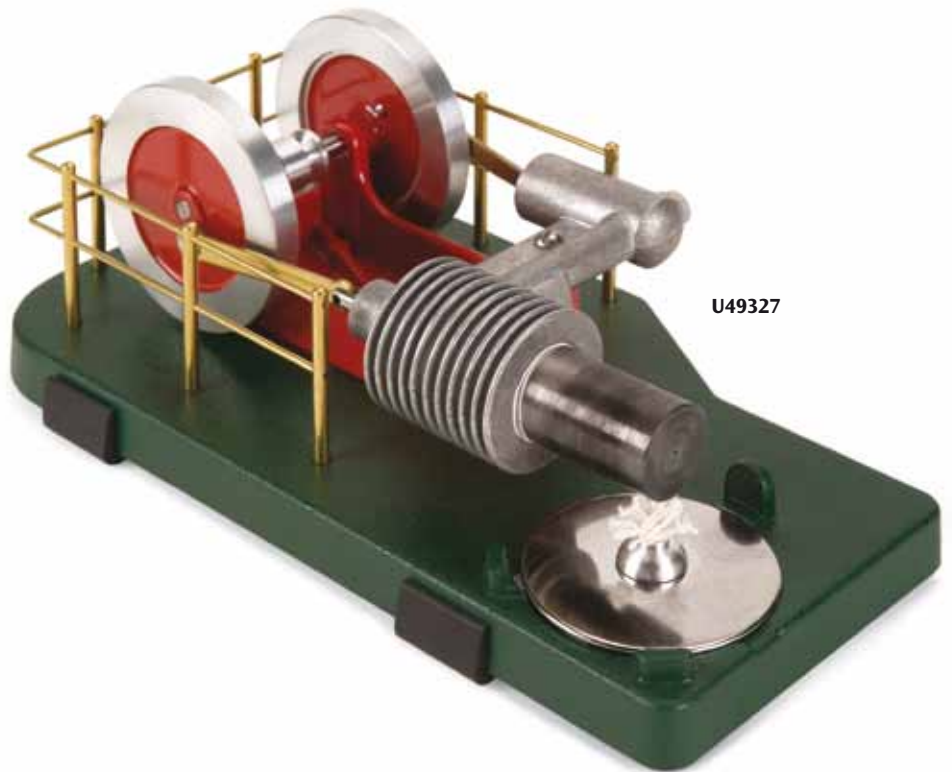
U13150

Stirling Engine S

This affordable Stirling engine comes complete with built-in alcohol burner. Red flywheels and chassis mounted on a green base, this all-metal engine runs silently at speeds in excess of 1,000 rpm. The engine demonstrates the principle of the Stirling cycle and the functioning of a classical heat engine. It comes completely assembled and ready to run, accompanied by the book "Stirling Cycle Engines" which explains the principles of operation.

Rotation speed: 1000 rpm
Base plate: 180x110 mm²
Weight: 1.15 kg

U49327



U49327



Low Temperature Stirling Engine, Assembly Kit (not shown)

U10061



Low Temperature Stirling Engine

A compact, transparent Stirling engine for demonstrating the operation and fundamental design of such engines. A temperature difference of approximately 5° C between the base and top plates is sufficient to set the motor in motion. This difference can be generated just by the warmth of a human hand or by cooling through contact with a cold object from a refrigerator. The top plate's matt, black coat also enables the device to be operated as a solar-powered engine. In this case the direction of rotation will depend on whether the heat is applied from above or from below. The power cylinder is made of precision glass, while the displacement cylinder and flywheel are made of acrylic glass; this allows a clear observation of the movements of the power piston, displacement mechanism and crankshaft drive. The crankshaft and connecting rod have miniature precision ball bearings.

Rotation speed: 80 rpm at $\Delta T = 10^{\circ}\text{C}$
Flywheel: 110 mm diam.
Dimensions: 138 mm x 110 mm diam.

U10060

Heat Pump D

Demonstration model for showing how refrigerators and electrical compression heat pumps work. Consisting of compressor with drive motor, vaporizer, expansion valve and condenser. May be used as an air water or water water heat pump. Includes wattmeter, so that one can record the operation time, the mains voltage, instantaneous power input and electrical work, and two thermometers for measuring the temperatures in the two reservoirs. The components are connected in a closed system by copper pipes and mounted on a base board, and the clear layout makes it possible to directly relate the sequence of changes of state to the cyclic operation of the heat pump. Evaporator and condenser are constructed as copper tubing spirals and each of them is submerged in water filled containers serving as heat reservoirs for determining the heat absorbed or emitted. Two large manometers display the pressure ratios of the coolant in both heat exchangers. Two observation windows are provided for observing the state of aggregation of the refrigerant after the evaporator and after the condenser. A protective overpressure switch disconnects the compressor motor from the circuit when overpressure reaches 15 bars.

- Compressor power: 120 W
- Coolant: R 134A, free of fluorochlorohydrocarbons
- Temperature reservoirs: 2000 ml each
- Manometer: 160 mm diam.
- Dimensions: 560x300x630 mm³
- Weight: 21 kg

Heat Pump D (230 V, 50 Hz)

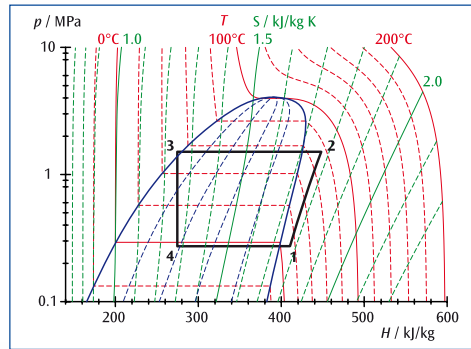
U8440600-230

Heat Pump D (115 V, 60 Hz)

U8440600-115

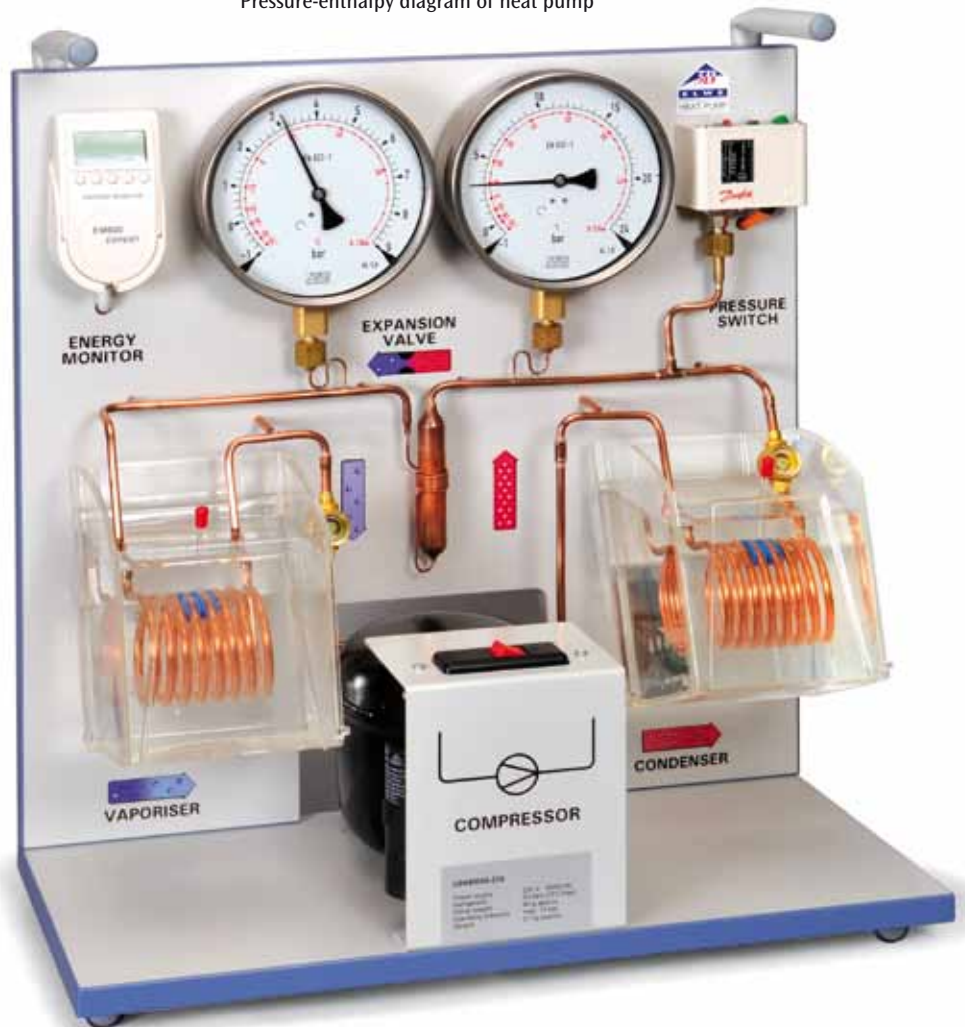
Experiment Topics:

- Determining the power output as a function of the temperature difference
- Analysing the cyclic process by means of a Mollier diagram



Pressure-enthalpy diagram of heat pump

Particularly clear layout!



U8440600-230
U8440600-115

NEW



1009922

Temperature Sensor, Pt100 with Measurement Terminal

Temperature sensor for the measurement of temperatures on the copper tubing of a heat pump (U8440600-230 resp. U8440600-115). Temperature sensor shaft made of rust-proof stainless steel. Tip with matching copper terminal. Can be used in conjunction with 3B NET/log™ unit (U11300-230 resp. U11300-115) for manual measurements or for processing measurement data when connected to a computer. Includes connector lead with 8 pin miniDIN plugs.

- Measurement range: -50°C – 150°C
- Resolution: 0.1° C
- Accuracy: 0.1% of measured value plus 0.25°C
- Sensor cable: 1 m, with silicone insulation
- Sensor type: Pt100 thermocouple

1009922



U10055

Steam Engine G

Transparent steam engine for demonstrating how an oscillating steam engine operates. In this engine the cylinder moves around a centre axis. This motion causes the inlet port and outlet port of the steam conduit to open and close. The base plate and flywheel are made of acrylic glass, while the boiler and working cylinder are made of heat proof quartz glass, making all of the moveable parts and actions very clearly visible. With a ball bearing supported crankshaft made of brass and a safety valve built into the boiler to prevent excessive pressure. Includes spirit burner with adjustable wick for use as heat source.

- Rotation speed: 800 rpm
- Mech. Power: 1 W
- Boiler volume: 50 ml
- Run time per load: 20 – 25 min
- Max. operating pressure: 0.5 bars
- Dimensions: 260x170x110 mm³

U10055

Steam Engine B

Steam engine model for demonstrating a cycle where the working substance (water and steam) changes phase. Includes a fixed brass cylinder which operates in both directions with a flywheel and drive wheel also operating in both directions, plus a centrifugal governor and a steam-jet oiling mechanism. Highly polished, nickel-coated brass boiler with an inspection window to show the water level, a spring safety valve and a domed steam whistle. The brass boiler is fitted onto old-copper-coloured boiler housing with a brick pattern and a chimney. The water is heated using dry fuel. A tray for collecting condensed water is located under the chimney, allowing it to “smoke” like a real steam train.

- Base: 260x200 mm
- Height: 240 mm
- Flywheel: 70 mm diam.
- Boiler: 115 mm x 45 mm diam.
- Boiler volume: 155 ml
- Capacity: 120 ml approx.
- Weight: 1.3 kg

U13850

Dry Fuel for Steam Engine B (not shown)

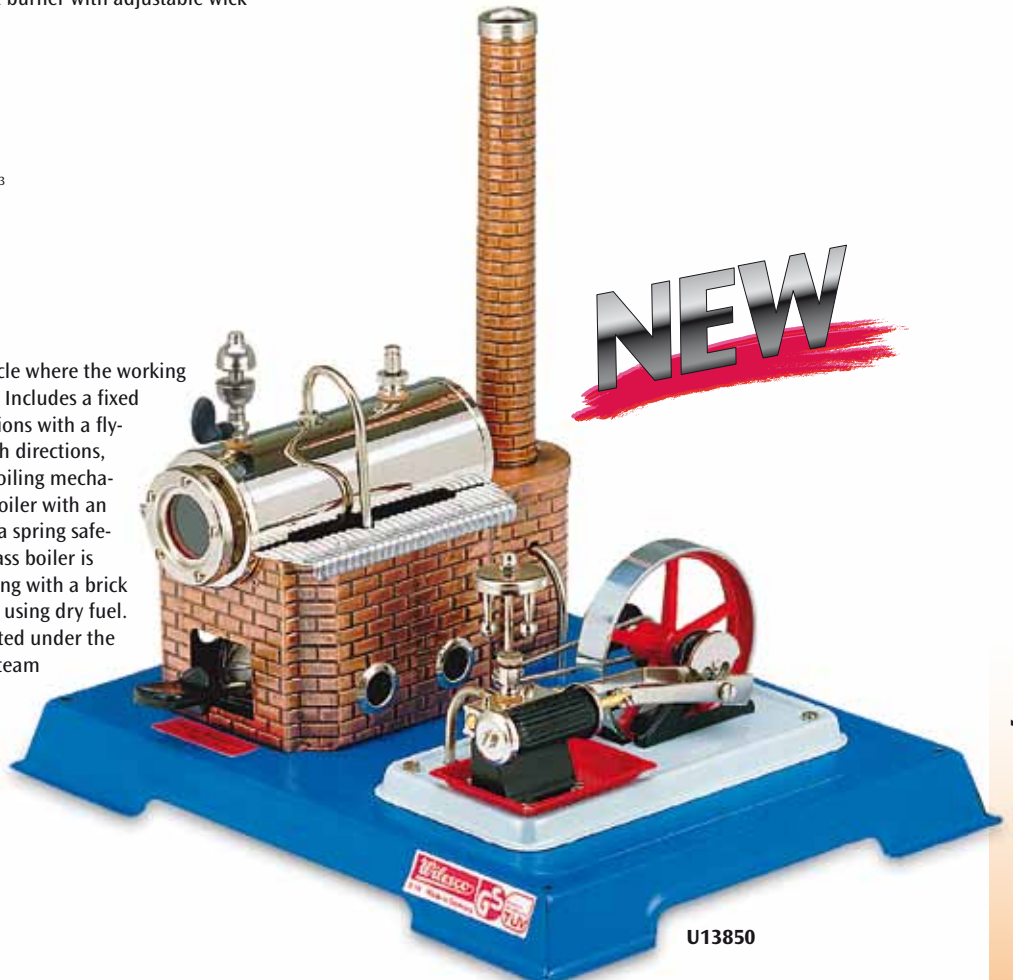
20 Esbit fuel tablets for heating water in steam engine B (U13850).

1012886

Oil for Steam Engine (not shown)

Oil for lubricating pistons, cylinders and all other bearings of the B-model steam engine (U13850).

1012887



U13850

Function Models, Transparent

Movable, transparent, function cutaway models for demonstrating the operation of various engine types on an overhead projector.

The models are made of high-grade, transparent acrylic glass, 3 – 5 mm thick, and extremely robust and durable.

Dimensions: approx. 250x250 mm²



Wankel Engine, Transparent
Cutaway model for the overhead projector
U15600



Four-Stroke Engine, Transparent
Cutaway model for the overhead projector
U15601



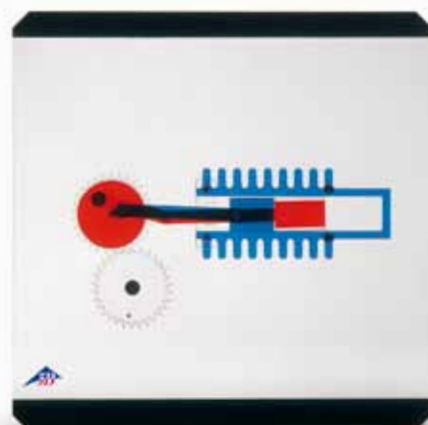
Diesel Engine, Transparent
Cutaway model for the overhead projector
U15602



Steam Engine, Transparent
Cutaway model for the overhead projector.
U15603



Two-Stroke Engine, Transparent
Cutaway model for the overhead projector.
U15604



Stirling Engine, Transparent
Cutaway model for the overhead projector.
U15606

Spirit Lamp

Made of metal, with a knurled screw for feeding the wick and cap for extinguishing the flame.

Contents: 60 ml

Dimensions: 55mm x 65 mm diam.

Weight: 50 g approx.

U8621240



U8621240

Wick (not shown)

Spare wick for the (U8621240) spirit lamp.

Length: 100 mm

U8621250

Immersion Heater – 300 W

Immersion heater with protection against overheating (VDE-compliant).

Important: operates solely on a mains voltage of 230 V.

U8624110-230



U8624110-230

Electrical Burners

Burners for experiments which would have formerly needed to be undertaken using a Bunsen burner. Designed to be both thermally and electrically safe. Heating via a column of hot air with a patented air management system. Featuring operation and temperature displays.

- Controlled via energy regulator with bimetallic strips
- Protected against overheating
- No overheating of housing during long periods of use
- Boils liquids without causing them to spit
- Perfectly sealed against spilt liquids

Liquid reservoir: Up to 140 mm in diameter
 Dimensions: 170x130x195 mm³
 Weight: 3.8 kg



NEW

W13650-230

LAB2 Electrical Burner (230 V, 50 Hz)

Operating temperature: 20 ... 650°C
 Temperature of heating element: max. 900°C
 Electrical power consumption: 500 W
 Fuse: F-type, 5 A, 250 V

W13650-230



W13651-230

LAB3 Electrical Burner (230 V, 50 Hz)

Operating temperature: 20 ... 750°C
 Temperature of heating element: max. 1000°C
 Electrical power consumption: 900 W
 Fuse: F-type, 6.3 A, 250 V

W13651-230

Holder for Glassware

Complete accessories for holding test tubes or round-bottom flasks onto the grid of the LAB2 and LAB3 electrical burners. The holder remains sufficiently cool while the glassware is being heated to be safely touched with fingers.
 Tube diameter: 12 mm or 35 mm approx.



W13653

W13653

NEW

NEW



Set of 60 Ecoflam Pellets

Pellets for environmentally friendly generation of an open flame on the grid of the LAB2 and LAB3 electrical burners.

W13654

W13654



NEW



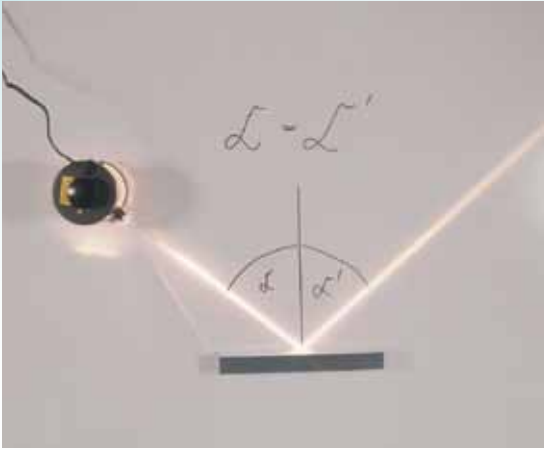
Plate for Metal Filings

Plate for adding to LAB2 and LAB3 electrical burners in order to burn metal filings in an open flame. Complete with central hole for one ECOFLAM pellet.

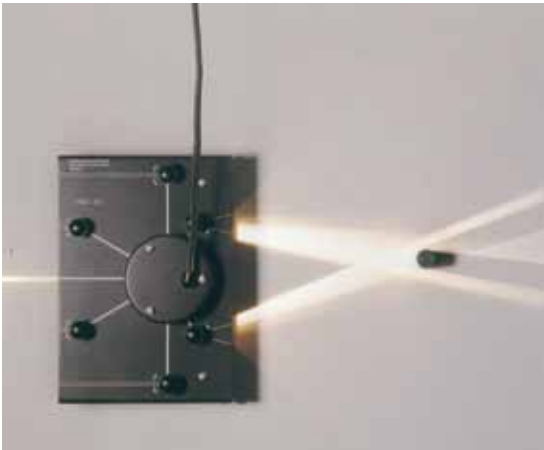
W13655

W13655

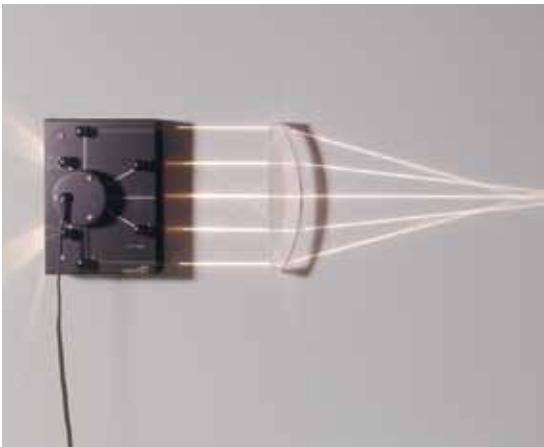
NEW



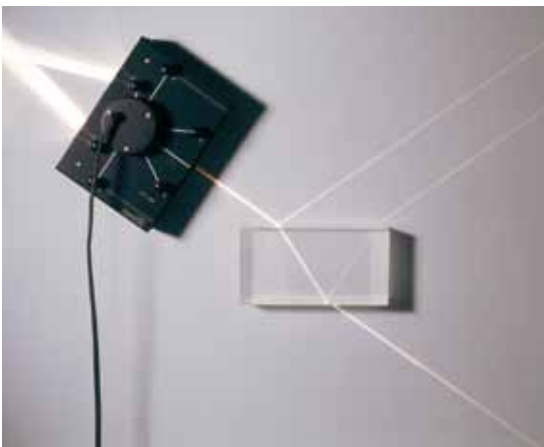
Reflection



Shadow projection



Lens errors



Refraction

Experiment topics:

- Laws of reflection
- Laws of refraction
- Total reflection
- Minimum deflection angle for a prism
- Focal determination of mirrors and lenses
- Laws of lenses and image errors
- Shadow casting



Single-Ray Projector

Light source for experiments demonstrating ray optics on a whiteboard (U10030 resp. U10031). With an adjustable aperture for producing a concentrated or divergent light beam.

Lamp: 12 V, 35 W
 Connecting line: 1.5 m long with 4 mm plug
 Dimensions: approx. 120 mm x 70 mm diam.
 Weight: approx. 0.25 kg

U40120

Additionally required:

U40121 Magnetic Holder for Single-Ray Projector

U13900-230 Transformer 12 V, 60 VA (230 V, 50/60 Hz)

or

U13900-115 Transformer 12 V, 60 VA (115 V, 50/60 Hz)

Halogen Lamp, 12 V, 35 W

(not illustrated)

Spare lamp for single-ray projector (U40120).

U40122

Magnetic Holder for Single-Ray Projector

Magnet holder for mounting single-ray projector (U40120) on a whiteboard (U10030 resp. U10031).

U40121

Optics Kit for Whiteboard

Set of optical components for use in conjunction with a single-beam lamp (U40120) or multiple-beam lamp (U40110) on a whiteboard (U10030 resp. U10031). All components are lined with magnetic foil or furnished with a magnet holder and can be easily mounted and aligned on the whiteboard. This apparatus permits a wide range of experiments demonstrating ray optics without the need for a dark room; handwritten notes can be added to provide a clearer explanation.

U14600

Additionally required:

U10030 Whiteboard 600x900 mm²

or

U10031 Whiteboard 900x1200 mm²

U40120 Single-Ray Projector

U40121 Magnetic Holder for Single-Ray Projector

or

U40110 Multiple-Ray Projector



Contents:

Art. No.	Designation	Dimensions	Material
Mirrors:			
U15510	Plane mirror	200x35x35 mm ³	Plastic
U15511	Convex – concave mirror, f = ±100 mm	200x35x35 mm ³	Plastic
Shadow-casting bodies:			
U15515	Plano-concave lens, f = -400 mm	200x40x35 mm ³	Acrylic glass
U15516	Plano-convex lens, f = +400 mm	200x40x35 mm ³	Acrylic glass
U15517	Plane-parallel plate	200x100x35 mm ³	Acrylic glass
U15518	Semi-circular body, f = +200 mm	diam. 200x35 mm ²	Acrylic glass
U15520	Right-angled prism	200x200x35 mm ³	Acrylic glass
Shadow-casting bodies:			
	Cuboid	100x20x35 mm ³	Plastic
U15525	Cylinder	diam. 5x35 mm ²	Plastic
	Cylinder	diam. 60x35 mm ²	Plastic

Multiple-Ray Projector, Magnetic

Light source for experiments demonstrating ray optics on a whiteboard (U10030 resp. U10031). In metal housing on magnetic foil. Experiments on reflection, refraction and basic lens laws can be performed using five narrow light rays which emerge from the right-hand side. With the help of rotating mirrors, these rays can be directed to make parallel, divergent or convergent beams, or can be masked out individually. Highly demonstrative experiments on shadow casting can be conducted using the two divergent light rays emerging from the left-hand side. With the help of rotating mirrors, these rays can be directed or masked out individually.

Lamp: 12 V, 55 W

Connecting line: 1.5 m long with 4 mm plug

Dimensions: approx. 150x200x50 mm³

Weight: approx. 0.9 kg

U40110

Additionally required:

U13900-230 Transformer

12 V, 60 VA (230 V, 50/60 Hz)

or

U13900-115 Transformer

12 V, 60 VA (115 V, 50/60 Hz)

Halogen Lamp, 12 V, 55 W

(not shown)

Spare halogen lamp for multiple-ray projector (U40110).

U40113

U40110



Whiteboards

Metal board with enamelled surface for demonstration experiments using magnetic components, e.g., for mechanics or optics. Scratch and acid resistant steel board that can be written on using water soluble pens. Can be wall mounted or set up on a stand (U10381 or U10382).

Art. No.	Designation	Dimensions
U10030	Whiteboard	600x900 mm ²
U10031	Whiteboard	900x1200 mm ²



U10030 + U10381

Laser Ray Box

Laser diode capable of producing up to five parallel rays, for use with related board (U17306). In metal housing with magnetic foil. The number of emerging light beams can be selected electronically via switches. Power is supplied via a plug-in unit or batteries that are automatically disconnected after 60 minutes.

Diode laser: 5 beams, each max. 1 mW,
Laser safety class II

Wavelength: 635 nm

Separation of laser beams: 18 mm

Plug-in power supply: Primary 100 – 240 VAC,
Secondary 3 V DC, 300 mA

Battery compartment: for 2x 1.5 V AA-batteries
(batteries not included)

Dimensions: approx. 110x60x20 mm³

Laser Ray Box (230 V, 50/60Hz)

U17302-230

Laser Ray Box (115, 50/60 Hz)

U17302-115

Board for Laser Ray Box

Magnetic board for conducting experiments with laser ray box (U17302-230 resp. U17302-115). With a removable prop for inclining board.

Dimensions: app. 600x450 mm²

U17306



BESTSELLER

Equipment Set Optics with Laser Ray Box

Set of optical components for use in combination with a laser ray box (U17302-230 resp. U17302-115) and related board (U17306). This equipment set is ideal for conducting a wide variety of experiments on ray optics. Equipped with magnetic foil, the components can be easily attached to the board and aligned. Six work templates with pre-defined positions facilitate experiment setup. The beam paths can be observed from a relatively long way away without any need for darkening the room.

Basic length: 100 mm each (in most cases)

Thickness: 15 mm each

Contents:

- | | |
|------------------------------|---|
| 1 Biconcave lens | 1 Convex mirror |
| 4 Biconvex lenses | 1 Flat parallel block (60x100 mm ²) |
| 1 Plano-concave lens | 1 Prism |
| 1 Hemispherical body (45 mm) | 1 Wave guide (20x200 mm ²) |
| 1 Hemispherical body (75 mm) | 6 Work sheets (410x290 mm ²) |
| 1 Plane mirror | 1 Experiment guide |
| 1 Concave mirror | |

U17300

Additionally required:

- U17302-230 Laser Ray Box (230 V, 50/60 Hz)**
or
U17302-115 Laser Ray Box (115 V, 50/60 Hz)

U17306 Board for Laser Ray Box

Experiment topics:

- Law of refraction
- Law of reflection
- Total reflection
- Determining the focal length of curved mirrors and lenses
- Lens laws
- Correction of spherical aberration
- Short-sightedness and long-sightedness of the human eye and the correction of such defects
- Beam paths in cameras, microscopes and telescopes

Laser Optics Supplemental Set with Laser Ray Box

Supplementary kit to the demonstration laser optic set with laser ray box, consisting of 13 optical components for more advanced experiments on geometric optics, e.g. experiments using air lens that show why optical elements cause either negative or positive refraction. All components are coated with magnetic foil.

Base length: 100 mm each (in most cases)

Thickness: 15 mm each

Contents:

- | | |
|--------------------------------|--------------------------------------|
| 1 Biconcave lens | 2 Flat parallel blocks (rectangular) |
| 1 Biconvex lens | 2 Plane mirror |
| 1 Equilateral prism | 1 Biconcave 'air lens' |
| 2 Rectangular prisms | 1 Biconvex 'air lens' |
| 1 Flat parallel block (square) | 1 'Air prism' |

U17301



Experiment topics:

- Focal point of a converging lens
- Focal length
- Diverging lens
- Prism
- Parallel block



U21880

Five-Beam Optical Halogen Lamp 12 V, 55 W

Bright light source with five parallel light apertures for experiments involving ray optics to be conducted on a lab bench. In metal housing with integrated ventilation fan. Includes an adjustable reflecting mirror for setting the beam length. Thanks to a magnetic foil the lamp can also be used on a whiteboard.

Halogen lamp: 12 V, 50 W
 Connection: 4 mm safety sockets
 Slit width: 2 mm
 Slit spacing: 18 mm
 Housing dimensions: approx. 210x118x85 mm³

U21880

Set of Optical Components

In conjunction with the five-beam optical lamp (U21880), this equipment set is intended for experiments introducing students to geometric optics. The optical components are made of acrylic glass.
 Height: 15 mm each

Contents:

- | | |
|----------------------|------------------------|
| 1 Planar-convex lens | 1 Irregular prism |
| 2 Bi-convex lenses | 1 Plane-parallel plate |
| 1 Bi-concave lens | 1 Semicircular element |
| 1 Equilateral prism | 1 Cylindrical lens |
| 1 Rectangular prism | |

U15530

U15530



Geometric optics

Additionally required:

- U13900-230 Transformer 12 V, 60 VA (230 V, 50/60 Hz)
 or
 U13900-115 Transformer 12 V, 60 VA (115 V, 50/60 Hz)
 U15530 Set of Optical Components

Experiment topics:

- Reflection and refraction of light by semicircular elements and prisms
- Snell's law
- Critical Angle



U17307-230
 U17307-115

Optical Disc with Diode Laser

Set of apparatus for a comprehensive and easily understandable introduction to the basic principles of refraction and reflection of light by means of demonstration or student experiments. The laser can be easily attached via its built-in magnet and aligned on the end of the metal base. The rotating optical disc has an angular scale with 1° divisions and marked lines to position the elements. The set includes a semi-circular disc and an equilateral prism for use in optical experiments, as well as a plug-in mains-adaptor power supply and a battery compartment (batteries are not included in the apparatus as supplied).

Diode Laser: 1 beam, Class II
 Output power: <1 mW
 Wavelength: 635 nm
 Operating voltage: 3 V DC
 Battery-box: for 2x 1.5 V batteries (AA, LR6, MN1500, Mignon)

U21887



Laser ray box: 80x25x21 mm³
 Metal base: 320x40x35 mm³
 Optical disc: 250 mm diam.
 Semicircular element: 90 mm diam.
 Prism: 100 mm equilateral

Optical Disc with Diode Laser (230 V, 50/60 Hz)

U17307-230

Optical Disc with Diode Laser (115 V, 50/60 Hz)

U17307-115

Additionally recommended:
 U21887 Semicircular Cell

Semicircular Cell

Graduated cell with 1 mm scale division, made of acrylic glass.
 Dimensions: 200 mm diam.
 Height: 20 mm

U21887

Light and Optics

With a dependability that has been proven over the course of decades, the Kröncke optical system provides the precision necessary for student exercises and practical experiments in a wide range of experiments on ray optics and wave optics. All optical components are mounted in diaphragms with no stem and can easily be moved up and down on an optical rider, perpendicular to the popular optical axis for the purpose of precise adjustment. The optical riders can be freely moved along the optical bench's U-shaped profile and secured by means of a simple clamping mechanism.

Optical Bench K

Optical bench made of black anodised aluminium profile with printed millimetre scale.
Cross-section: approx. 70x30 mm

Art. No.	Length	Weight
U8475260	2000 mm	2.4 kg
U8475240	1000 mm	1.2 kg
1009926	500 mm	0.6 kg



Halogen Lamp 12 V/20 W
(not shown)
Special substitute lamp for the optical lamp K (U8475400).

U8475410

Optical Lamp K

Halogen lamp in cylindrical housing attached to diaphragm screen (100x100 mm²) for mounting on optical rider K (U8475350). The filament can be aligned horizontally or vertically.
Halogen lamp: 12 V, 20 W
Terminals: 4 mm safety sockets
Dimensions: approx. 60x100x100 mm³
Weight: approx. 130 g

U8475400

Additionally required:
U8475470-230 Transformer 12 V, 25 VA (230 V, 50/60 Hz)
or
U8475470-115 Transformer 12 V, 25 VA (115 V, 50/60 Hz)

Optical Rider K

Optical rider for K-model optical benches (U8475260, U8475240 and 1009926). With two clamps for diaphragms from the Kröncke optical system or for plates up to 2 mm thick.
Dimensions: approx. 40x50x35 mm³
Weight: approx. 70 g

U8475350

Prism Table K

Prism table with clip for clamping prisms. Holder fits the optical rider K (U8475350).

U8476110



Micrometer Screw K

Micrometer screw with fine tip for measuring diffraction and interference lines. Holder fits the optical rider K (U8475350).
Dimensions: approx. 80x30x60 mm³
Weight: approx. 120 g

U8476630

Plane Mirror K

Simple plane mirror, glass.
Dimensions: 100x100 mm²
Weight: approx. 70 g

U8475180

Concave Mirror K

Concave mirror on diaphragm screen 100x100 mm².
Focal length: 180 mm
Mirror diam.: 38 mm
Dimensions: 100x100 mm²

U8475200

Iris Diaphragm K

Continuously adjustable iris on diaphragm screen 100x100 mm².
Aperture: 2 – 18 mm
Dimensions: 100x100 mm²

U8472345



Optical Lenses K

Lenses made of high-grade optical glass. Shock-proof and crack-proof installation in optical diaphragm (100x100 mm²). With focal length specification.

Dimensions: 100x100 mm²
 Lens diameter: 38 mm



U8475901 – 1009863



1009864 – 1009865

Art. No.	Designation
U8475901	Convex Lens K, f = 50 mm
U8475911	Convex Lens K, f = 100 mm
U8475921	Convex Lens K, f = 150 mm
1009861	Convex Lens K, f = 200 mm
1009866	Convex Lens K, f = 300 mm
1009863	Convex Lens K, f = 500 mm
1009864	Concave Lens K, f = -100 mm
1009865	Concave Lens K, f = -500 mm



U8776140



1009927

Fresnel Mirror K

Fresnel mirror with holder for use on K-model optical benches (U8475260, U8475240 or 1009926). Two mutually inclined surface-coated mirrors are bonded to a common metal plate. A knurled screw at the rear can be used to adjust the angle between the mirrors. The wave nature of light can be demonstrated by interference following reflection at both mirrors. Holder matches the optical rider K (U8475350).

Dimensions: 135x100x40 mm³
 Weight: approx. 123 g

U8475350

Clamp K

Tough clamp for diaphragms, filters, diffraction objects and other objects in a slide frame (see as of page 149). On diaphragm screen 100x100 mm².

Clamping range: 0,2 – 4 mm
 Dimensions: 100x100 mm²
 Round opening: 38 mm diam.

U84755401

Adjustable Slit K

Continuously adjustable slit on diaphragm screen (100x100 mm²). The slit width can be adjusted by means of a micrometer screw.

Slit width: 0 – 3 mm
 Slit height: 25 mm
 Dimensions: 100x100 mm²
 Weight: approx. 240 g

U8476675

Storage Box

Box made from smoked beech, varnished, with 20 compartments for lenses and optical elements of width 100 mm.

Dimensions: 400x130x90 mm³
 Weight: approx. 1,000 g

U8776140

Projection Screens K

(not shown)
 Plastic projection screens for mounting on optical rider K (U8475350).

Dimensions: 200x150 mm²

Projection Screen K, transparent

U8476310

Projection Screen K, white

U8476320

Holder K for Diode Laser

Magnetic holder for diode laser (U22000 resp. U22001). On diaphragm screen 100x100 mm².

U8475550

Pair of Polarsation Filters K

Two polarising filters on a diaphragm screen (100x100 mm²) for producing and analysing polarised light. In a rotating frame with a pointer and protractor scale.

Scale: 0 – 180°
 Scale division: 5°
 Dimensions: 100x100 mm²
 Filter diameter: 32 mm

U8476526



U84755401



U8476675



U8476526



U8475550

NEW

The inexpensive NEVA optics system offers reliability and ease of use for setting up basic experiments in ray optics.

All the optical components are set in a slide with a magnetic base and can easily be aligned on a sturdy optical base and moved into a beam of light.

1006791
1006790



NEVA Optical System



4003987

Optical Bench N

Metal rail with millimetre scale and guide slots for accommodating optical components on a magnetic base.

Dimensions: 400x75x10 mm³

Weight: 230 g approx.

4003987

Optical Lamp N

High-powered white LED in a plastic housing with a magnetic base.

Includes 5-V-DC, 1000-mA plug-in power supply.

Dimensions: 90x70x70 mm³

Weight: 200 g approx.

Optical Lamp N (230 V, 50/60 Hz)

1009946

Optical Lamp N (115 V, 50/60 Hz)

1009945



1009946

Parallel Light Optical Lamp N

Light source for parallel and divergent beams based on a high-powered white LED in a plastic housing with a magnetic base. The outlet side for parallel light has a slot for a slide and there is also a side for outputting divergent beams. Includes 5-V-DC, 1000-mA plug-in power supply.

Dimensions: 90x70x70 mm³

Weight: 400 g approx.

Parallel Light Optical Lamp N (230 V, 50/60 Hz)

1006791

Parallel Light Optical Lamp N (115 V, 50/60 Hz)

1006790

Projection Screen N

Angled, white-painted metal projection screen for horizontal or vertical use or placement beyond the N-model optical bench (4003987).

Screen area: 120x170 mm²

1012891

Object Holder N

Object holder with magnetic base to accommodate optical apertures in slides (50x50 mm²), e.g. single slit N (4004002) or triple/quintuple slit N (4004057).

1000845



1012891



U8470350

Optical Lenses N

Lenses made of high-quality optical glass. Breakage and impact-resistant, set in a slide with magnetic base.

Dimensions: 70x70 mm²

Lens diameter: 36 mm

Art. No.	Designation
U8470130	Convex Lens N, f = +50 mm
U8470120	Convex Lens N, f = +100 mm
U8470110	Convex Lens N, f = +300 mm
U8470140	Concave Lens N, f = -100 mm

Single Slit N

Single slit slide for mounting in N-model object holder or in the filter slot of the N-model parallel light optical lamp to use in optical experiments requiring a tight single beam.

Dimensions: 50x50 mm²

4004002

Triple/Quintuple Slit N

Slide with a triple and a quintuple slit arrangement for mounting in N-model object holder (U8470350) or in the slide slot of the N-model parallel light optical lamp (1006791 resp. 1006790) to use in optical experiments requiring multiple tight beams.

Dimensions: 50x50 mm²

4004057



U8470110–U8470140



4004002



4004057

Light and Optics



Optical bench U

Comprising a solid aluminium profile, anodised with natural finish, robust and resistant to twisting, with mm scale along the full length. For experiments with optical attachments on a stem.

Cross-section: approx. 100x40 mm²

Art. No.	Length	Scale length	Weight
U17150	1200 mm	1000 mm	approx. 3.0 kg
U17151	600 mm	500 mm	approx. 1.5 kg

Optical Rider U

Optical rider for U-model optical benches (U17150 and U17151) for mounting optical attachments on a stem. A smooth base ensures easy movement on the optical bench.

Clamping width for stems: 10 mm

Art. No.	Sleeve height
U17160	75 mm
U17161	30 mm

Experiment topics:

- Demonstration of various light beams
- Reflection of a light ray by a plane mirror
- Reflection of a beam of rays by a plane mirror
- Reflection of a beam of rays by a concave/convex mirror
- Snell's law of refraction
- Refraction by a plane-parallel plate
- Refraction by a prism
- Inverting prism
- Concave and convex lenses

Optical Disc with Accessories

This equipment set introduces the fundamentals of geometric optics. It consists of a base plate with an angular scale possessing 1° divisions, a block scale and two bore holes for mounting clamps for optical components (lenses, prisms, mirrors). An adjustable holder and tripod permit horizontal as well as vertical installation.

Delivered with a storage case, this equipment set comprises the following items:

- 1 Optical disc with a holding stem and 2 clamps, 240 mm diam.
- 1 Bi-concave lens, 90 mm
- 1 Bi-convex lens, 90 mm
- 1 Semi-circular element, 90 mm
- 1 Trapezoid element, 45° and 60°
- 1 Prism, rectangular, leg length 50 mm
- 1 Combined mirror (planar, convex, concave)

U17128



U17128

Pair of Rail Supports

Two support feet made of natural-finish, anodised aluminium for U-model optical benches (U17150 und U17151).

Dimensions: 220x20x15 mm³

U171661

Swivel Joint with Scale

Connecting piece for articulated linking of two U-model optical benches (U17150 and U17151). Profile rails. 90° articulation angle in both directions. Natural-finish, anodised aluminium. With a mounting for optical attachments on a stem at the axis of rotation.

Clamping width

for stems: 10 mm

Scale division: 5°

Dimensions: 180x82x100 mm³

U17165



Basic Optics Equipment Set

Complete set of apparatus for performing experiments with optical disc (U17128).

Contents:

Art. No.	Description	Quantity
U17150	Optical bench U, 120 cm	1
U17160	Optical rider U, 75 mm	3
U17161	Optical rider U, 30 mm	1
U17140	Experiment lamp, halogen	1
U13735	Spare lamp, Halogen 12 V, 50 W	1
U8474000	Object holder on a stem	1
U17103	Convex lens, $f = + 150$ mm (50 mm diam.)	1
U17040	Set of slits and apertures	1
U17128	Optical disc with accessories	1
U17120	Storage strip	1

U17145

Additionally required:

U13900-230 Transformer 12 V, 60 VA (230 V, 50/60 Hz)

or

U13900-115 Transformer 12 V, 60 VA (115 V, 50/60 Hz)

U10300



Optical Precision Bench D

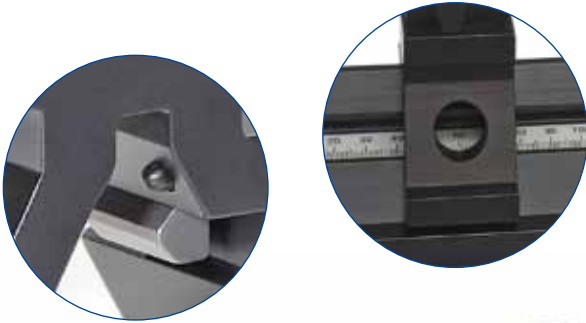
Optical precision bench with a triangular profile for research and demonstration experiments requiring maximum accuracy. Made of black, anodized aluminium. Tilt-proof, slip-proof, resistant to bending and twisting, equipped with a full-length scale with cm/mm divisions. Bore holes on front end for securing connecting elements for additional rails or swivel joint (U10305). Available in three designs. On request, also available in any length up to 2000 mm (inquire about price).
Cross-section: approx. 90x60 mm³

Art. No.	Length	Weight
U10302	500 mm	approx. 1.75 kg
U10300	1000 mm	approx. 3.5 kg
U10301	2000 mm	approx. 7 kg



U10300

Optics Using an Optical Bench D



Optical Rider D

Optical rider for D-model precision optical benches (U10300, U10301 and U10302) for mounting optical attachments on a stem. For research and demonstration experiments requiring maximum accuracy. Made of black anodized aluminum. Thanks to a hole drilled in the middle of the base and an accompanying scale, it is possible to read off the position of the centre of the rider on the optical bench directly. The riders are preliminarily fixed to the optical bench via springy built-in plastic nipples until the grub screw is tightened. Long-term attachment is designed to protect the materials using a stainless steel pressure shoe rather than the point of a screw. The stems of the optical equipment placed on the bench are also designed to protect the materials in that they are clamped using a stainless bracket. Clamping width for rods: 10 – 14 mm

Art. No.	Sleeve height	Base width
U103101	60 mm	50 mm
U103111	90 mm	50 mm
U103121	120 mm	50 mm
U103151	60 mm	36 mm
U103161	90 mm	36 mm
U103171	120 mm	36 mm



U103101

U103111

U103121

Light and Optics



U103202

Sliding Rider D

Optical rider with a mounting for optical attachments on a stem, adjustable vertically with respect to the optical axis. Sliding rider with micrometer screw for position adjustment.

Sliding range: ±12.5 mm
Sleeve height: 90 mm
Base width: 50 mm
Clamping width for rods: 10 – 14 mm

U103202



U103301

Tilting Rider D

Optical rider for tilting optical elements out of the optical axis.

Sleeve height: 90 mm
Base width: 50 mm
Clamping width for rods: 10 – 14 mm
Tilting range: 90°

U103301

Support for Optical Bench D

One rail support and a single-point support with screws for adjusting optical bench. Made of black, anodised aluminium.
Length of rail support: 270 mm

U103041



Swivel Joint for Optical Bench D

For experiments where light is deflected and where the highest precision requirements prevail. Black anodized aluminum with adjustable protractor scale $\pm 180^\circ$ in 1° divisions. Sleeve for holding optical elements shaft mounted.

Protractor scale: $\pm 90^\circ$
Sleeve height: 60 mm
Clamping width for rods: 10 – 14 mm

U10305



Optical Base D

Optical base used for mounting a U-shaped transformer core (U8497215) with coils and pole terminals for conducting experiments on the Faraday effect using precision optical bench D (U10300).

Dimensions: 148x85x60 mm³ approx.

U10319

NEW



Extension Arm D

Extension Arm to clamp on an optical rider D, for positioning optical elements out of the optical axis.

Extension arm: 100 mm
Clamping width for rods: 10 – 14 mm

U10331

Optical Lamp, Halogen

Ultra-bright light source for experiments on optical bench and for projection. It consists of a metal housing with a condenser, a movable element for axial light adjustment, a holding stem with a screw mounting and an integrated fan.

Halogen lamp: 12 V, 50 W
Connection: via 4 mm safety jacks
Condenser focal length: 75 mm
Condenser diameter: 45 mm
Stem: 120 mm x 10 mm diam.
Housing: approx. 190x125x110 mm³

U21881

Additionally required:

U13900-230 Transformer 12 V, 60 VA (230 V, 50/60 Hz)

or

U13900-115 Transformer 12 V, 60 VA (115 V, 50/60 Hz)

Spare Halogen Lamp, 12 V, 50 W

(not shown)

Spare halogen lamp for optical lamps (U17140 and U21881).

U13735

Experimental Lamp, Halogen

Light source with low-divergence beam for optical experiments. Black-painted metal housing on a stem, with fixture for vertical or horizontal set-up.

Halogen lamp: 12 V, 50 W
Connection: via 4 mm safety sockets
Light aperture: 40 mm diam.
Shaft diameter: 10 mm
Dimensions: approx. 80x80x105 mm³

U17140

Additionally required:

U13900-230 Transformer 12 V, 60 VA (230 V, 50/60 Hz)

or

U13900-115 Transformer 12 V, 60 VA (115 V, 50/60 Hz)





U22000



U22001

Laser Diode, Red

Red light source giving a beam with minimal divergence, housed in a compact and sturdy aluminium body. It is based on a 650 nm class II industrial laser module with a glass collimating lens. Fitted with a 10 cm stainless steel rod. A 100-230V AC/DC converter is included.

Laser protection class: II
 Output power: 0.6 – 1mW
 Wavelength: 650 nm ± 5 nm
 Spot size at 5 m distance: <8 mm diam.
 Divergence: <1 mrad
 Operating voltage: 6 – 12 V DC

U22000

Laser Module, Green

High performance 532 nm green laser (doubled NdYag). The laser (safety classification II) produces green light ideally suitable for optical demonstrations, as the wavelength is in the range where the human eye has maximum sensitivity. The visibility is as good as that for red laser light from a 5 mW source. Fitted with a 10 cm stainless steel stem. The apparatus supplied includes a plug-in mains-adaptor power supply.

Laser protection class: II
 Output power: 0.4 – 1 mW
 Wavelength: 532 nm ± 0.1 nm
 Spot size at 5 m distance: < 9 mm diam.
 Divergence: < 2 mrad
 Operating voltage: 3 V DC

U22001

Achromatic Objective – 10x/0.25

Microscope objective for diverging beam in conjunction with He-Ne laser U21840.

W30614

Objective for Beam Divergence

Microscope objective 4x mounted on an adapter for diverging the beam in conjunction with the red laser diode (U22000) or the green laser module (U22001).

U22002



Divergence of laser beam by a microscope objective.



U22002

Diode Laser

Extremely compact light source for experiment set-ups in geometrical and wave optics. Due to its compact design, sophisticated and space-saving configurations can be set up. A laser with all the safety features for both school and practical training applications:

- Instruction laser of safety class 2 with key-operated switch
- Clearly visible LED operating mode indicator
- Potentiometer to adjust output power

Laser protection class: II
 Output power: 0.5 mW up to < 1 mW, Adjustable with potentiometer
 Wavelength: 650 nm ± 3 nm
 Beam diameter: 2.5 mm, ±10%

Stability of the output power: ±5% in 24 h
 Beam divergence: < 2 mrad
 Polarization: random
 Supply voltage: 12 V from a power supply unit
 Shaft: 130 mm x 10 mm diam.
 Dimensions: approx. 50x72x54 mm³

Diode Laser (230 V, 50/60 Hz)

U16040-230

Diode Laser (115 V, 50/60 Hz)

U16040-115

He-Ne Laser

Monochromatic, coherent light source for optical experiments, e.g. on diffraction, interference, and hologram reconstitution. Anodised metal housing with key switch, neutral filter for attenuating beam, 2 stand rods and power supply unit. To widen the beam, microscope objectives (e.g. W30614) can be screwed to the beam aperture.

Laser protection class: II
 Output power: <0.2 mW (with neutral grey filter)
 <1 mW (without neutral grey filter)
 Wavelength: 633 nm
 Beam diameter: 0.48 mm
 Radiation divergence: 1.7 mrad
 Mode: TEM₀₀
 Polarisation: Random
 Service life: > 12000 hours
 Plug-in power supply: 12 V DC, 1 A
 Dimensions: approx. 200x60x50 mm³
 Weight: approx. 0.6 kg

Contents:

- 1 Helium-Neon Laser
- 2 Keys
- 1 Long stand rod
- 1 Short stand rod, 6-edges
- 1 Transformer 12 V

U21840



U16040-230
U16040-115



U21840

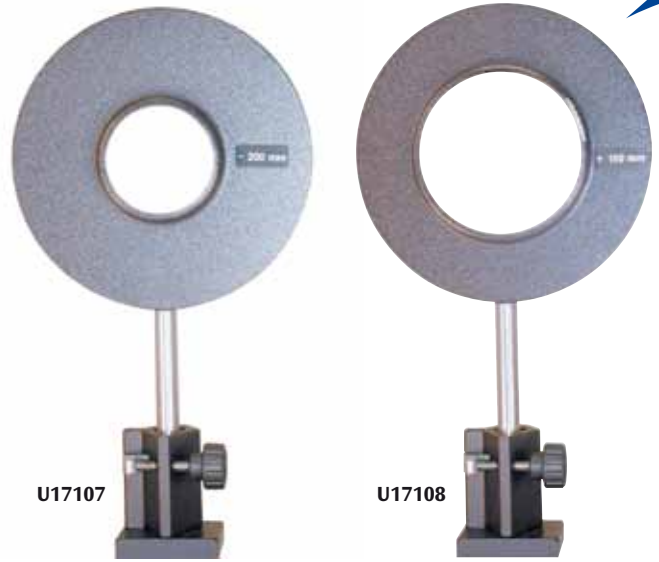
Note:

All the components on stems illustrated on the following pages are supplied without an optical rider.

Lenses on Stem

Lenses in black frame on stem. With a lens protection ring for preventing damage to the lens.

Holder: 130 mm diam.
Shaft: 10 mm diam.



Art. No.	Designation	Focal length	Diaphragm diameter
U17101	Convex lens on stem	+50 mm	50 mm
U17102	Convex lens on stem	+100 mm	50 mm
U17103	Convex lens on stem	+150 mm	50 mm
U17104	Convex lens on stem	+200 mm	50 mm
U17105	Convex lens on stem	+300 mm	50 mm
U17108	Convex lens on stem	+150 mm	75 mm
U17106	Concave lens on stem	-100 mm	50 mm
U17107	Concave lens on stem	-200 mm	50 mm

Mirrors on Stem

Mirrors in black metal frame on stem. With protective ring for preventing damage to mirror.

Holder: 130 mm diam.
Diaphragm: 50 mm diam.
Shaft: 10 mm diam.

Art. No.	Designation	Focal length
U17110	Concave mirror, on stem	+75 mm
U17111	Convex mirror, on stem	-75 mm
U17112	Plane mirror, on stem	-



Variable Focus Lens

Transparent silicone lens, on stem. The radius of curvature of the soft silicone lens can be adjusted via the water pressure in the lens using a plastic syringe, e.g. for demonstrating the accommodation capacity of the eye. Includes plastic syringe and connecting tube.

Holder: 130 mm diam.
Lens: 65 mm diam.
Shaft: 10 mm diam.

U17109



U8474030



U22016



U22010



U22017



U8474015



U8474000

Component Holder on Stem

Holder on steel rod for supporting an optical component of circular shape. The component is held in place by a metal ring.
 Aperture: 36 mm diam.
 Components: 7 mm x 42 mm diam. max.
 Height of optical axis: 150 mm
 Mounting: 100 mm diam.
 Stem: 10 mm diam.

U22010

Object Holder on Stem

Object holder in black metal frame on stem. With plug-in frame for diaphragms, filters, diffraction gratings and other objects in slide frame (see as of page 149). Includes panels to partially cover the inserted objects.
 Metal frame: 130 mm diam.
 Plug-in socket: 50x50 mm²
 Shaft diameter: 10 mm

U8474000

Holder for Four Optical Components on Stem

Revolving holder on steel rod for supporting up to four circular optical components. One component at a time is rotated into the beam path, while the others are covered by a metal disc on one side.
 Mounting: 130 mm diam.
 Components: 7 mm x 42 mm diam. max.
 Height of optical axis: 180 mm
 Stem: 10 mm diam.

U22016

Adjustable Slit on Stem

Slit with symmetric aperture, in black metal frame on stem. With micrometer screw.
 Holder: 130 mm diam.
 Slit width: 0 – 3 mm
 Slit height: 25 mm
 Shaft: 10 mm diam.

U8474015

Polarisation Filter on Stem

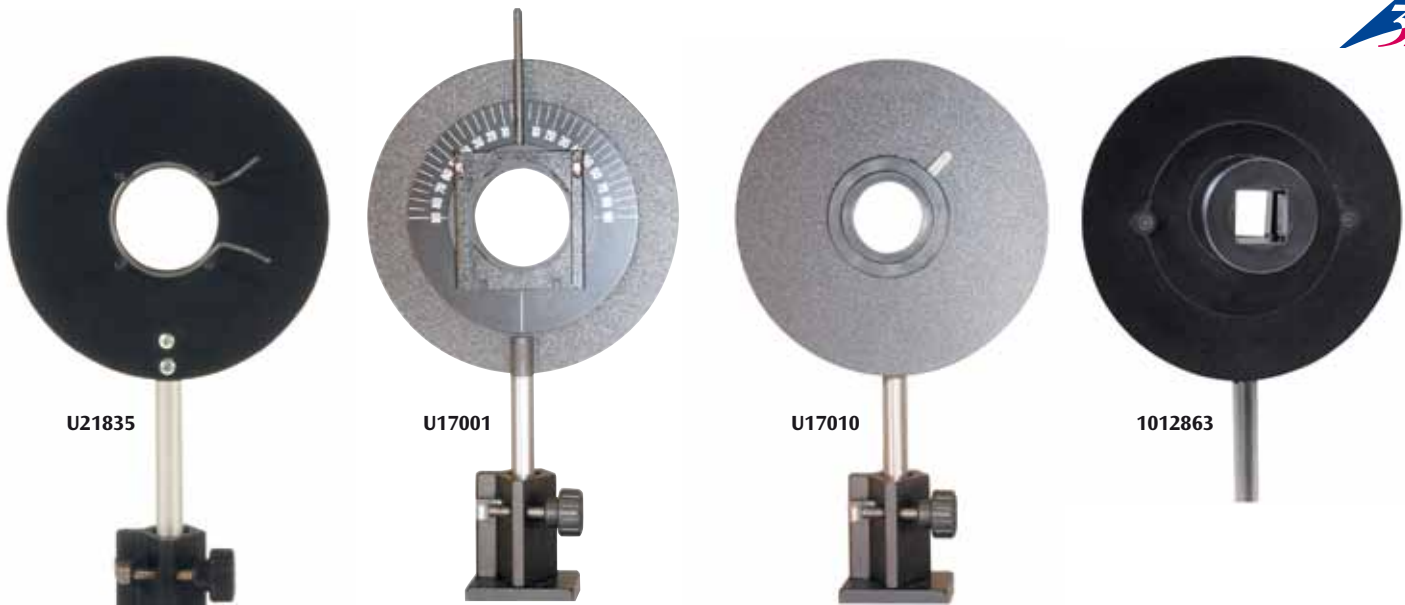
Precision glass polarisation filter, which is in a mounting on a steel rod and can be rotated on a ball-bearing. With angular scale marked in 1° intervals.
 Aperture: 38 mm diam.
 Extinction coefficient: >99,9 % at $\lambda = 450 - 750$ nm
 Height of optical axis: 150 mm
 Mounting: 100 mm diam.
 Stem: 10 mm diam.

U22017

Total Reflection Apparatus on Stem

Plexiglas rod with bend in black metal frame on stem. Parallel light shone through the rod undergoes total internal reflection and is guided around the bent end.
 Metall holder: 130 mm diam.
 Shaft: 10 mm diam.

U8474030



Holder on Stem for Lenses without Frame

Holder with a clamp for mounting frameless lenses. In black metal frame on stem.

Holder: 130 mm diam.
Aperture: 40 mm diam.
Shaft: 10 mm diam.

U21835

Rotating Object Holder on Stem

Object holder in black metal frame on stem. With rotating, plug-in frame for diaphragms, filters, diffraction gratings and other objects in slide frame (see as of page 149) with protractor scale.

Holder: 130 mm diam.
Plug-in frame: 50x50 mm
Angular scale: $\pm 90^\circ$
Divisions: 5°
Shaft: 10 mm diam.

U17001

Iris on Stem

Iris diaphragm in black metal frame, shaft-mounted. Continuously adjustable diaphragm diameter.

Holder: 130 mm diam.
Iris diameter: 3 – 29 mm
Shaft: 10 mm diam.

U17010

Holder on Stem for Direct-Vision Prism

Holder with rotating mounting for direct-vision prism (U14020). In black metal frame on stem.

Holder: 130 mm diam.
Shaft: 10 mm dia

1012863

Storing Base for Lenses

Wooden strip with ten bore holes for storing instruments with 10 mm-shaft.

U17120

Prism Table on Stem

Round prism table with a height-adjustable clamp, e.g. for fixing prisms. On stem for mounting on optical rider.

Table: 60 mm diam.
Shaft: 10 mm diam.

U17020



NEW



U22018

Glass Inset for Newton's Rings Experiments

Optical component for demonstrating and investigating Newton's interference rings. Composed of flat and curved glass pane in setting on a stem. Includes three adjustment screws for centring the interference module.

- Height of optical beam: 150 mm
- Usable diameter: 38 mm
- Thickness of glass pane: 3 mm
- Radius of curvature: 50 m
- Diameter of setting: 100 mm
- Diameter of stem: 10 mm

U22018



U22010

Interference Filters

Narrow frequency-range optical filters for filtering out light of a specific wavelength from a spectrum featuring multiple wavelengths or for making a nearly mono-chromatic light source from a continuous spectrum.

- Diameter: 40 mm
- Thickness: 3 mm
- Precision: 3 nm
- Band width (full width half maximum): 10 nm
- Transmission: > 60 %
- Parasitical transmission: < 1 %

Art. No.	Wavelength	Filtered spectral lines
U22020	436 nm	Blue mercury line
U22019	546 nm	Green mercury line
U22021	578 nm	Yellow mercury doublet

Additionally required:

U22010 Component Holder

or

U22016 Holder for Four Optical Components



U10345

Fresnel Mirror on Stem

This device is used to demonstrate the wave nature of light by observing interference caused by reflection at two mirrors and can be used to calculate the wavelength of light. It consists of two mutually inclined, front-coated mirrors made of black acrylic glass and fitted in black, anodized aluminum holders with firmly mounted mirror protection elements on a tripod made of high-grade steel. The angle of inclination can be finely adjusted from the rear.

- Total mirror area: 30x95 mm²
- Adjustment range: -0.3° – +0.7°
- Shaft: 10 mm diam.

U10345



U17130

Projection Screen

Translucent screen, on stem, for all projection purposes on optical bench.

- Dimensions: 250x250 mm²
- Shaft: 10 mm diam.

U17130



U8473200-230



U8473210-230

E14 Lamp Socket on Stem

E14 lamp socket on stem, with mains connection cable and Euro-plug conforming to CEE 7/16.

- Shaft: 113 mm x 10 mm diam.
- Weight: approx. 135 g

U8473200-230

E27 Lamp Socket on Stem

E14 lamp socket on stem, with mains connection cable and earthed plug conforming to CEE 7/4.

- Shaft: 113 mm x 10 mm diam.
- Weight: approx. 240 g

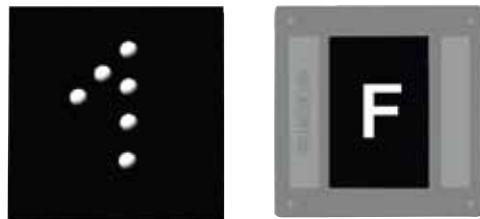
U8473210-230

Diaphragms, diffraction objects and filters

For fitting on an object holder on a stem (U8474000), in a rotatable object holder on a stem (U17001) or in a clamping holder K (U84755401).



U8476605



Set of 4 Image Objects

Set of four image objects in a slide frame.

Dimensions: 50x50 mm²

U8476605

Contents:

- 1 Scale, 15 mm with scale divisions of 0.1 mm
- 1 Photograph
- 1 F diaphragm
- 1 Number 1 diaphragm

Set of 5 Hole Diaphragms

Five hole diaphragms of different diameters in a slide frame.

Hole diameter: 1/ 3/ 6/ 10/ 15 mm

Dimensions: 50x50 mm²

U8470800



U17040

Set of 5 Slit and Hole Diaphragms

Five slit and hole diaphragms in a slide frame.

Dimensions: 50x50 mm²

Contents:

- 1 Slit, slit width 1 mm
- 1 Threefold slit, slit width 1 mm, slit spacing 5 mm
- 1 Fivefold slit, slit width 1 mm, slit spacing 5 mm
- 1 Apertured diaphragm, diam. 8 mm
- 1 F diaphragm

U17040



U8470800

Set of 7 Colour Filters

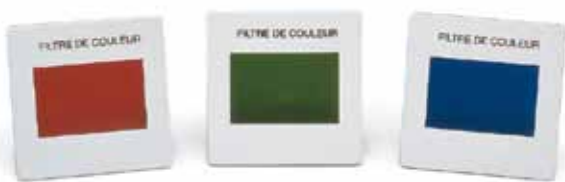
Set of 7 colour filters for experiments on additive and subtractive colour combination. Colored plastic transparencies fitted in slide frame between glass plates.

Primary colours: Red, blue, green

Secondary colours: Cyan, magenta, yellow and violet

Dimensions: 50x50 mm²

U19530



U21878



U21879

Set of 3 Colour Filters, Primary Colours

Set of 3 colour filters, primary colours, in slide frames.

Colours: Red, green, blue

Dimensions: 50x50 mm²

U21878

Set of 3 Colour Filters, Secondary Colours

Set of 3 colour filters, secondary colours, in slide frames.

Colours: Cyan, yellow, magenta

Dimensions: 50x50 mm²

U21879



U19530

Transmission Grating

Transmission grating for spectroscopic examinations and for experiments on diffraction and interference. Suitable to resolve the Na-D lines.

Mounted on glass carrier.

Dimensions: 38x50 mm²

Art. No.	Description	Lines/mm
U19512	Transmission Grating	300
U19511	Transmission Grating	600



Diaphragm with a Single Slit and Rib

Photographic diffraction object in a slide frame.

Slit and rib width: 0.5 mm each

Dimensions: 50x50 mm²

U14107



U14107

Diaphragm with 3 Single Slits and 1 Double Slit

Photographic diffraction object in a slide frame.

Single slit widths: 0.075 / 0.15 / 0.4 mm

Double slit width: 0.1

Double slit spacing: 0.5 mm

Dimensions: 50x50 mm²

U8476600



U8476600



U8470790

Set of 5 Single Slits

Five single slits of different widths in a slide frame.

Slit widths: 0.1 / 0.2 / 0.4 / 0.8 / 1.6 mm

Dimensions: 50x50 mm²

U8470790

Copy of a Rowland Grating

This copy of a Rowland Grating is supplied on a collodion foil between two glass plates in a metal frame for the purpose of projecting diffraction spectra, measuring wavelengths and observing spectra with spectrum lamps.

Number of lines: 600 Lines/mm

Dimensions: 50x50 mm²

U14424



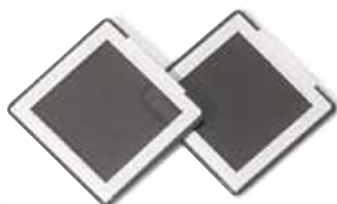
U14424

Polarisation Filter

Set of two polarisation filters in a slide frame.

Dimensions: 50x50 mm²

U40129



U40129



U21870

Hologram

Transmission hologram in slide holder.

Dimensions: 50x50 mm²

U21870

Reflection Grating

Reflection grating for demonstrating visible spectra and UV-spectra of 1st and 2nd order and when inclined, of up to 5th order. Mounted on round, concave glass carrier.

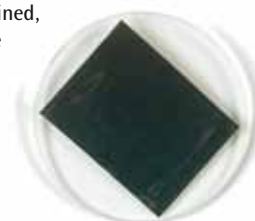
Curvature radius: 500 mm

Number of lines: 530 lines/mm

Grating dimensions: 40x30 mm²

Glass carrier: 50 mm diam.

U19525



U19525

U19520



Demonstration Gratings

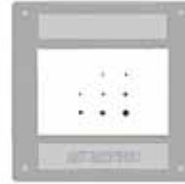
Three diffraction gratings on a frame for demonstrating the relationship between line spacing and diffraction angle.

Number of lines: 100 / 300 / 600 lines/mm.

Dimensions: 90x30 mm²

U19520

U8476655

U8476655

U14108

Diaphragms with Circular Holes and Discs

Photographic diffraction objects in a slide frame.

 Dimensions: 50x50 mm²

Art. No.	Description	Diameter
U14108	Diaphragm with 3 Circular Hole and Disc Pairs	1.0/1.5/2.0 mm
U8476655	Diaphragm with 9 Circular Discs	0.1 – 1.8 mm
U8476655	Diaphragm with 9 Circular Holes	0.1 – 1.8 mm

U14100

U14101

U14102

Diaphragms with Double and Multiple Slits

Photographic diffraction objects in a slide frame.

 Dimensions: 50x50 mm²

Art. No.	Description	Slit spacing	Slit width	No. of slits
U14100	Diaphragm with 3 Double Slits of Different Widths	0.3 mm	0.10/0.15/0.20 mm	2
U14101	Diaphragm with 4 Double Slits of Different Spacings	0.25/0.50/0.75/ 1.00 mm	0.15 mm	2
U14102	Diaphragm with 4 Multiple Slits and Gratings	0.25 mm	0.15 mm	2/3/4/5/40

U14103

U14104

U14106

Diaphragms with Gratings

Photographic diffraction objects in a slide frame.

 Dimensions: 50x50 mm²

Art. No.	Description	Grating constant	Slit width	No. of lines
U14103	Diaphragm with 3 Ruled Gratings	0.5/0.25/0.125 mm	0.25/0.125/ 0.063 mm	2/4/8 Lines/mm
U14104	Ruled Gratings	0.125 mm	0.063 mm	8 Lines/mm
U14106	Diaphragm with 2 Cross Gratings	0.25 mm	0.125 mm	4 Lines/mm

Gratings

Line gratings in slide frames. For students and demonstration experiments.

 Dimensions: 50x50 mm²

U21871

U21872

U21873

U21874

Art. No.	Description	Lines/mm
U21871	Grating	140
U21872	Grating	530
U21873	Grating	600
U21874	Grating	1000

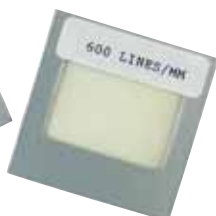
Set of 4 Gratings

Four line gratings mounted in slide frame with protective glass plates.

For student and demonstration experiments.

Number of lines: 80/ 100/ 300/ 600 Lines/mm

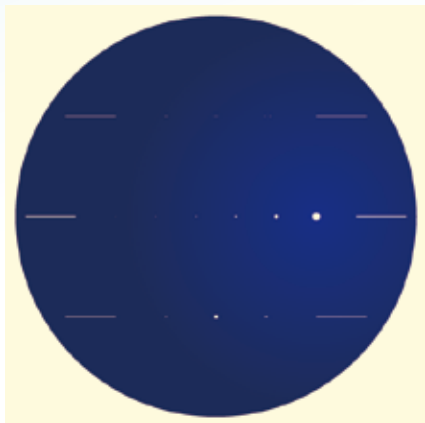
 Dimensions: 50x50 mm²
U19515.....

U19515


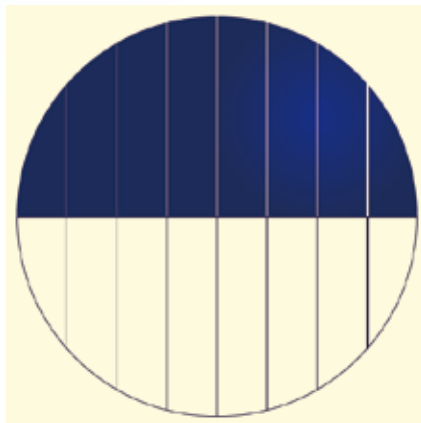
Diffraction Targets on Glass Plates

Suitable for mounting in the optical component holder (U22010) or holder for four components (U22016).

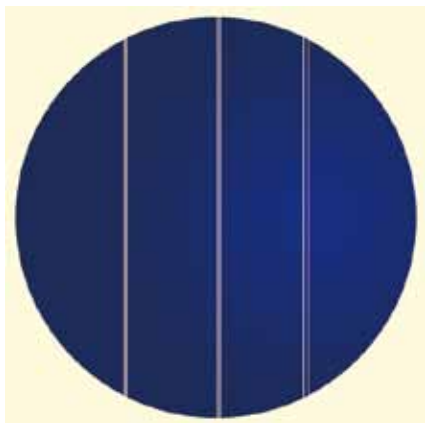
Chromium-coated glass plates with diffraction targets of high precision and regularity applied by microlithography. The glass supports are highly resistant against ageing and contamination.



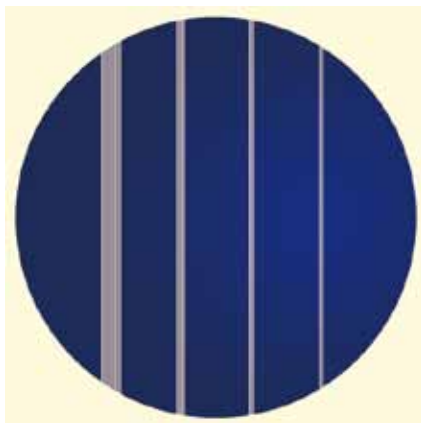
U22011



U22012



U22014



U22015

Diffraction Apertures on Glass Plate

Glass plates with 12 different single and double diffraction apertures for quantitative diffraction experiments.

- Diameter of support: 40 mm
- Aperture irregularities: <math><1\ \mu\text{m}</math>
- Single apertures:
 - Diameters: 20, 30, 50, 100, 200 and 500 μm
- Double apertures:
 - Separations: 100, 200 and 400 μm
 - Diameter: 50 μm
- Rectangular apertures:
 - Dimensions: 70x70 μm^2 , 200x200 μm^2 and 70x200 μm^2

U22011

Slits and Bars on Glass Plate

Glass plates with 7 sets of slits and bars of different widths for quantitative diffraction experiments.

- Diameter of support: 40 mm
- Irregularities: <math><1\ \mu\text{m}</math>
- Slit widths: 30, 40, 60, 80, 100, 150 and 200 μm
- Bar widths: 30, 40, 60, 80, 100, 150 and 200 μm

U22012

Double Slits on Glass Plate

Glass plates with three double slits of different separations for quantitative diffraction experiments.

- Diameter of support: 40 mm
- Irregularities: <math><1\ \mu\text{m}</math>
- Slit width: 70 μm
- Separations: 200, 300 and 500 μm

U22014

Multiple Slits on Glass Plate

Glass plates with four different numbers of multiple slits for quantitative diffraction experiments.

- Diameter of support: 40 mm
- Irregularities: <math><1\ \mu\text{m}</math>
- Slit width: 40 μm
- Slit separation: 100 μm
- Number of slits: 3, 4, 6 and 14

U22015

U287050

Frosted Discs

Glass discs with frosted surface. Suitable for use as frosted transparent object in optical experiments.

- Diameter: 40 mm
- Thickness: 2 mm

Frosted Disc with "d"

U287020

Frosted Disc

U287050

NEW

U287020

60° Prisms

Equilateral prisms for use on the prism table on shaft (U17020) or prism table K (U8476110).

	U140001	U14005
Material	Crown glass	Crown glass
Refractive index	1.515	1.515
Side length	27 mm	45 mm
Height	50 mm	50 mm

	U14051	U14052
Material	Crown glass	Flint glass
Refractive index	1.515	1.608
Average dispersion	0.008	0.017
Side length	30 mm	30 mm
Height	30 mm	30 mm

	U283060	U283070
Material	Crown glass	Flint glass
Refractive index	1.515	1.608
Side length	40 mm	40 mm
Height	40 mm	40 mm

90° Prisms

Rectangular prisms for use on the prism table on stem (U17020) or prism table K (U8476110).

	U14010	U14015
Material	Crown glass	Crown glass
Refractive index	1.515	1.515
Side length	30 mm	45 mm
Height	30 mm	30 mm

Set of 3 Prisms

Set of prisms for demonstrating the design of an achromatic prism and a direct vision prism. Consists of a thin flint glass prism, as well as thin and thick crown glass equilateral prisms. The two thin prisms deflect a light beam equally strongly but with different dispersions. Moving them closer together in the light path results in a direct vision prism which decomposes light into its spectral components without deflecting it. The thick crown glass prism has the same dispersion as the flint glass prism, but deflects the light beam twice the distance. This permits configuration of an achromatic prism which deflects light without splitting it into a spectrum.

U14050

Material	Flint glass	Crown glass	Crown glass
Refractive index	1.608	1.515	1.515
Average dispersion	0.017	0.008	0.008
Base	15 mm	30 mm	18 mm
Side length	40 mm	40 mm	40 mm
Height	40 mm	40 mm	40 mm

Glass Prism, 60°

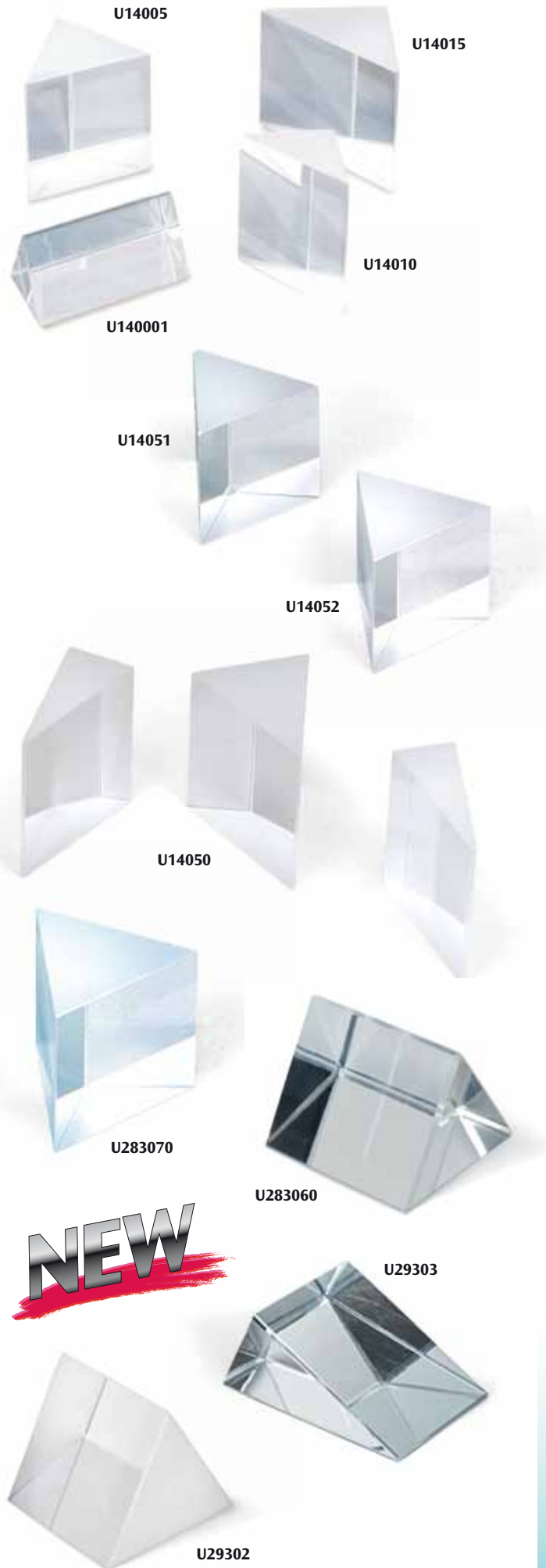
Equilateral prism made of ordinary glass.
Length of sides: 55 mm, height: 60 mm.

U29302

Glass Prism, 90-60-30°

Equilateral prism cut in half, made of ordinary glass.
Hypotenuse: 70 mm, height: 40 mm.

U29303



Accessories for Faraday Effect

Three-part set of accessories for holding a flint glass block (1012860) and a U-shaped transformer core (U8497215) in experiments on the Faraday effect.

1012861



1012885

NEW

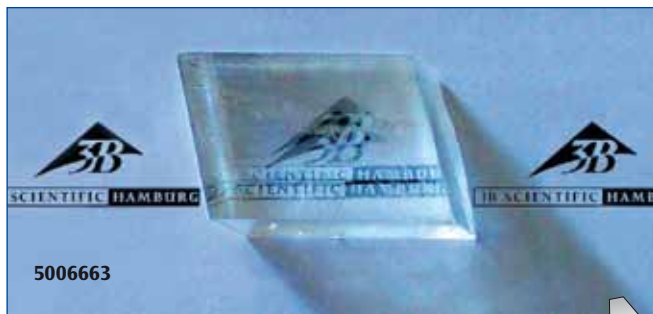
Equipment for Faraday Effect:

- U10300 Optical Precision Bench D**
- U10319 Optical Base D**
- 1012860 Flint Glass Block for Faraday Effect**
- 1012861 Accessories for Faraday Effect**
- U8497215 U Core**
- U8497200 Pair of Pole Shoes**
- U8497181 Pair of Clamps**
- 1012859 Coil D 900 Turns (2x)**



Set-up for Faraday effect

- 1012857 DC Power Supply 1 – 32 V, 0 – 20 A (230 V, 50/60 Hz)**
- or
- 1012858 DC Power Supply 1 – 32 V, 0 – 20 A (115 V, 50/60 Hz)**
- U138021 Set of 15 Safety Experiment Leads, 75 cm**
- U22017 Polarisation Filter on Stem (2x)**
- U103111 Optical Rider D, 90/50**
- Light source with colour filter or laser**



5006663

Flint Glass Block for Faraday Effect

Rectangular block made of flint glass for demonstrating optical activity in a magnetic field (Faraday effect).

Dimensions: 20x10x10 mm³

1012860



1012860

NEW

Doubly Refracting Crystal

Calcite crystal showing the birefringence in crystals.

5006663



U14053

Fresnel Biprism

Fresnel biprism for observing interference by creating two virtual sources of light by refracting the light from a single coherent source.

Dimensions: 50x50x2 mm³

Prism angle: 179° approx.

Refractive index: 1.5231

U14053



U8476730

Inverting Spectacles

Spectacles with two fully rotatable inverting prisms in a shielded spectacle frame. The inverting prisms reverse incoming light rays, turning the world upside down, so to speak, and making it unexpectedly difficult for the wearer to perform even the simplest of daily tasks such as reaching for objects, drawing, moving about in a room etc.

U8476730

Amici Direct Vision Prism

A combined prism for splitting light beams into a spectrum without deflecting them. Comprises an alternating combination of two crown glass prisms and one flint glass prism; blackened on the outside.

Dispersion angle: 4.2°

Dimensions: approx. 105x20x20 mm³

U14020

Additionally recommended:

- 1012863 Holder for Direct-Vision Prism on Stem**



U14020

Experiment Topics:

- Refraction and interference at the surfaces of a glass block, apertured diaphragm, square diaphragm, grating with slits, cross grating
- Michelson interferometer
- Investigation of linearly polarised light
- Absorption of light
- Reconstruction of a hologram

Equipment Set for Wave Optics with Laser

Equipment set for demonstrating fundamental phenomena in wave optics by means of practical experiments. The light source is provided by a partially polarised diode laser with adjustable mount. Power is supplied from a plug-in power supply (included) or from batteries. The components are magnetic and can be placed horizontally or vertically on the included metal board, according to the set-up required for the various experiments. All components are stored in a case with shaped foam inlay.

Diode laser: max. 1 mW, laser safety class II
 Wavelength: 635 nm
 Plug-in power supply: primary 100 V AC – 240 V AC
 secondary 3 V DC, 300 mA
 Battery holder: for 2x 1.5 V AA batteries
 (batteries not included)

Contents:

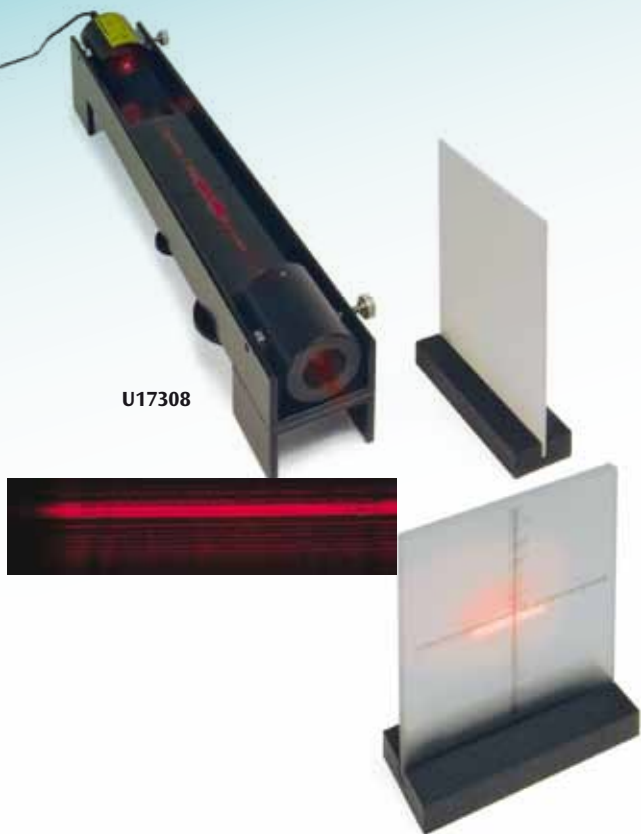
- 1 Diode laser with adjustable mounting
- 1 Plug-in power supply
- 1 Battery holder (without batteries)
- 2 Mirrors with adjustable mounting
- 1 Half-silvered mirror
- 1 Screen, white
- 1 Screen, frosted glass
- 1 Convex lens
- 1 Polarisation filter
- 1 Holder for lens and filter
- 3 Colour filters in slide frames (red, green, blue)
- 2 Apertured diaphragms in slide frames
- 2 Square diaphragms in slide frames
- 3 Gratings with slits in slide frames
- 1 Cross grating in slide frame
- 1 Glass plate in slide frame
- 1 Holder for slide frames
- 1 Hologram
- 1 Metal board (60x45 cm²) with removable strut
- 4 Rubber feet for metal board
- 1 Storage case
- 1 Experiment guide

U17303



U17303





U17308

Fresnel Mirror Experiment Set

Complete equipment set for demonstrating the wave nature of light by observing the interference of laser light. This is caused by the reflection of a laser at two black planar glass mirrors which are offset by a small angle of a few minutes. The laser, mirrors and the optical projector are all mounted on a metal base. One mirror is fixed and the other is adjustable to change the angle of inclination. A projection screen, a ground glass screen with scaled crosshairs and a battery box are also included.

Diode Laser: class II
 Output power: < 1 mW
 Wavelength: 635 nm
 Operating voltage: 3 V DC
 Battery-box: for 2x 1.5 V batteries (AA, LR6, MN1500, Mignon) (batteries not included)

Dimensions:
 Metal base: 400x75x85 mm³
 Screens: 150x90x30 mm³

U17308

Additionally recommended:
U17309 Plug-In Power Supply 3 V DC

Plug-In Power Supply 3 V DC (not shown)

Plug-in mains adapter to provide electrical power supply for the Fresnel mirror experiment set (U17308).
 Mains voltage: 100 – 240 V, 50/60 Hz

U17309

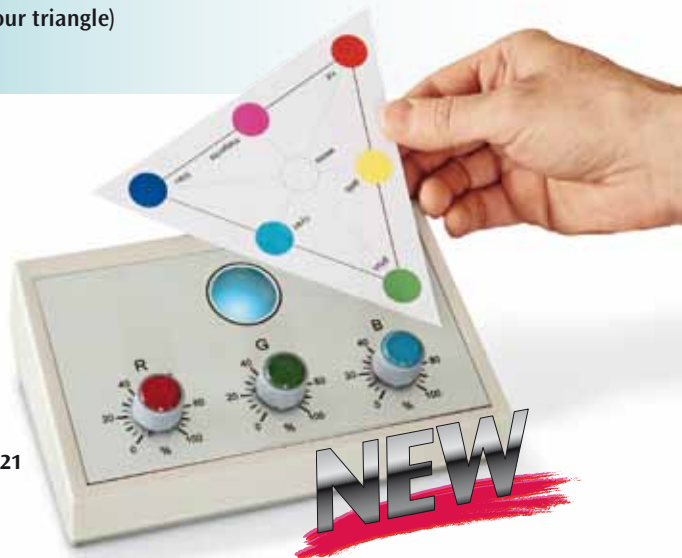
U29555



NEW

Experiment topics:

- The three primary colours
- Creating colours by additive colour mixing
- Components of primary colours in mixed colours
- Colours on a monitor screen
- Principles of perceiving colours (colour triangle)



1012821

NEW

“Addition of Colours” School Apparatus

Handy desk-top device for investigating additive mixing of the primary colours, red, green and blue (RGB) to make any other colour. Three adjustment mechanisms allow any intensity of each primary colour to be selected so that various components of LED light can be mixed and observed with the help of a frosted glass screen. Includes 12 V/500 mA plug-in power supply and instruction manual for a colour triangle.
 Dimensions: 192x65x120 mm³

1012821

Newton’s Colour Disc, with Crank

Newton’s Colour Disc for demonstrating additive combination of colours. Mounted on a stable base, moved with crank.
 Diameter of disc: 178 mm
 Dimensions of the base: 143x90x282 mm³

U29587

U29587



NEW

Newton’s Colour Disc, with DC Motor

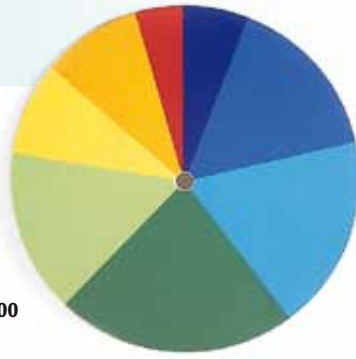
Newton’s Colour Disc for demonstrating additive combination of colours. Mounted on a stable box, moved by a DC motor.
 Diameter of disc: 90 mm
 Motor: 4 ... 6 V DC
 Connection: 4 mm safety sockets
 Dimensions: 135x85x130 mm³

U29555

Additionally required:
U13812 Pair of Safety Experiment Leads, 75 cm
U8521121-230 DC Power Supply 1.5 – 15 V, 1.5 A (230 V, 50/60 Hz)
 or
U8521121-115 DC Power Supply 1.5 – 15 V, 1.5 A (115 V, 50/60 Hz)

Experiment topics:

- Additive colour mixing
- Subtractive colour mixing



U15500



U21883

U11040

Equipment Set for Colour Mixing

Equipment set for demonstrating how colours combine (with the aid of an overhead projector). This equipment set is designed to permit quick setting up and safe, simple operation. The clear configuration facilitates understanding of the experiments and allows direct viewing of results. The projection plate, along with its three holders for mirrors and lenses, is placed onto the projection surface of the overhead projector. Depending on the projection distance, three large circles with diameters of 30 to 80 cm appear on the projection screen. By turning the holders and mirrors, it is possible to project colours so that they are separated or so that they partially overlap. Such adjustments can be performed easily and precisely. The large colour filters can be simply inserted into the lens holders, or placed directly on the overhead projector.

Contents:

- 1 Projection plate with three mirror and lens holders
- 3 Colour filters; red, green, blue (120x50 mm²)
- 3 Colour filters; cyan, yellow, magenta (120x50 mm²)

U21883

Additionally required:

- U30150-230 Overhead Projector (230 V, 50/60 Hz)**
- or
- U30150-115 Overhead Projector (115 V, 50/60 Hz)**

Newton's Colour Disc

Plastic, circular disc with segments coloured red, orange, yellow, light green, dark green, light blue, dark blue and violet for demonstrating additive combination of colours. When the disc is turned rapidly, its colours merge to produce white.

Diameter: 170 mm

U15500

Additionally required:

- U11040 Motor with Drive Control**

Motor with Drive Control

Controllable motor for spinning the colour disc fast (U15500). With disc holder and clamp for attachment to a stand rod. Including plug-in power supply.

Control range: 0 – 25 rev/s
 Rotation direction: reversible
 Dimensions: approx. 110x70x45 mm³
 Weight: approx. 0.2 kg

U11040

Additionally recommended:

- U13270 Tripod Stand, 150 mm**
- U15002 Stainless Steel Rod, 470 mm**



CCD Linear Camera

Intended for investigating all optical phenomena in real time, this precision CCD linear camera consists of a measuring head with a CCD linear array and data acquisition accessories. The scope of supply includes user-friendly software, neutral grey filters, a USB cable and a storage case.

Measurement Head with a CCD Linear Array

Resolution: 2048 pixel (14x200 µm)
 Sensitive length: 30 mm
 Neutral-grey filter: density factor 3.0: black/white
 Integration time
 (remote or direct control): 5 ms to 42.5 ms – step 2.5 ms
 Rod: 170 mmx10 mm diam.

Computer Connection: USB interface
 Refresh rate: 20 fps @ P233 MMX – RAM 16 Mo

System Requirements

Operating system: Windows
 Screen resolution: at least 640x480 pixels with 256 colors

Software

The multi-lingual software offers a wide range of functions: Real-time displays for observing time-dependent phenomena, for example, during experiment adjustments

- Adjustable sensitivity of the measuring head in accordance with the intensity of the light source
- Representation of the intensity distribution of interference spectra in diagrams and grey stages, as well as coloured display of measured emission and absorption spectra
- Measurement functions such as adjustable axis scaling, grids, vertical and horizontal cursor with corresponding displays, peak-search routine with display of intensity and position, zoom
- Signal processing functions such as smoothing, averaging and inversion of spectra, Fast-Fourier Transformation
- Simulations for comparing theoretically calculated interference and diffraction intensity distributions with experimental data
- Storage, printing, online help and export of data and graphics (in the form of word processing, spreadsheet and bitmap files)

Experiment topics:

Spectrometer

Investigations of

- Emission and absorption spectra
- Transmission curves of filters
- Spectral resolution of white light

Wave Optics

Display and measurement of diffraction and interference spectra, for example, diffraction at a slit, pinhole, grating, Newton’s rings, Fresnel mirrors; comparison of measured spectra with theoretical calculations.

Geometric Optics

For example, measurement of focal lengths, enlargements and divergence of a light beam.

Time-Dependent Data Acquisition

For measuring light modulation on a pixel, for instance, oscillations of monochromatic light sources, measurement of doublets in emission and absorption spectra (e.g. sodium, mercury). Fast Fourier transformation allows wavelengths to be determined.

Contents:

- CCD linear camera
- Neutral-grey filter
- Manual with experiment descriptions
- Software for data recording and evaluation
- USB cable
- Transport case

CCD Linear Camera

1013311

Additionally required:

U21821 Polarisation Filter (2x)

Additionally recommended:

U16040-230 Diode Laser (230 V, 50/60 Hz)

or

U16040-115 Diode Laser (115 V, 50/60 Hz)

U22010 Component Holder on stem

U22011 Diffraction Apertures on Glass Plate

U22012 Slits and Bars on Glass Plate

U22014 Double Slits on Glass Plate

U22015 Multiple Slits on Glass Plate



Polarisation Filter

High-grade glass filter for producing and studying linearly polarised light.
In a rotatable frame with pointer and thread.

Degree of polarization: 99.9 %
Holder diameter: 50 mm
Filter diameter: 45 mm
Thread: M49

U21821



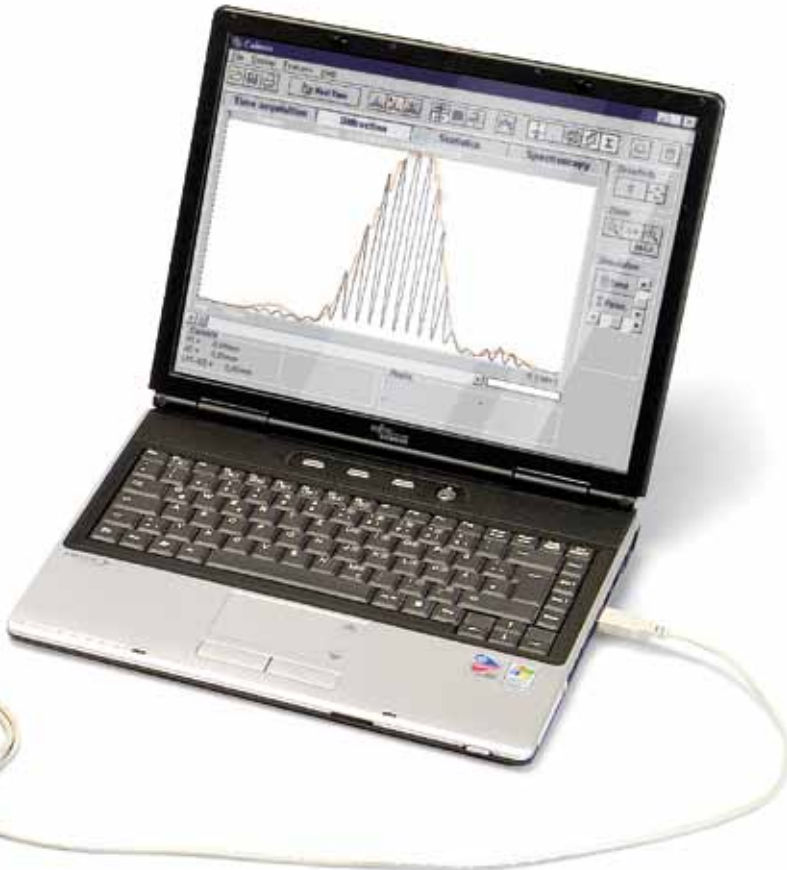
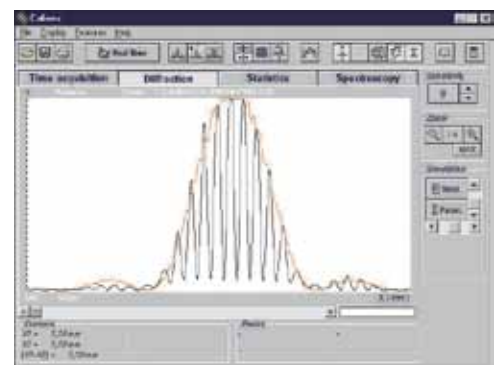
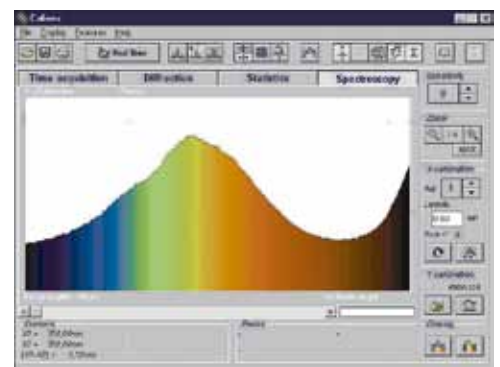
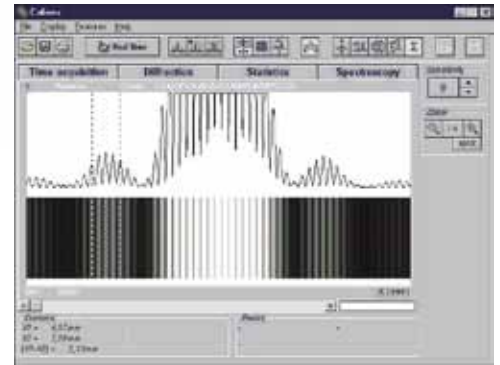
1013311



U21821



CCD Camera



Light and Optics



U14390

Demonstration Polarimeter

Device for use on an overhead projector to demonstrate optical activity and determine specific angles of rotation and concentrations at known specific angles of rotation. A yellow filter (for more precise measurement accuracy) and a polarizer are embedded in a black plastic base plate. A cell containing a solution of the substance to be investigated with 50 mm and 100 mm markings is inserted into the holder. The analyzer is situated above this set-up in a holder with rotary handle and pointer. By turning the analyser, it is possible to ascertain the angle of rotation and read it off a transparent angle scale.

Cuvette: Markings at 50 mm and 100 mm
 Angle scale: -40° – $+40^{\circ}$
 Scale divisions: 1°
 Dimensions: approx. 370x330x190 mm³

U14390

Additionally required:

U30150-230 Overhead Projector (230 V, 50/60 Hz)
 or
U30150-115 Overhead Projector (115 V, 50/60 Hz)

Demonstration Polariscope

Apparatus for use on an overhead projector to demonstrate a photo-elastic image in samples subjected to stress and strain. The polarising filter is incorporated into the base plate of the frame; the analyser is embedded in the laterally swivelling upper base plate. Via the spindle drive, a tensile or pressure load can be exerted on the test body.

Samples: Epoxy-resin
 Dimensions: approx. 150x150x45 mm³
 Total weight: approx. 820 g

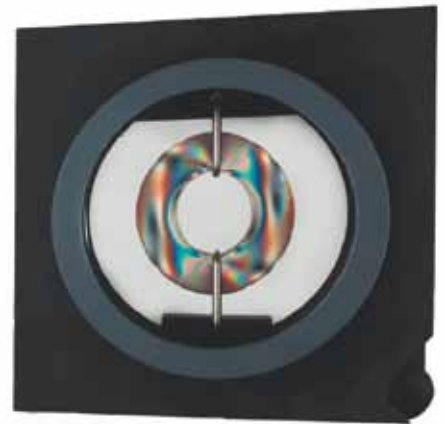
Contents:

- 1 Basic apparatus
- 2 Metal clamps for applying tension
- 1 Ring, 60 mm diam.
- 1 Block, 60x10x10 mm³
- 2 Blocks, 20x10x8 mm³
- 3 Triangles to lay on surface

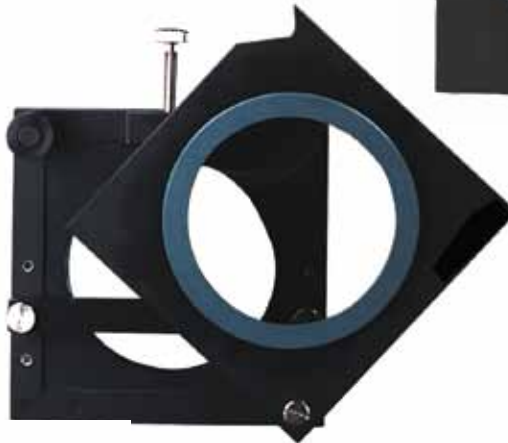
U8472580

Additionally required:

U30150-230 Overhead Projector (230 V, 50/60 Hz)
 or
U30150-115 Overhead Projector (115 V, 50/60 Hz)



U8472580



Polarimeter with 4 LEDs

Polarimeter with a lighting unit comprising four monochromatic LEDs for determining the angle and direction of rotation of polarised light as a function of wavelength as well as sample thickness and concentration with the help of an optically active substance. The light emerging from those LEDs that are lit is polarised linearly and transmitted through a fitted sample cylinder filled with the optically active substance. The analyser in the cover is used to identify the direction of polarisation which can be read on the cover's angle scale.

Wavelength of LEDs: 468 nm (blue), 525 nm (green),
 580 nm (yellow), 630 nm (red)

Dimensions: approx. 110x190x320 mm³
 Weight: approx. 1 kg

Polarimeter with 4 LEDs (230 V, 50/60 Hz)

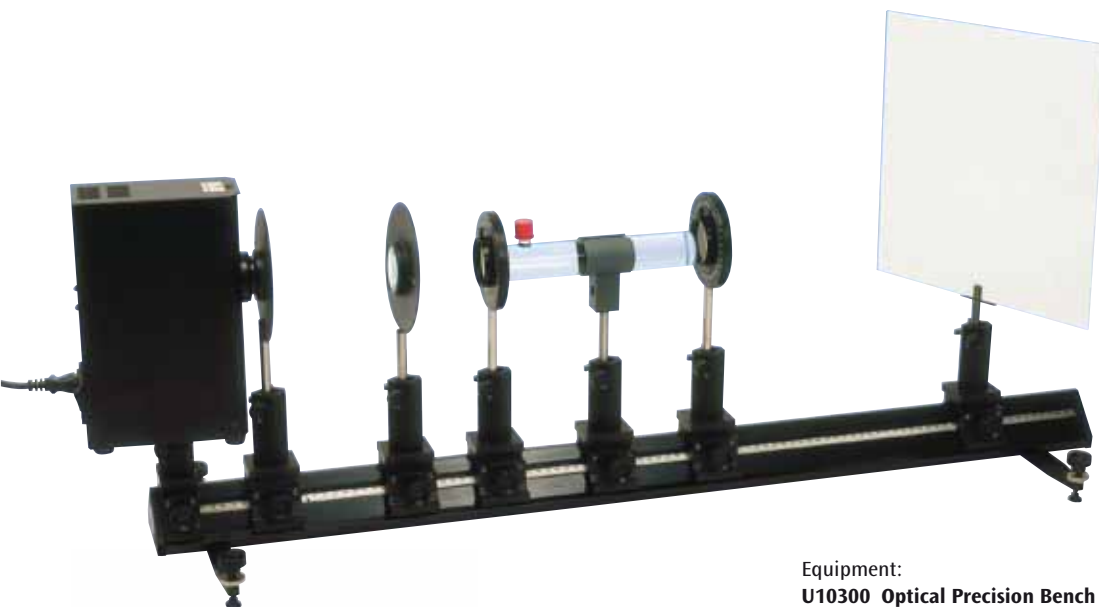
U8761161-230

Polarimeter with 4 LEDs (115 V, 50/60 Hz)

U8761161-115

U8761161-230
 U8761161-115





Determination of the angle of rotation of optically active substances



Equipment:

- U10300 Optical Precision Bench D, 1000 mm**
- U103101 Optical Rider D, 60/50 (2x)**
- U103111 Optical Rider D, 90/50 (5x)**
- U11112 Cell Holder on Stem**
- U14313 Round Cell, 200 mm**
- U14314 Round Cell, 100 mm**
- U17010 Iris Diaphragm on Stem**
- U17101 Convex Lens on Stem, f = 50 mm**
- U17130 Projection Screen**
- U22017 Polarisation Filter on Stem (2x)**
- U21829-230 Na Low-Pressure Spectral Lamp (230 V, 50/60 Hz)**

Round Cells

Duran glass cells with bonded optical discs and GL threads. E.g. for experiments on the determination of the angle of rotation of optically active substances on the optical bench.

Diameter: 35 mm
Thread: GL-14

Round Cell, 100 mm

U14313

Round Cell, 200 mm

U14314

Polarimeter

Polarimeter with a sodium lamp as the light source for the measurement of the rotation and the rotation direction of the polarization plane of polarized light through optically active substances as well as the determination of the concentration of liquids. Robust metal stand with slightly tilted shaft for tubes with lengths up to 220 mm. With swivel cover, analyzer and polarizer. A sodium lamp with filter holder is used as a light source. Includes polarimeter tubes 100 mm, 200 mm and spare sodium lamp.

- Measurement range: 2 semi-circles (0 – 180°)
- Glass tubes: 100 and 200 mm, 15 mm diam.
- Scale division: 1°
- Readability: 0.05° (with Vernier scale)
- Dimensions: 200x360x450 mm³
- Weight: 10 kg
- Light source: Sodium lamp (589 nm)
- Mains voltage: 115 V ... 230 V, 50/60 Hz

U33400

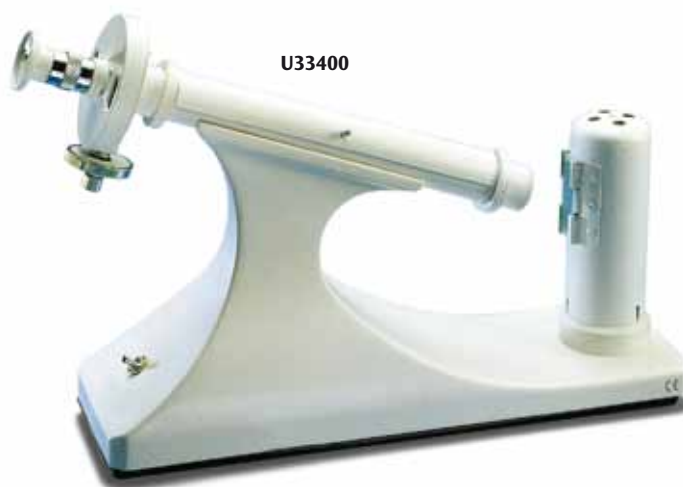
Cell Holder on Stem

Plastic holder for round cells (U14313) and (U14314).
Holder: 36 mm diam.
Stem: 90 mm x 10 mm diam.

U11112

Spare Sodium Lamp (not shown)
Spare lamp for polarimeter (U33400).

1012885



Polarimeter Tube 100 mm

(not shown)
Spare glass tube for polarimeter (U33400).
Length: 100 mm, 15 mm diam.

1012883

Polarimeter Tube 200 mm

(not shown)
Spare glass tube for polarimeter (U33400).
Length: 200 mm, 15 mm diam.

1012884

Control Unit for Spectrum Lamps

Control unit for operating spectral lamps (U8476800 – U8476875), including a lamp housing on a stand rod. A second lamp housing on a stand rod can be clamped to the rear side of the stable metal housing and connected to the electricity supply. A switch on the front can be used to change over between the right-hand and left-hand spectral lamps.

Maximum output current: 1 A
 Lamp housing: 180 mm x 50 mm diam.
 Tripod rod: 300 mm x 10 mm diam.
 Lamp socket: Pico 9
 Dimensions: approx. 255x175x135 mm³
 Weight: approx. 5.3 kg

Contents:

- 1 Control unit
- 1 Lamp housing on a stand rod with a 7-pole connection cable

Control Unit for Spectrum Lamps (230 V, 50/60 Hz)

U21905-230

Control Unit for Spectrum Lamps (115 V, 50/60 Hz)

U21905-115

Additionally recommended:

U21906 Lamp Housing on a Stand Rod

Lamp Housing on a Stand Rod (not shown)

Additional lamp housing with a cable for connecting to a spectral lamp ballast coil (U21905-230 resp. U21905-115).

U21906

Spectrum Tube Power Supply

Control unit for stable operation of spectral tubes (U41810 – U41825). The integrated current limiter ensures a long service life of the tubes. Spring-contacts in fully insulated fixtures and a protective window guarantee secure mounting and reliable operation.

Voltage: 5000 V
 Maximum current: 10 mA
 Dimensions: approx. 370x120x90 mm³

Spectrum Tube Power Supply (230 V, 50/60 Hz)

U418001-230

Spectrum Tube Power Supply (115 V, 50/60 Hz)

U418001-115

Spectrum Tubes

High luminance spectral tubes emitting the line or band spectrum of a gas or mercury vapour. Partly evacuated capillary glass tubes filled with gas or mercury vapour are furnished with electrodes for the application of a voltage to generate the electrical field that provides the necessary energy.

Capillary length: 100 mm
 Total length: approx. 260 mm

Spectral Lamps

Gas discharge lamps for emitting line spectra of inert gases and metal vapours with high luminance and spectral purity.

Socket: Pico 9
 Operating current: max. 1A
 Weight: approx. 350 g

Additionally required:

U21905-230 Control Unit for Spectrum Lamps (230 V, 50/60 Hz)

or

U21905-115 Control Unit for Spectrum Lamps (115 V, 50/60 Hz)



U8476800 / U8476875

Art. No.	Filling
U8476800	Cd
U8476810	He
U8476840	Na
U8476850	Ne
U8476855	Tl
U8476870	Hg 100
U8476875	Hg/Cd



U21905-230 U21905-115



U418001-230 U418001-115

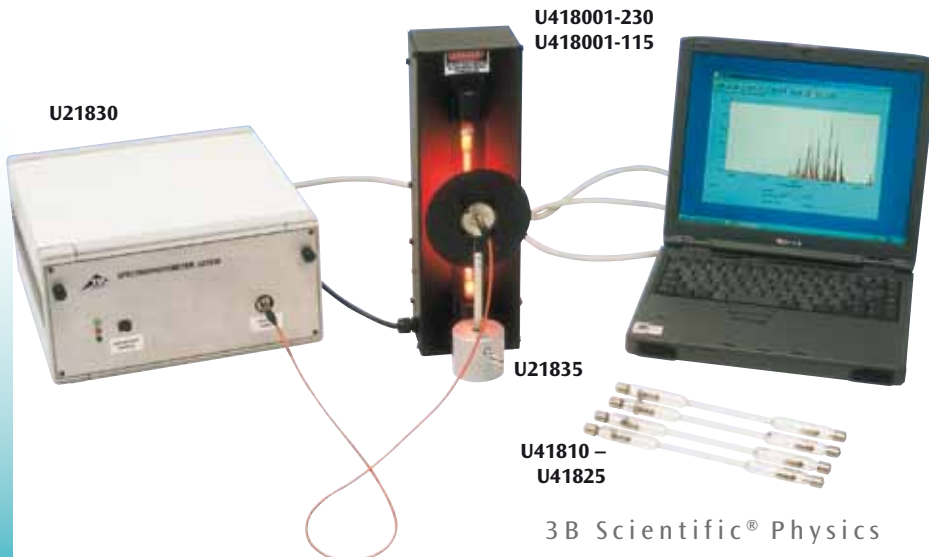
Additionally required:

U418001-230 Spectrum Tube Power Supply (230 V, 50/60 Hz)

or

U418001-115 Spectrum Tube Power Supply (115 V, 50/60 Hz)

Art. No.	Filling
U41810	Air
U41811	Argon
U41812	Bromine
U41813	Carbon dioxide
U41814	Chlorine
U41815	Deuterium
U41816	Helium
U41817	Hydrogen
U41818	Iodine
U41819	Krypton
U41820	Mercury
U41821	Neon
U41822	Nitrogen
U41823	Oxygen
U41824	Water vapor
U41825	Xenon



U21830

U418001-230 U418001-115

U21835

U41810 – U41825

High-Pressure Mercury Spectral Lamp

Gas discharge lamp for observing high-intensity mercury spectral lines at high vapour pressures. Lines in the ultra-violet range are suppressed by the glass body. Includes a black metal housing with integrated power supply unit, a light aperture with a fine thread for direct screw-mounting of filters and a threaded stand rod.

Luminance: 1800 lm
 Operating current: 0.6 A
 Power: 50 W
 Base: E27
 Service life: approx. 24000 h
 Threaded light aperture: 40 mm diam.
 Fine thread for filter: M49
 Dimensions: approx. 242x153x80 mm³
 Weight: approx. 2.4 kg

U21827-230

Low-Pressure Mercury Spectral Lamp (230 V, 50/60 Hz)

Gas discharge lamp for observing mercury spectral lines at low vapour pressures with optimal line widths. The body is made of quartz glass to allow detection of lines in the ultra-violet range too. Includes a black metal housing with integrated power supply unit, a light aperture with a fine thread for direct screw-mounting of filters and a threaded stand rod.

Operating current: 0.16 A
 Power: 6 W
 Base: G5
 Service life: approx. 3000 h
 Threaded light aperture: 40 mm diam.
 Fine thread for filter: M49
 Dimensions: approx. 242x153x80 mm³
 Weight: approx. 2.2 kg

U21828-230

Low-Pressure Sodium Spectral Lamp

Gas discharge lamp for observing Na D lines and investigating of the doublet. Includes a black metal housing with integrated power supply unit, a light aperture with a fine thread for direct screw-mounting of filters and a threaded stand rod.

Luminance: 1800 lm
 Operating current: 0.35 A
 Power: 18 W
 Base: BY22d
 Service life: approx. 10000 h
 Threaded light aperture: 40 mm diam.
 Fine thread for filter: M49
 Dimensions: approx. 242x153x80 mm³
 Weight: approx. 2.5 kg

U21829-230

Spare Lamps: (not shown)

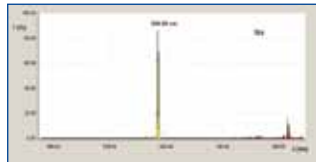
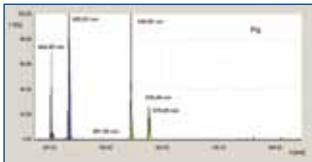
Art. No.	U140215
U21831-230	Hg High-Pressure Spectral Lamp for U21827-230
U21832-230	Hg Low-Pressure Spectral Lamp for U21828-230
U21833-230	Na Low-Pressure Spectral Lamp for U21829-230



U21828-230

U21827-230

U21829-230



Line spectra of Hg (high-pressure) and Na, recorded using the digital spectrophotometer (U21830)

High-Pressure Mercury Vapour Lamp

High-pressure mercury vapour lamp in hardened glass bulb made of blackened borosilicate glass, with tube-shaped hole allowing emission of unfiltered ultra-violet radiation. Includes E27 lamp holder on stem and see-through screen to protect users from UV radiation.

Wavelength ranges: UV-A, UV-B, UV-C
 Power consumption: 125 W

U8473155

Additionally required:

U21905-230 Control Unit for Spectrum Lamps (230 V, 50/60 Hz)

or

U21905-115 Control Unit for Spectrum Lamps (215 V, 50/60 Hz)



U8473155

U21905-230
 U21905-115

Pocket Spectroscope

High quality optical system with centered visible spectrum, which is linear with respect to the wavelength. In metal sleeve. With fixed slit and prism system with grating

- Slit width: 0.2 mm
- Number of grating lines: 600 lines/mm
- Dimensions: approx. 115 mm x 25 mm diam.
- Weight: approx. 62 g

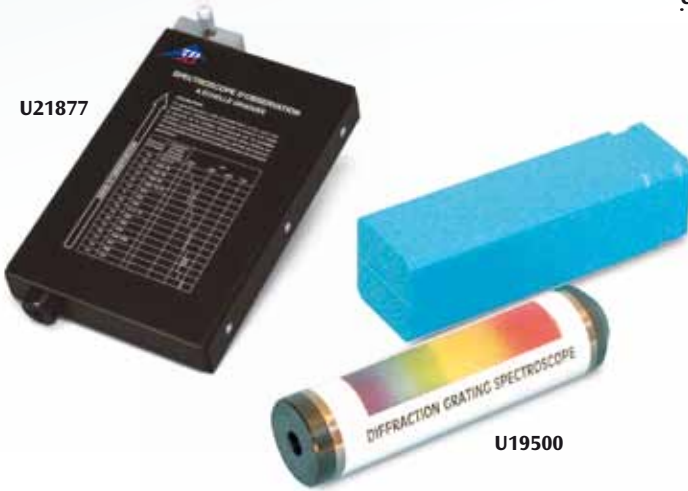
U19500

Hand Spectroscope with an Amici Prism

Precise optical system with a visible spectrum that is linear in terms of wavelength around the centre point. In a metal housing with an adjustable slit and high-grade Amici prism. Delivery in hinged case for protective and dust-free storage.

- Angular dispersion: 7° (C-F)
- Linear dispersion: 60 mm
- Slit width: 0 – 1 mm
- Folding case: approx. 150x70x30 mm³
- Weight: approx. 150 g

U8472660



Spectroscope in Metal Case

Hand spectroscope in a flat metal case with printed wavelength scale for easy reading of spectral lines and spectra. With holder for mounting a probe in a plastic vessel.

- Dimensions: approx. 180x115x25 mm³

U21877

Spectrometer-Goniometer

Spectrometer with rotatable prism and directionally-adjustable objective tube for observing and measuring emission and absorption spectra. Can also be used for precise determination of the optical parameters of prisms. Includes prism with mounting and a holder for transmission gratings.

- Objective tube: Symmetrical precision slit of hardened steel; adjustable slit width, slit height and distance; f = 160 mm, 18 mm diam.
- Eyepiece tube: Continuous focusing and viewing angle adjustment, eyepiece with cross-wire, f = 160 mm, 18 mm diam.
- Prism: flint glass (60°)
 - Dispersion ($n_F - n_C$): 0.017
 - Base length: 33 mm
 - Height: 22 mm
- Angular scale: 0° to 360°
 - Scale divisions: 0.5°
 - Reading precision: 1' (Vernier scale with magnifying lens)
- Height: 250 mm approx.
- Weight: 8 kg approx.

U14416

Kirchhoff-Bunsen Spectroscope

Desktop spectroscope for the observation and measurement of emission and absorption spectra. With adjustable slit, condenser, flint glass prism as well as an observation telescope with sliding ocular. Scale tube with reference division, which is superimposed on the image plane of the spectrum due to reflection at the front surface of the prism. Includes removable prism hood. Ideal for schools and universities.

- Observation tube: moveable, with locking screw, slideable eyepiece
- Objective: f = 160 mm, 18 mm diam.
- Slit tube: stationary, with symmetrical slit
- Objective: f = 160 mm, 18 mm diam.
- Scale tube: stationary, 200-division scale
- Eyepiece: f = 90 mm, 18 mm diam.
- Scale: can be calibrated in wavelengths
- Prism: Flint glass (60°), Dispersion ($n_F - n_C$): 0.017
- Length of base: 20 mm, height: 30 mm
- Weight: 4.8 kg

U14415



Handheld Spectroscope

Device for observing absorption and emission spectra, e.g. to observe the Fraunhofer line spectrum in sunlight for the observation of absorption spectra through liquids, the emission spectra of gas discharge tubes or for chemical analysis during flame tests.

Hand Spectroscope

Simple spectroscope for observing spectra and spectral lines. Made of cardboard and plastic with built-in grid.

Dimensions: approx. 145 mmx28 mm diam.

U21875

Spectroscope in Cardboard Box

Hand spectroscope in a flat cardboard box with printed wavelength scale for easy reading of spectral lines and spectra.

Dimensions: approx. 180x115x25 mm³

U21876

Spectrophotometer S

A new and easy-to-use high resolution spectrophotometer that is ideal for schools and colleges. The solidly constructed spectrometer is designed to examine the near and infrared part of the spectrum from 360 nm to 800 nm; its removable covers allow students to see first hand the spectrum analysis process. Setup is quick and easy. The optical signal enters the device through a flexible fibre optic cable. Connection to a PC is via the USB 2.0 interface. A specially selected transmission grating and precision slit gives high resolution and excellent results. Data collection software is intuitive with real time graphical output. For easier interpretation of the spectrum, each wave band is shaded with the corresponding colour. The spectrum can be viewed either as a graph or in text form, which allows for more advanced calculations. The availability of several toolbars makes it possible to set the spectrometer parameters to exactly fit the requirements of the experiment. Spectrometer S is supplied ready to use; tested and calibrated.

Spectral range: 360 – 800 nm
 Spectrometer resolution: < 2.0 nm
 Pixel resolution: < 0.5 nm
 Operating system: Win XP and Vista
 Interface: USB 2.0
 Dimensions: 60x60x120 mm³
 Weight: 600 g

Contents:

Spectrometer S with USB cable, fibre optic cable, and a CD containing experimental software and an instruction manual. Laptop not included.

U17310



S-system Spectrometer-Goniometer

Spectrometer with rotatable prism or grating and directionally-adjustable objective tube for observing and measuring emission and absorption spectra. Can also be used for precise determination of the optical parameters of prisms or gratings. Includes prism with holder and transmission grating with holder.

Objective tube: Adjustable slit width and object distance; f = 175 mm, 32 mm diam.
 Eyepiece tube: Continuous focusing and viewing angle adjustment, eyepiece with cross-wire, f = 175 mm, 32 mm diam.
 Prism: flint glass (60°)
 Dispersion ($n_r - n_c$): 0.017
 Base length: 40 mm
 Height: 40 mm
 Transmission grating: 300 lines/mm
 Angular scale: 0° to 360°
 Scale divisions: 0.5°
 Reading precision: 0.5' (Vernier scale)
 Height: 250 mm
 Weight: approx. 12 kg

U22050

Digital Spectrophotometer

This digital spectrophotometer is used for quantitative investigations of emission and absorption spectra and transmission curves, and for measurements related to calorimetry and chemical kinetics. Based on the Czerny-Turner principle, this device permits simultaneous, real-time recording and analysis of the entire visible range from 380 nm – 830 nm in conjunction with the user-friendly measurement and evaluation software. Light recorded by means of an optical fibre and projected on a CCD detector via two mirrors and a reflection grating. Includes an absorption module with cell and slide holders for disposable cells and colour filters, a software program and various connecting cables.

Spectral range:	380 – 830 nm
Wavelength accuracy:	0.25 nm
Resolution:	1 nm
Transmission:	0 – 100%
Resolution:	0.1%
Absorption:	0 – 100%
Resolution:	0.1%
Optical configuration:	Czerny Turner
CCD detector:	2048 pixels
Absorption module:	
Quartz halogen lamp:	12 V/20 W
Optical connection:	via optical fibre
Mains voltage:	115 V/230 V, 50/60 Hz
Dimensions:	approx. 315x175x322 mm ³
Weight:	approx. 6.6 kg

System requirements:

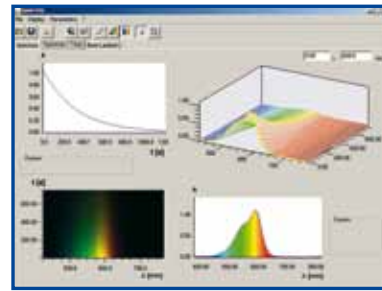
Operating system:	WINDOWS
PC:	Pentium 133 or higher, 32 MB RAM, CD-ROM drive
Free disk space:	at least 15 MB
Screen resolution:	at least 800x600 pixels (16 bit)
Computer connection :	USB interface

Contents:

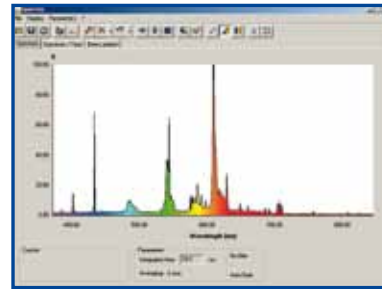
- 1 Spectrophotometer
- 1 Absorption module
- 1 CD with software
- 1 Optical fibre, 1 m
- 1 PC connection cable (USB)
- 1 DIN cable for connecting the absorption module
- 1 Mains connection cable
- 100 Disposable cells
- 1 Operating manual

Software:

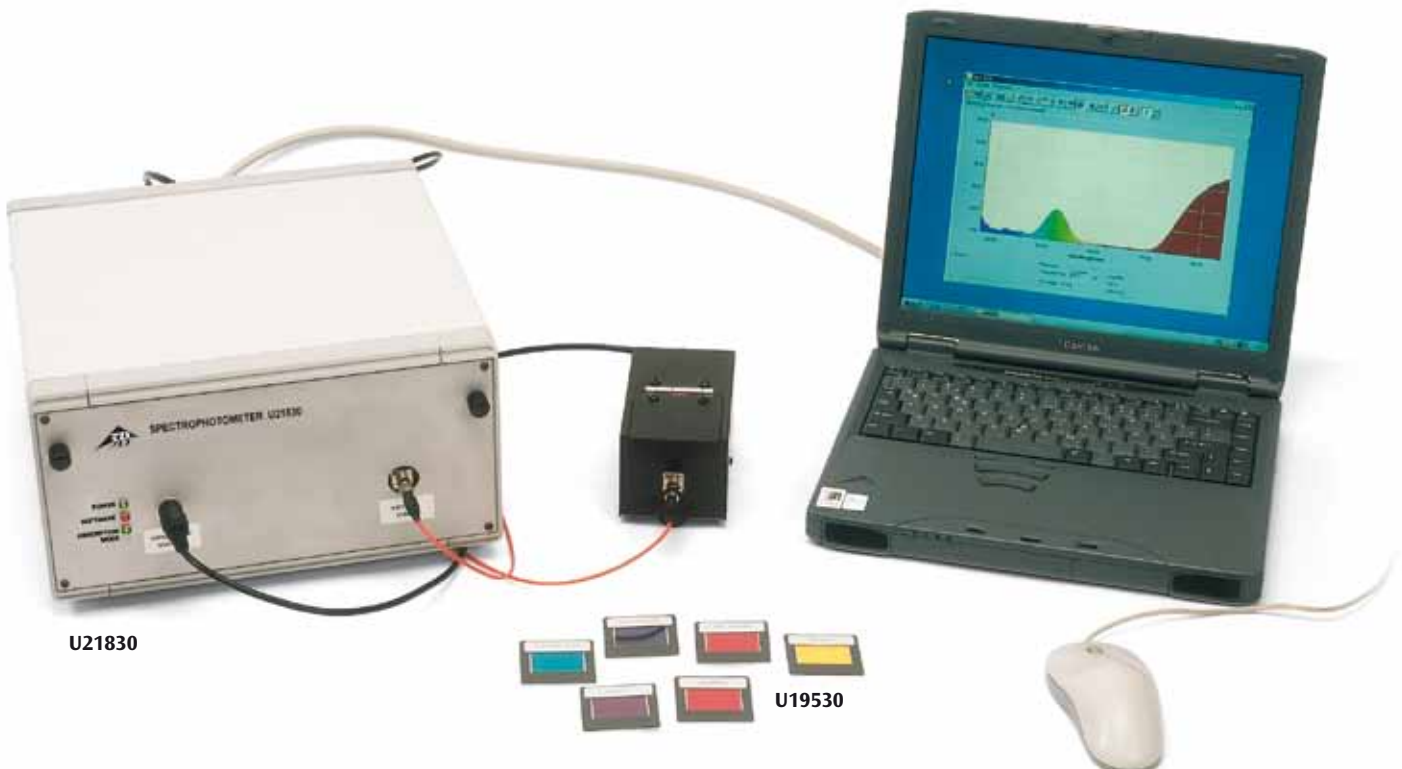
- Real-time recording of emission and absorption spectra as well as transmission curves
- Simultaneous recording of spectra over the entire wavelength range (recording time per spectrum less than 2 ms)
- Recording of spectra as a function of time (chemical kinetics)
- 3D display; functional relationship between absorption, time and wavelength
- Display of spectra in authentic colours
- Display of several spectra in one diagram
- Manual calibration option
- Wavelength measurements
- Recording and evaluation of concentration measurements (Lambert-Beer law)
- Zoom and cursor function
- Storage of recorded spectra
- Export of measured data to standard text and bitmap formats, as well as Regressi and Excel formats
- Colour printout of spectra

U21830

Decolourization of dissolved potassium permanganate (KMnO_4) with oxalic acid ($\text{C}_2\text{H}_2\text{O}_4$)



Line spectrum of a fluorescent lamp



U21830

U19530

See physics experiments catalogue

Experiment topics:

- Michelson Interferometer
- Fabry-Perot Interferometer
- Determination of the refractive index of glass*
- Determination of the refractive index of air*
- Twyman-Green test for optical components (qualitative)*

* Accessory set (U10351) required



U10350

Interferometers

Interferometer

This complete equipment set comprises high grade optical components mounted on a heavy, rigid base plate for precise and reproducible measurements. The large optical components permit a generation of clear and well defined interference patterns in daylight. The reflective observation screen has an adjustable inclination. Pre-defined component positions allow quick rearrangement to ensure extremely rapid preparation for the various experiments. The equipment set includes a stable plastic box for storing the mounted and adjusted interferometer as well as the base plate for laser.

Beam splitter:

- Diameter: 40 mm
- Evenness: $\lambda/10$ (front side), $\lambda/4$ (rear side)

Surface-coated mirror:

- Dimensions 40x40 mm²
- Evenness: $<\lambda/2$

Mirror adjustment:

- Eccentric reduction: approx. 1:1000 (individual calibration specified on eccentric base)

Base plate:

- Weight: 5.5 kg
- Dimensions: 245x330x25 mm³

U10350

Additionally required:

U21840 He-Ne Laser

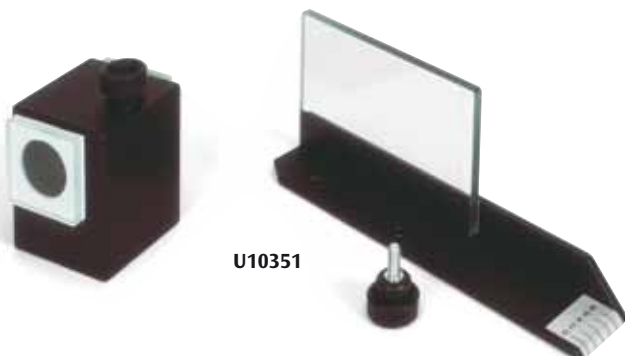
Accessory Set for the Interferometer

This accessory set for the interferometer (U10350) consists of a vacuum cell for determining the refractive index of air and a glass plate on a rotatable holder for determining the refractive index of glass and investigating the surface quality of optical components (Twyman-Green interferometer).

U10351

Additionally required:

- 1012856 Vacuum Hand Pump**
- U10146 Silicone Tube**



U10351



Glass plate in the beam path of the Michelson interferometer



Vacuum chamber in the beam path of the Michelson interferometer

Light and Optics

For laser experiments refer to pages 170/171



Laser Diode Driver and Temperature Controller (cw and pulsed)

- Precise current-controlled continuous wave and pulse-type laser driver
- Two TEC (Thermo Electric Cooler) drivers with PID controllers
- Digital and analogue modulation inputs
- Multiple safety circuits
- Stored configuration (EEPROM)
- Very low power dissipation due to bias voltage control in cw-mode
- Digital control using isolated RS232 serial interface

The diode laser driver and temperature controller is a highly precise, safe and cost-efficient operating solution for continuous wave (cw) and pulsed diode lasers. The power supply unit is designed for current-stabilized control of the laser diode and is also equipped with a control unit for laser diode's controlling optical beam power in cw-mode by means of the integrated photodiode input. In pulsed mode the laser diode can be operated with the freely configurable built-in oscillator or externally using the modulation input. The temperature controllers are designed as PID controllers and configured for standard operation with NTC and Pt100 sensors. The use of silicon temperature sensors or other types is equally possible simply by altering the software.

Laser Diode Driver and Temperature Controller DSc01-0,5

U140215

Laser Diode Driver and Temperature Controller DSc01-2,5

U14021

	U140215	U14021
Laser:		
Laser current range	0...500 mA	0...2500 mA
Laser current resolution	1 mA	1 mA
Laser current accuracy	<1 mA	<1 mA
Laser current noise	<60 µs	<60 µs
Pulse rise time	<10 µs	<10 µs
Pulse fall time	<5 µs	<5 µs
Voltage range	1.2...5 V	1.,2...5 V
Current limit	adjustable between 0...500 mA	adjustable between 0...2500 mA
External digital modulation input	TTL	TTL
TEC Driver:		
Peltier current	max. -4...+4 A	max. -4...+4 A
Peltier current (2nd driver)	---	max. -2...+2 A
Peltier voltage	max. 8 V	max. 8 V
Peltier current limit	adjustable between 0...4 A	adjustable between 0...4 A
Peltier current limit (2nd driver):	---	adjustable between 0...2 A
Peltier current resolution	1 mA	1 mA
Temperature control accuracy	<10 mK	<10 mK
General specs:		
Over-temperature protection	for driver and laser	for driver and laser
Mains voltage	100 bis 240 V AC	100 bis 240 V AC
Dimensions	88x110x240 mm ³	88x110x240 mm ³



Laser Safety Goggles for Nd:YAG Laser

Nylon goggles for average protection levels, integral construction for reduced weight with enlarged visual field due to large filter lenses. Supplied in a storage pouch.

Filter colour: light blue
 Degree of light transmission: TD₆₅ = 62%
 Specification according to DIN EN 207/208: 750-1100 D L5 + IR L7 > 1100-1200 DIR L5

U14085

Diode Laser 1000 mW

1000 mW diode laser with built-in Peltier cooler and thermistor, collimator and focusing lens, mounted and aligned with mounting plate and optical rider.

Emitted wavelength: 808 nm

U14022

Diode Laser 100 mW

100 mW diode laser with built-in Peltier cooler, thermistor and photodiode, mounted on a 2-way rotating plate and optical rider.

U14023

Alignment Laser Diode

Alignment laser diode with mounting plate and optical rider

Wavelength: 633 nm

Power: 1 mW

U14024

Nd:YAG Cristal

Nd:YAG crystal, aligned with mounting plate and mounted on optical rider.

U14025

Frequency Doubling Module

Frequency doubling module with KTP crystal and built-in Peltier cooler, thermistor. Alignment holder and optical rider, assembly.

U14026

Passive Q-Switch

Passive Q-switch with mounting plate, mounted on optical rider.

U14027

Laser Mirror I

Laser mirror for decoupling laser beams, pl-cc, $r = -200$ mm, PR@1064 nm ($R = 97\%$)/AR@1064 nm. Includes an adjustable holder and is mounted on an optical rider.

U14028

Laser Mirror II

Laser mirror for decoupling frequency-doubled laser beams, pl-cc, $r = -200$ mm, HR@1064 nm +HAT@532 nm/AR@532 nm. Includes an adjustable holder and is mounted on an optical rider.

U14029

PIN Photodiode

PIN photodiode, mounted on optical rider.

U14038

PIN Photodiode, Fast

Fast PIN photodiode, mounted on optical rider.

U14039

Optical Bench KL

Guide rail with leveling platform, 600 mm.

U14040

Cylindrical Lens $f = +15$ mm

Beam shaping lens for collimation of laser diode's fast axis, anti-reflection coating on both sides, mounted on optical rider.

U14041

Collimator Lens $f = +25$ mm

Collimator lens with focal length of $f = +25$ mm, anti-reflection coating on both sides, mounted on optical rider.

U14042

Cylindrical Lens $f = +45$ mm

Beam shaping lens for the collimation of the laser diode's slow axis, anti-reflection coating on both sides, mounted on optical rider.

U14043

Collimator lens $f = +75$ mm

Collimator lens with a focal length of $f = +75$ mm, anti-reflection coating on both sides, mounted on optical rider.

U14044

Focusing lens $f = +75$ mm

Focusing lens with a focal length of $f = +75$ mm, anti-reflection coating on both sides, mounted on optical rider.

U14045

Filter Holder with Filter RG850

Filter holder with filter, type RG850, to suppress the pumping beam.

U14046

Filter Holder with Filter-Types RG850 and BG40

Filter holder with filter-types RG850 and BG40 for suppressing the pumped beam as well as the fundamental wavelength.

U14047

Polarization Filter

Polarization filter, mounted on a rotating plate and optical rider.

U14048

Transport Case KL

Padded transport case for all components. Free of charge with order of a complete experiment as per list p. 171

U14049



This collection of key experiments on the principles and uses of diode pumped solid lasers uses an Nd:YAG crystal. This is probably the most important material in use for solid-state lasers.

Today the diode laser is a popular tool in three different areas of application: in communications engineering, measurement and instrumentation technology and as a pumping source for solid-state lasers. Its emission wavelength is not determined by two discrete energy levels but by the way the energy of the electrons is distributed across the energy bands. Thus the energy level is dependent on the temperature and the injection current. The laser beam propagates within a pn-junction and is thus also limited by this in terms of space and energy. The distinctions resulting from this with respect to “classical resonator lasers” are explored in **Experiment 1**.

Selecting the most suitable light pumping source plays a crucial role in the optical pumping process. The selection of the emission and absorption transitions are critical for the efficiency of the system, as the investigations in **Experiment 2** show.

Experiment 3 investigates optical pumping of Nd:YAG lasers with the aid of laser diodes. This has become established as an efficient method and an alternative to lasers pumped by lamps.

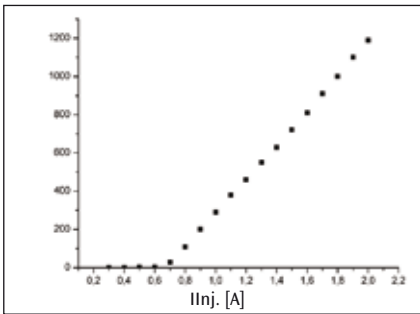
Important applications are explored in **Experiment 4** dealing with the generation of short pulses using a passive Q-switch and in **Experiment 5** on frequency doubling with the aid of a non-linear optical crystal.

Experiment 1: Diode Laser

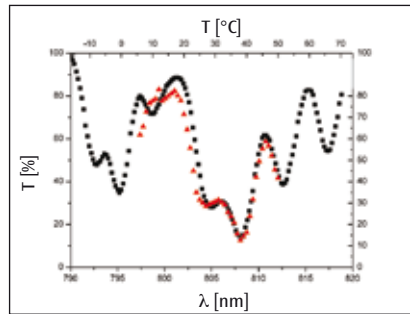
- Measurement of laser diode output power and how it relates to the applied current
- Investigation of how the wavelength of light from the laser diode depends on temperature by means of the transmission spectrum of the Nd:YAG crystal
- Confirmation of how laser diode wavelength depends on temperature to the extent of approximately 0.27 nm/K
- Determination of how the wavelength of light from the laser diode depends on the injection current
- Graph of injection current against temperature at a constant wavelength (maximum absorption) for the laser diode
- Determination of beam divergence from the laser diode in both axes (slow axis and fast axis)
- Determination of polarising components in both axes (slow axis and fast axis)

Experiment 2: Emission and Absorption Experiment

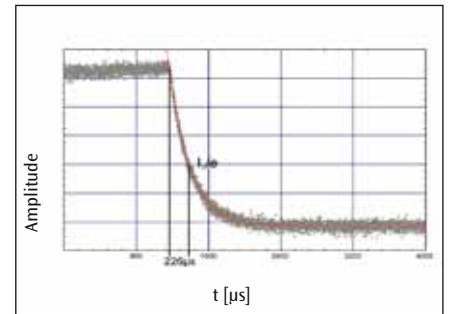
- Measurement of laser diode output power and how it relates to the applied current
- Investigation of how the wavelength of light from the laser diode depends on temperature by means of the transmission spectrum of the Nd:YAG crystal
- Determination of how the wavelength of light from the laser diode depends on the injection current
- Graph of injection current against temperature at a constant wavelength (maximum absorption) for the laser diode
- Determination of lifetime of laser level ${}^4F_{3/2}$ for laser in pulsed operation



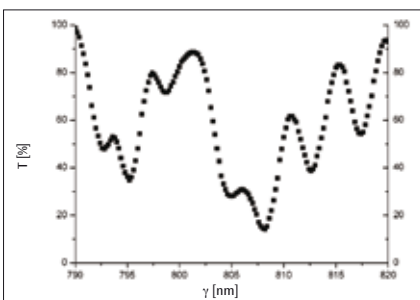
Output power of diode laser at 20° C as a function of the injection current



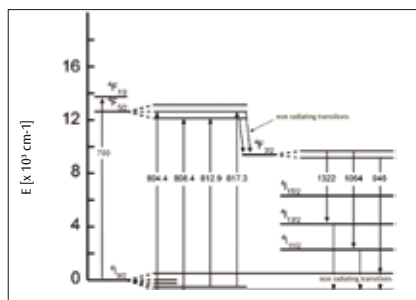
Comparison of transmission functions:
Square – $T(\lambda)$ recorded using a spectrometer
Triangular – Transmission as a function of temperature



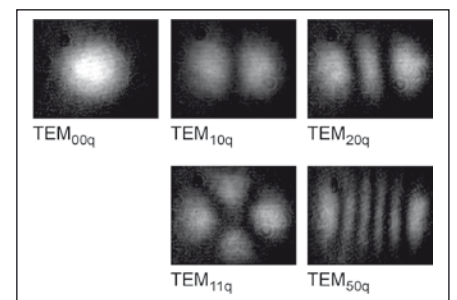
Measurement of half-life for the ${}^4F_{3/2}$ level in an Nd:YAG crystal.
An exponential function has been fitted to the measurements



Transmission spectrum of an Nd:YAG crystal as a function of wavelength, recorded using a spectrometer



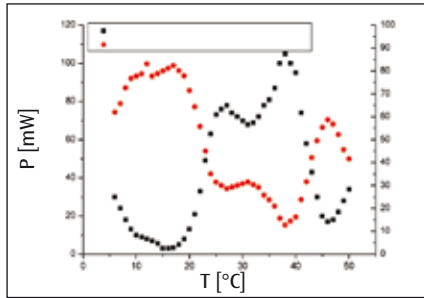
Energy level diagram for an Nd:YAG crystal with the most important transitions for optical pumping and laser operation



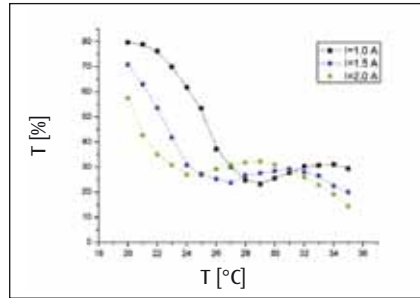
Transverse modes

Experiment 3: Nd:YAG Laser

- Investigation of how the wavelength of light from the laser diode depends on temperature by means of the transmission spectrum of the Nd:YAG crystal.
- Graph of injection current against temperature at a constant wavelength (maximum absorption) for the laser diode.
- Determination of lifetime of laser level ${}^4F_{3/2}$ for laser in pulsed operation.
- Design of an Nd:YAG laser with stable resonator plus determination of laser threshold and output power.
- Determination of output power for an Nd:YAG lasers and how it depends on the wavelength of the pumping diode, plus comparison with the transmission spectrum of the Nd:YAG crystal.
- Recording of transient response (spiking) of a laser by means of an oscilloscope with the laser diode in pulsed operation.
- Demonstration of transverse modes due to detuning of the resonator.



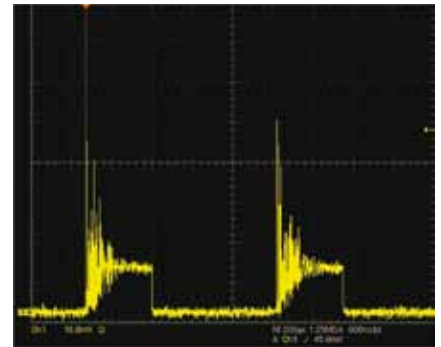
Transmission of light from a diode through an Nd:YAG crystal as a function of temperature for various injection currents



Comparison of curve characteristics for transmission of light through an Nd:YAG crystal and output power of the Nd:YAG laser as a function of the diode temperature

Experiment 4: Generation of Short Pulses

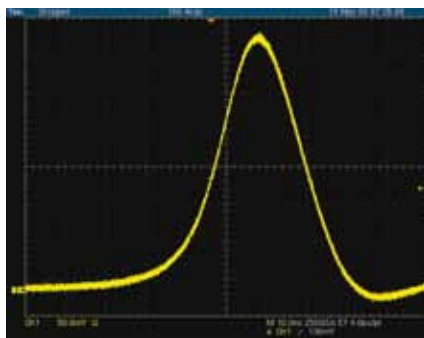
- Investigation of how the wavelength of light from the laser diode depends on temperature by means of the transmission spectrum of the Nd:YAG crystal.
- Graph of injection current against temperature at a constant wavelength (maximum absorption) for the laser diode.
- Determination of lifetime of laser level ${}^4F_{3/2}$ for laser in pulsed operation.
- Design of an Nd:YAG laser with stable resonator plus determination of laser threshold and output power.
- Recording of transient response (spiking) of a laser by means of an oscilloscope with the laser diode in pulsed operation.
- Q-switch for Nd:YAG laser with Cr:YAG module plus measurement of pulse duration and energy.



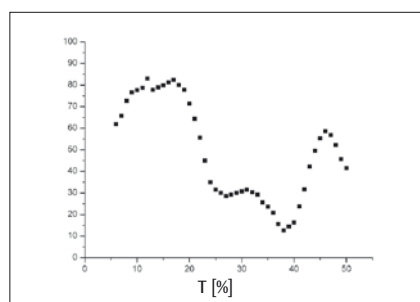
Oscilloscope trace: spiking in a Nd:YAG laser

Experiment 5: Frequency Doubling with KTP Crystal

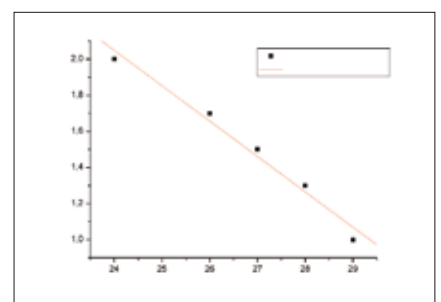
- Investigation of how the wavelength of light from the laser diode depends on temperature by means of the transmission spectrum of the Nd:YAG crystal.
- Graph of injection current against temperature at a constant wavelength (maximum absorption) for the laser diode.
- Determination of lifetime of laser level ${}^4F_{3/2}$ for laser in pulsed operation.
- Design of an Nd:YAG laser with stable resonator plus determination of laser threshold and output power.
- Determination of output power for an Nd:YAG lasers and how it depends on the wavelength of the pumping diode, plus comparison with the transmission spectrum of the Nd:YAG crystal.
- Recording of transient response (spiking) of a laser by means of an oscilloscope with the laser diode in pulsed operation.
- Demonstration of transverse modes due to detuning of the resonator.
- Frequency doubling inside the resonator with a KTP (potassium titanyl phosphate) crystal, plus measurement of how conversion efficiency depends on the crystal's temperature and orientation.



Oscilloscope trace: trace of pulses from a passive Q-switched Nd:YAG laser. Pulse duration 25 ns



Transmission of light from a diode through an Nd:YAG crystal as a function of temperature at an injection current of 1.5 A

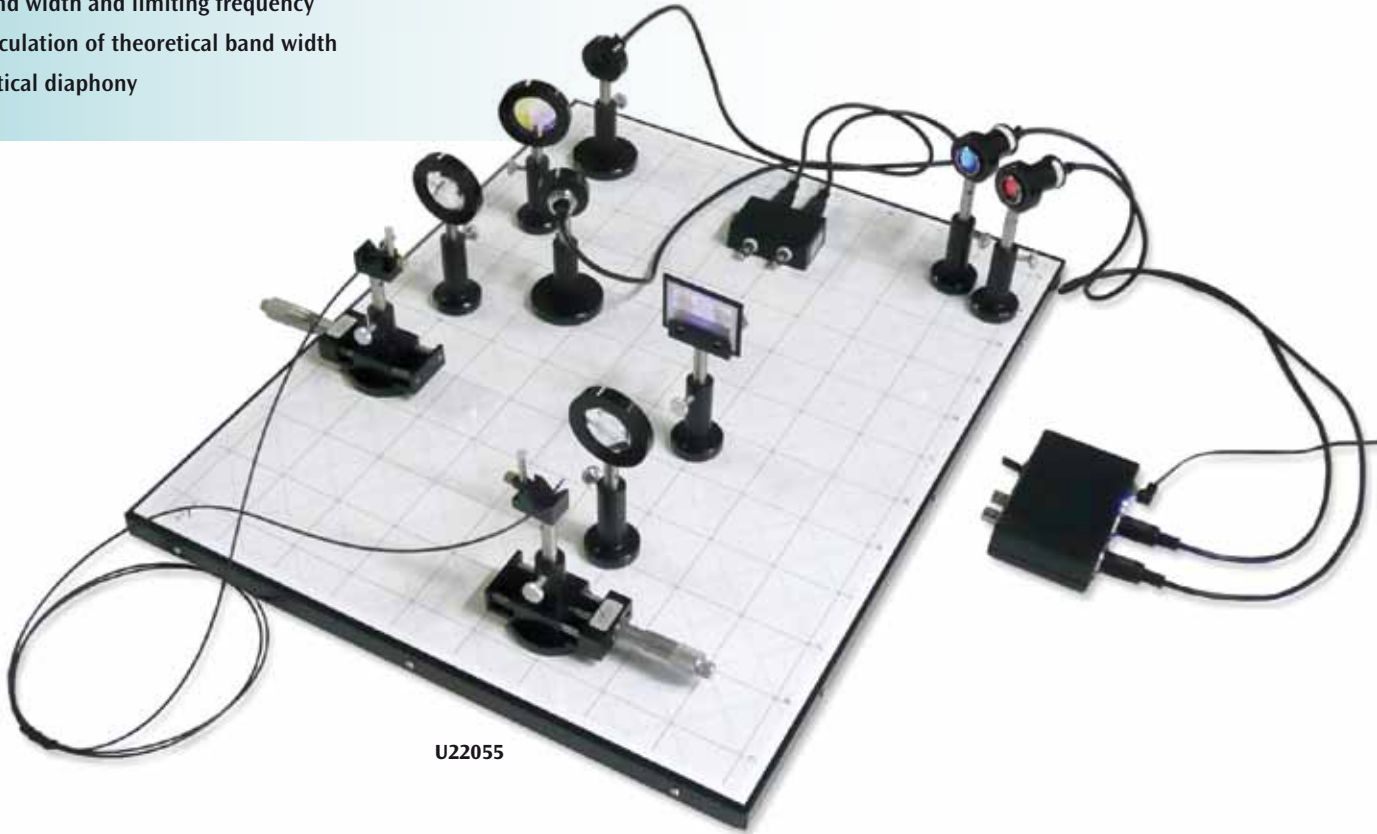


Current-temperature graph at constant wavelength

Art. No.	Exp. 1	Exp. 2	Exp. 3	Exp. 4	Exp. 5
U14021		yes	yes	yes	yes
U140215	yes				
U14022		yes	yes	yes	yes
U14023	yes				
U14024		yes	yes	yes	yes
U14025	yes	yes	yes	yes	yes
U14026					yes
U14027				yes	
U14028			yes	yes	
U14029					yes
U14038	yes	yes	yes		yes
U14039				yes	
U14040	yes	yes	yes	yes	yes
U14041	yes				
U14042	yes				
U14043	yes				
U14044		yes			
U14045		yes			
U14046		yes	yes	yes	
U14047					yes
U14048	yes				
U14049	yes	yes	yes	yes	yes

Experiment topics:

- Glass fibres and optical telecommunications
- Acceptance cone and optimisation of coupling to a fibre optic cable
- Absorption, effect of the length of the transmission line
- Coupling losses
- Diffraction by an optical grating and optical multiplexing.
- Dichroitic filters and optical demultiplexing
- Spectral composition of light sources
- Spectral dispersion and recombination
- Colour and interference filters
- Signal shaping and matching
- Band width and limiting frequency
- Calculation of theoretical band width
- Optical diaphony



U22055

“Optical Telecommunications” Equipment Set

Complete experiment system for quantitative investigation of transmission of signals via optical media, plus the processes of optical multiplexing and demultiplexing. To build a two-dimensional optical system of high precision, a magnetic bench with a printed grid is provided, upon which it is possible to write.

Optical bench:

Available surface:	600x480 mm ²
Grid radials:	0°, 45°, 90°, 135°
Grid subdivisions:	5 cm, 1 cm
Weight:	6 kg approx.

Contents:

- 1 Optical bench, 600x480 mm, for attachment of magnetic components
- 8 Optical riders with magnetic base
- 2 Movable riders, $l = 25$ mm, with magnetic base
- 1 LED with collimating lens, in frame on stem, red
- 1 LED with collimating lens, in frame on stem, blue
- 1 Electronic signal transmitter, including power supply
- 1 Electronic signal receiver, including power supply
- 2 Phototransistors in housing on stem
- 1 Fibre-optic cable with SMA plugs, 1 m
- 1 Diffraction grating, 600 lines/mm
- 1 Dichroitic filter in housing on stem, blue
- 1 Dichroitic filter in housing on stem, yellow

- 2 Converging lenses in housing on stem, $f = 50$ mm, 40 mm diam.
- 1 Slide holder for gratings, on stem
- Component holders and spring clips

U22055

Additionally recommended:

- U22056 “Spectrometry” Supplementary Set**
- U22065 Two-Channel Function Generator, 20 MHz**
- U22060 Digital Oscilloscope 4x60 MHz**

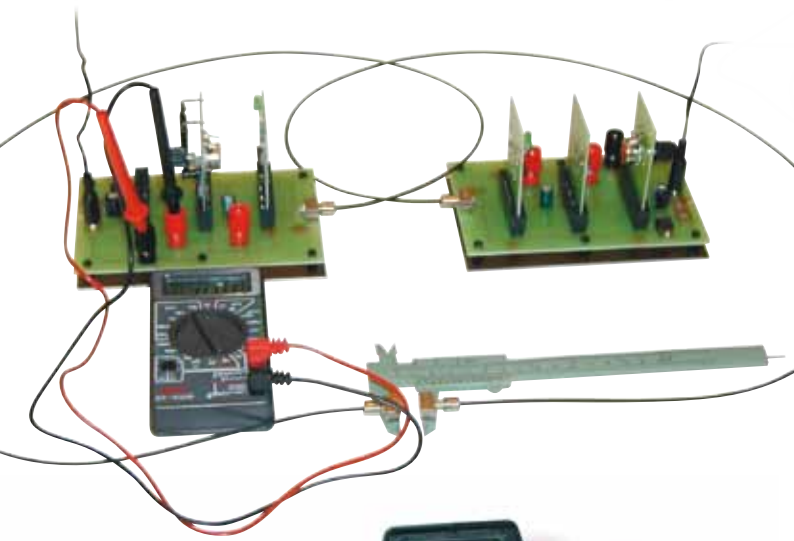
“Spectrometry” Supplementary Set (not shown)

Supplement to the “Optical telecommunications” equipment set for investigating spectrometry of transmitted signals and measurement of absorption losses.

Contents:

- 1 Spectrometer with SMA connectors
- 1 Reference light source with SMA connectors
- 5 Fibre optic cables with SMA plugs, 2 m
- 1 Fibre optic cable with SMA plugs, 10 m
- 5 SMA/SMA connectors

U22056



Experiment Topics:

- Tyndall's light guide experiment
- Attenuation in curved optical waveguides
- Attenuation in liquids
- Attenuation at optical transitions
- Setup for force measurement
- Setup of light barrier
- Setup for proximity sensor
- Transmission of audio signals
- Data transmission between two computers



U17304

Equipment Set for Waveguide Optics

Complete modular experiment set for examining optical waveguide phenomena and their applications. Consisting of one base PCB for use as a transmitting and receiving module, one analogue transmitting and receiving unit, one digital transmitting and receiving unit, one microphone amplifier and low-frequency generator, one low-frequency amplifier with integrated loudspeaker, RS232 interface for transmitter and receiver, one digital multimeter, sheathed and unsheathed optical fibres of different lengths and all connecting cables. Including universal plug-in power supplies and storage case.

Wall power supply units: 100 – 240 V AC (primary)
9 V DC (secondary)

U17304

Additionally recommended:

U11175 Analogue Oscilloscope

U11257 High-Frequency Patch Cord, BNC / 4-mm Plug

Equipment Set for Laser Communication

Experiment system for transmitting audio and video signals with a laser beam. Consisting of power supply for laser diode with variable output power and with audio and video input for modulation of laser beam, receiver unit with integrated amplifier and connectors (CINCH) for loudspeakers and TV set, microphone and loudspeaker. Audio signals are frequency modulated and video signals amplitude modulated. For transmitting video signals, any PAL or NTSC video camera (refer to p. 272) can be connected (not included in scope of delivery). Including universal plug-in power supplies and storage case.

Laser diode: Laser protection class II
Wavelength: 635 nm
Laser power: 0.2 – 1mW continuously variable
Plug-in power supply: 100 – 240 V AC 50/60 Hz (primary),
12 V DC (secondary)

U17305



U17305



Light Speed Meter

Equipment set for determining the speed of light thanks to electronic run-time measurement. Comprises a compact housing containing a transmitter emitting short LED pulses, a photo receiver and a calibrated, oscillating quartz generator producing chronologically precise square-wave pulses. Emitted light pulses are returned by an internal reflector and by a triple-prism reflector placed a long distance from the light source. The returning light signals are then superimposed on the original signal. A dual-channel oscilloscope is used to measure the time difference between the two signals. The speed of light can be calculated from this difference and the distance to the triple-prism reflector. The triple-prism reflector can be installed by eye without the need for complex adjustments

Contents:

- 1 Control unit with a transmitter, receiver and integrated power supply unit
- 1 Fresnel lense on shaft
- 1 Triple-prism reflector on shaft
- 3 HF cables, 1 m

Light Speed Meter (230 V, 50/60 Hz)

U8476460-230

Light Speed Meter (115 V, 50/60 Hz)

U8476460-115

Additionally required:

- U11177 Oscilloscope, 150 MHz
- Optical Bench
- Optical Rider (2x)
- Stand Equipment



U8476460-230
U8476460-115



Funhouse Mirror

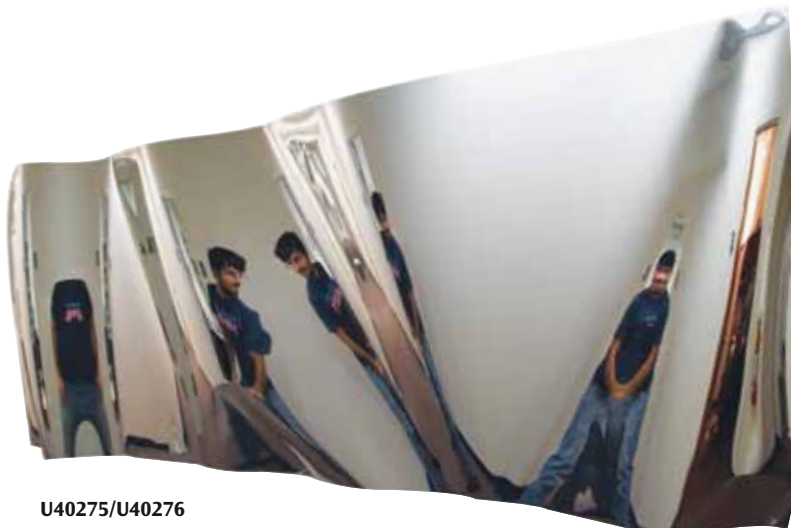
The Funhouse Mirror is a high grade polyester sheet with vacuum deposited silver metal surface. The mirror is 0.8 mm thick; it will not tear but can be cut with normal scissors. Keep out of sunlight as it can focus light and heat to start fires. Comes rolled into 4 cm tube, will unroll flat. This is a great way to teach concave and convex mirrors and real and virtual images. Many applications, use your imagination!

Funhouse Mirror 135x210 cm²

U40275

Funhouse Mirror 60x130 cm²

U40276



U40275/U40276

Experiment Topics:

- Adaptation (accommodation) of the eye's lens
- Short-sightedness
- Long-sightedness
- Presbyopia
- Correction by means of spectacles



W16003

Functional Model of the Eye

Model for demonstrating the functions of the human eye, including inverted display of images on the retina. The curvature of the silicone lens can be changed by means of water pressure in order to demonstrate the process of accommodation. A holder serves to position corrective glass lenses in front of the eye's lens. The set is mounted on a wooden base and includes an optical object, glass lenses (-0.5 D, +1.0 D) and English operating instructions.

Dimensions: approx. 320x180 mm²
 Weight: approx. 1.5 kg

W16003

6-Piece Model of a Human Eye

Model of a human eye enlarged to 3 to 1 scale. Features sclera (white of the eye) and cornea plus muscle attachments, which can be separated into two halves, plus choroid with retina and iris, which is also separable into two, as well as a lens and a glass body. Mounted on base.

Dimensions: 90x90x150 mm³ approx.
 Weight: 100 g approx.

F15



F15



U29616

U29617

Set of 8 Fibre Optic Cables

Set of 8 fibre optic cables, 70 cm long and 2 mm in diameter.

Fibre Optic Cables, Plain

U29616

Fibre Optic Cables, Sheathed

U29617

Magnifying Glass on Stem

All-purpose magnifying glass with lens in plastic setting and handle.

Magnification: 3.5x
 Diameter of lens: 50 mm
 Dimensions: 140x60x12 mm³

W11604

Ergonomic Magnifying Glass on Stem

All-purpose magnifying glass with two lenses in plastic setting and ergonomically shaped handle.

Magnification: 3.5x and 10x
 Diameter of lens: 75 mm and 15 mm

Dimensions: 135x90x12 mm³

W11605

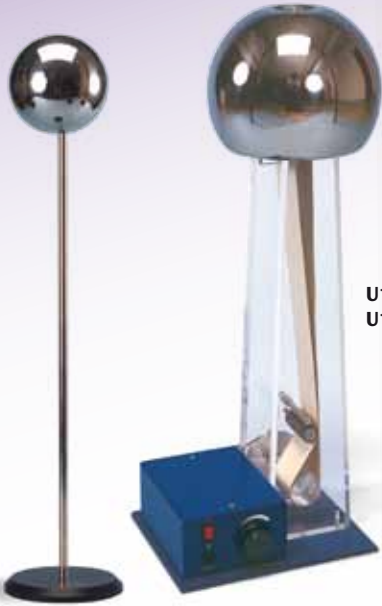


W11604



W11605

BEST SELLER



U15300-230
U15300-115

Van de Graaff Generator

Generator for the generation of DC potentials with low current for multiple experiments in electrostatics. Detachable conductor sphere, drive motor with controllable speed, including small discharge sphere on rod.

- Voltage: up to approx. 100 kV
- Length of sparks: up to 5 cm
- Conductor sphere: 190 mm diam.
- Sphere on rod: 460 mm, diam. 90 mm
- Dimensions: approx. 240x190x620 mm³

Van de Graaff Generator (230 V, 50/60 Hz)

U15300-230

Van de Graaff Generator (115 V, 50/60 Hz)

U15300-115



U15310

Wimshurst Machine

Historical experiment set-up for the generation of safe, high DC potentials for numerous experiments in the area of electrostatics. Hand crank operation and belt drive, adjustable spark gap, two high-voltage capacitors (Leyden jars).

- Diameter: 310 mm
- Spark gap: max. 120 mm
- Dimensions: approx. 360x250x400 mm³
- Weight: approx. 3.4 kg

U15310

Rubber Belt for Van de Graaff Generator (not shown)

Spare rubber belt for Van de Graaff generator (U15300-230 resp. U15300-115).

- Length: 930 mm
- Width: 50 mm

U15301

Electrostatic Equipment Set

Using this equipment many historical experiments can be performed to investigate electrostatic phenomena. The components are equipped with 4 mm connector pins thus providing for rapid and easy interchangeability of assembly on an insulated stand. Connection chains are included for connection to the charge source, but experiment cables with 4 mm plugs can also be used. We recommend that the Wimshurst machine (U15310) be used as a charge source in these experiments.

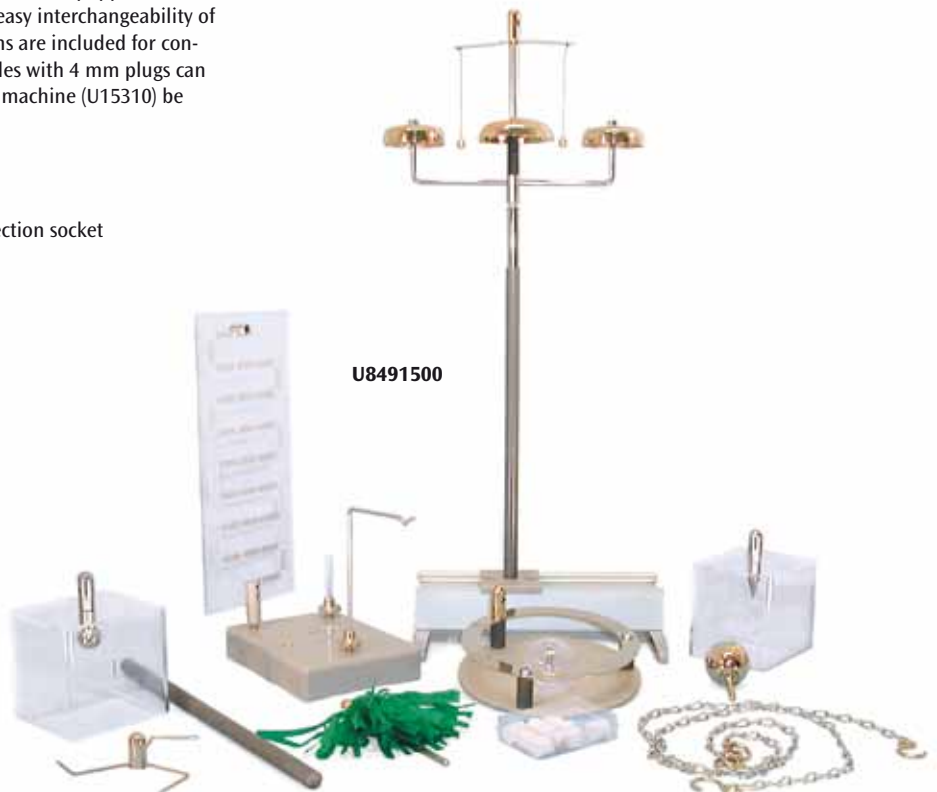
Contents:

- 1 Standbase
- 1 Stand rod, insulated, with retaining and connection socket
- 1 Conductor sphere 30 mm diam., with pin
- 1 Rolling sphere race
- 1 Elder-pith double pendulum with hook stand
- 10 Pieces of elder-pith (in box)
- 1 Box with spherical electrode
- 1 Box with pointed electrode
- 1 Triskelion wheel on needle bearing
- 1 Bundle of tissue paper strips on rod
- 1 Luminous pane
- 1 Chimes with bells
- 1 Friction rod, plastic, with 4 mm socket
- 2 Connection chains
- 1 Experiment instructions

U8491500

Additionally required:

U15310 Wimshurst Machine



U8491500



U17250

Electroscope

Pointer instrument for the detection of electrical charges and voltages. Shielding ring with 4 mm earthing sleeve. Suitable for shadow projection. Includes sphere, capacitor plate on 4 mm plug and capacitor plate on insulating rod.

Diameter: approx. 130 mm

U17250



U8532131

Kolbe's Electroscope

Pointer instrument for the detection of electrical charges and voltages with high sensitivity. Metal housing with 4 mm earthing sleeve, glass front and rear, needle with pivot bearing, scale, suitable for shadow projection. Includes capacitor plate on 4 mm plug.

Measuring range: 0 – 6 kV

Dimensions: approx. 170x110x190 mm³

U8532131

NEW



U8490210

Piezoelectric Charge Source

Hand-held unit used for the simple generation of safe voltages needed in electrostatic experiments. Featuring the functional principle of a piezoelectric gas lighter. With shortened earthing sleeve and 4 mm cable plug. The colour may deviate from the colour in the image.

Voltage: ±4,5 kV

Dimensions: approx. 250x25x33 mm³

Weight: approx. 130 g

U8490210

Electroscope S

Inexpensive instrument with dial for demonstrating electrical charge and voltage potential. Designed in the form of a stand base, frame, aluminium rod with magnet holder and electroscope unit.

Dimensions: 280x80x280 mm³ approx.

Weight: 500 g approx.

1009964



1009964



1009962

Charge Indicator

Display instrument for showing electric charge and its sign, whereby either a blue or a red LED lights up in the presence of charge. Includes two 1.5-V batteries (AA).

Dimensions: 62x67x20 mm³ approx.

Weight: 85 g approx.

1009962

NEW



1009963

Charge Storage Device with Piezo Charger

Storage device for electric charge generated by a piezo charger. The stored charge can be transferred from place to place using a so-called "charge-spoon", for example.

Capacitance: 2x 1 nF

Dimensions of storage device:

62x67x50 mm³ approx.

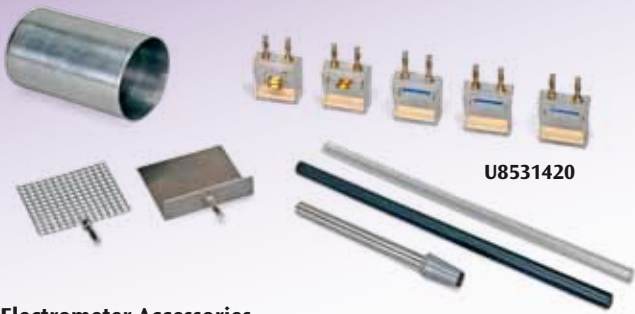
Dimensions of charger: 230x35x40 mm³ approx.

Total weight: 85 g approx.

1009963

Additionally recommended:
U11051 Charge Spoon, Small

NEW



U8531420

Electrometer Accessories

Set of accessories for carrying out basic experiments on electrostatics, electricity and the photoelectric effect in combination with an electrometer (U8531408-230 resp. U8531408-115) and 450-V DC power supply (U8521400-230 resp. U8521400-115).

Contents:

- 1 Faraday cup
- 1 Pair of friction rods
- 1 Metal rod with 4 mm drilled hole
- 1 Safety adapter socket
- 1 SK plug-in capacitor 1 nF
- 1 SK plug-in capacitor 10 nF
- 1 SK plug-in resistor 100 MΩ
- 1 SK plug-in resistor 1 GΩ
- 1 SK plug-in resistor 10 GΩ
- 1 Zinc electrode
- 1 Grid electrode

U8531420

Conducting Spheres with 4 mm Plugs

Conducting spheres for electrostatics experiments, e.g. for determining the capacity of a sphere or for experiments on the influence of nearby objects.

Conducting Sphere, diam. = 85 mm, with 4 mm Plug

U8492350

Conducting Sphere, diam. = 30 mm, with 4 mm Plug

U8532126

Additionally recommended:
U11055 Drilled Rod



U8492350

U8532126

Faraday Cup

Faraday pail with 4 mm plug, e.g. for mounting on an electroscope (U17250 or U8532131) or electrometer amplifier (U8531408-230 resp. U8531408-115).
Dimensions: 115 mm x 70 mm diam. approx.

U8496460



U8496460

Friction Rods

Two rods for experiments on frictional electricity, made of PVC and acrylic.

Length: approx. 250 mm
Diameter: approx. 10 mm

U11053

Charge Spoon

Metal plate on insulating rod for charge transport and for experiments on electrostatic induction.

Art. No.	Designation	Length	Plate	Rod
U11051	Charge Spoon, small	205 mm	40x35 mm ²	10 mm diam.
U11052	Charge Spoon, large	265 mm	40x70 mm ²	10 mm diam.

Experiment Topics:

- Measurement of charge and voltage in electrostatics
- Measurement of charge and voltage for a plate capacitor
- Ionisation of air by burning gases or α radiation
- Hallwachs effect (external photoelectric effect)



U8531408-230
U8531408-115

Electrometer

Impedance converter with high-resistance input for measuring extremely small charges and currents. The input signal is converted into a proportional voltage, which can then be measured with an external voltmeter. During the measurement the potentials of the electrometer and the experimenter must be matched by using a metal rod connected to earth. Includes a 12-V AC plug-in power supply.

- Electrometer gain factor: 1,00
- Input resistance: >10¹² Ω
- Output resistance: <1 kΩ
- Input current: <10 pA
- Input capacitance: <50 pF
- Max. output voltage: ±8 V
- Resistance to excess voltage: 1 kV (from low-resistance sources)
10 kV (from high-resistance sources)
- Supply voltage: 12 V AC
- Dimensions: 110x170x30 mm³ approx.
- Weight: 1 kg approx.

Electrometer (230 V, 50/60 Hz) or U8531408-230

Electrometer (115 V, 50/60 Hz) U8531408-115

Additionally recommended:
U8531420 Electrometer Accessories
U17450 Analogue Multimeter AM50

U8521400-230 DC Power Supply 450 V (230 V, 50/60 Hz) or
U8521400-115 DC Power Supply 450 V (115 V, 50/60 Hz)



U11053

U11052

U11051



U8492310

U8611200



U8492320

U8611200



U8492330

U8611200

Pair of Capacitor Plates

Pair of capacitor plates consisting of light metal castings with electrically isolated handling rod and 4 mm socket connector for constructing a capacitor. The distance between the plates is determined by the plexiglas spacers that are provided.

Pair of Capacitor Plates 500 cm²

U8492310

Pair of Capacitor Plates 250 cm²

U8492320

Pair of Capacitor Plates 125 cm²

U8492330

Additionally required:

U8611200 Barrel Foot, 0.9 kg

Additionally recommended:

U8492341 Plastic Dielectric Plate

U8476371 Plexiglas Dielectric Plate

Dielectric Plates

Dielectric plates for experiments with plate capacitors.

Plastic Dielectric Plate

Dimensions: 300x300x2 mm³ approx.

U8492341

Plexiglas Dielectric Plate

Dimensions: 300x300x2 mm³ approx.

U8476371



U8492341

U8476371

Plate Capacitor S

Plate capacitor used to investigate the relationship between charge, voltage and capacitance, as well as determining the dielectric and electric field constants. It consists of a fixed and a movable plate on a guide rail. A centimeter scale is used to read the plate spacing. The device comes with four dielectric sample plates made of acrylic, bakelite, plywood and cardboard.

Plate spacing: 0 – 150 mm

Plate diameter: approx. 149 mm

Plate area: 175 cm²

Connection: via 4 mm safety jacks

U30040

U30040



Plate Capacitor D

Plate capacitor used to investigate the relationship between electric charge and voltage, quantify capacitance as a function of plate spacing, measure the dielectric constant ϵ and precisely determine the electric field constant ϵ_0 . Plate separation can be finely adjusted and read off from a display to an accuracy of 1/10 mm.

Plate spacing: 0 – 160 mm

Plates can be adjusted between 0 and 20 mm via a spindle

Plates: Solid castings

Plate area: 500 cm²

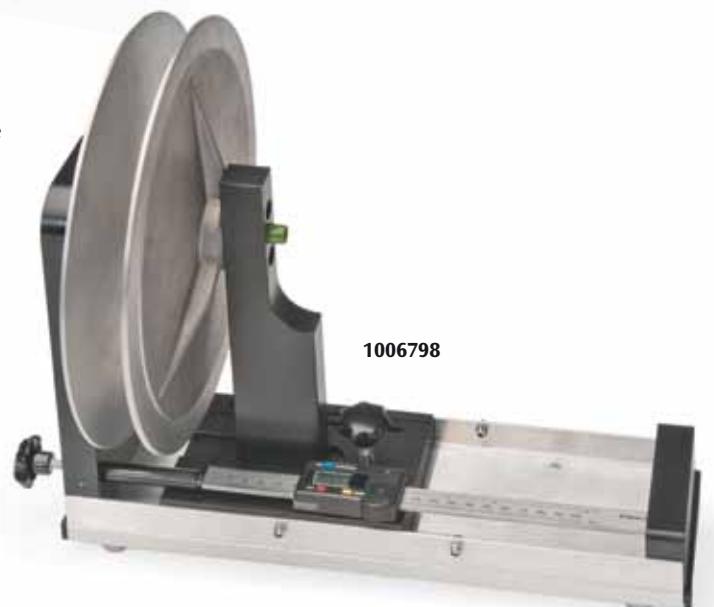
Weight: 4.2 kg approx.

1006798

Additionally recommended:

U8492341 Plastic Dielectric Plate

U8476371 Plexiglas Dielectric Plate



1006798

BEST SELLER

Electrostatics



U8533015-230
U8533015-115

Experiment Topics:

- Introductory experiments on the functioning of the apparatus
- Electrostatic tests
- Measurement of static electric field strength
- Capacitor tests
- Measurements of potential with an electrostatic meter



Electric Field Meter

Instrument for static measurements of electric field strength or electrical potential. A star-shaped modulation vane-wheel connected to earth is mounted a short distance in front of a measurement electrode, also star-shaped. Influenced by the electric field, the charges generate an alternating current proportional to the field strength. This alternating current is measured via a selective amplifier without the electric field experiencing any average energy loss over time. When used in conjunction with voltage measurement plates, the instrument can be used as an electrostatic voltmeter. The device is protected against excess voltage. A standard DC voltmeter can be used for display.

Max. output voltage: 10 V

Measurement ranges: 1 V output can correspond to:

- 100 V/cm, 300 V/cm, 1000 V/cm
- 10 V, 30V, 100 V (with 1x voltage measurement plate)
- 100 V, 300 V, 1000 V (with 10x voltage measurement plate)

Dimensions:

Weight:

- 140x110x70 mm³ approx.
- 1 kg approx.

Contents:

- 1 Electric field meter
- 1 Voltage measurement plate, measuring range 1x
- 1 Voltage measurement plate, measuring range 10x
- 1 Capacitor measurement plate, 250 cm²
- Set of plexiglas spacers

Electric Field Meter (230 V, 50/60 Hz)

U8533015-230

Electric Field Meter (115 V, 50/60 Hz)

U8533015-115

Additionally required:

U17450 Analogue Multimeter AM50

Additionally recommended:

U8496410 Drip Cup with Basin

Electricity and Magnetism



Measuring the electric field of a plate capacitor as a function of the capacitor voltage



U8521400-230
U8521400-115

DC Power Supply, 450 V

Power supply with three outputs for supplying electrical power in experiments using an electrometer (U8531408-230 resp. U8531408-115).

Output 1:

Voltage 0 – 450 V DC
Max. current: 10 μ A

Output 2:

Voltage 1.2 – 12 V DC
Max. current: 100 mA

Output 3:

Voltage 0 – 12 V AC
Max. current: 10 mA

Dimensions: 250x100x160 mm³

Weight: 0.8 kg approx

DC Power Supply, 450 V (230 V, 50/60 Hz)

U8521400-230

DC Power Supply, 450 V (115 V, 50/60 Hz)

U8521400-115

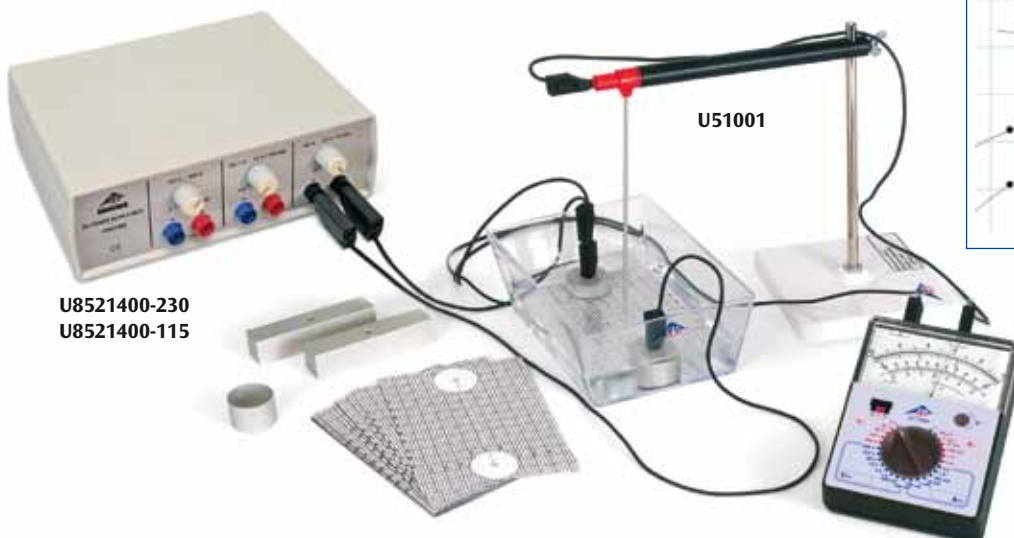
Electrolytic Trough

Equipment set for recording equipotential lines of electric fields. Electrodes of different shapes can be used to measure equipotential lines for a plate capacitor, dipole, induced surface charge and a Faraday beaker. Trough dimensions: 160x105x65 mm³ approx.

Contents:

- 1 Plastic trough
- 1 Stand with measurement electrode
- 2 Bar electrodes
- 2 Round disc electrodes
- 1 Ring electrode
- 20 Sheets of millimetre-grid paper

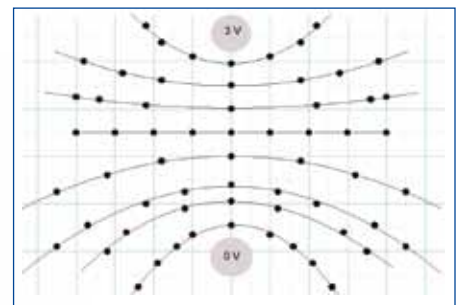
U51001



U8521400-230
U8521400-115

U51001

U17450



Equipotential lines of point charges

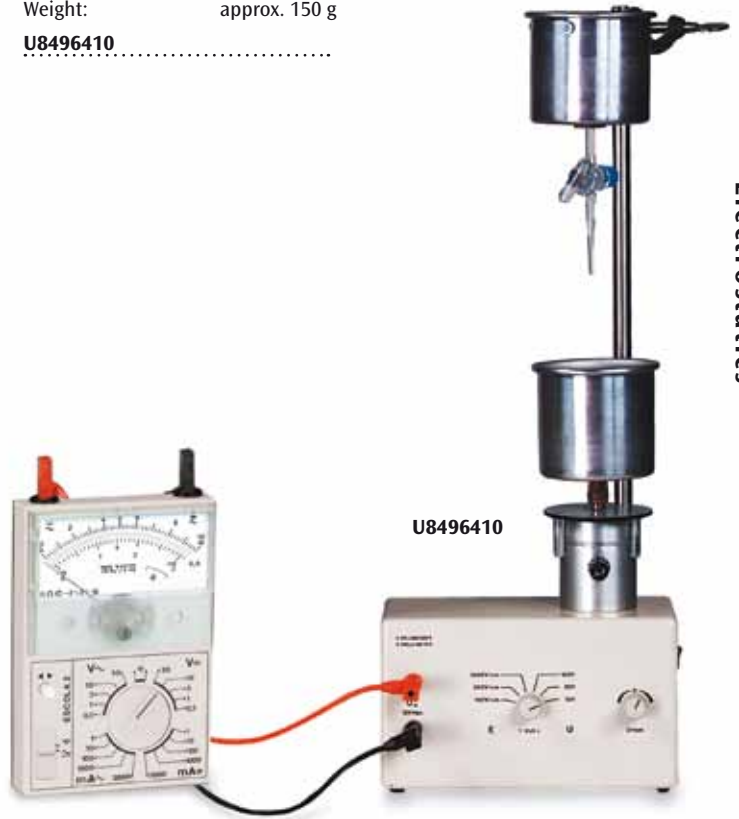
Drip Cup with Basin

Set for experiments involving electrostatic charging of fluids e.g. for charge separation when performing water separation in connection with the E-field meter (U8533015-230 resp. U8533015-115). Drip cup with side mounted holder and glass stopcock for precise regulation of the drip speed. Basin with 4 mm connector plug.

Dimensions: 70 mm x 75 mm diam. approx.

Weight: approx. 150 g

U8496410



U8496410

Additionally required:

U17450 Analogue Multimeter AM50

U8521400-230 DC Power Supply, 450 V (230 V, 50/60 Hz)

or

U8521400-115 DC Power Supply, 450 V (115 V, 50/60 Hz)

Pack of Millimetre Paper Sheets (not shown)

20 sheets of millimetre-grid paper for setting up an electrolytic trough (U51001).

U51015



U8495420 – U8495505



U8495527 – U8495515

Resistance Wires

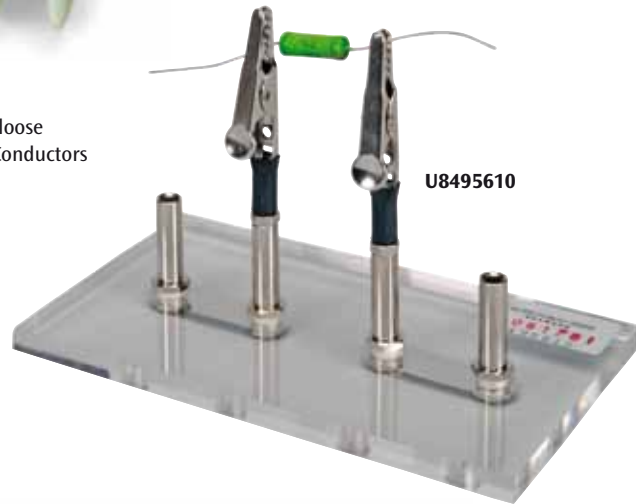
Metal wires on bobbins, e.g. for experiments to investigate how resistance depends on the material, cross-sectional area and length of the wire.

Art. No.	Material	Length	Diameter
U8495420	Copper	100 m	0.3 mm
U8495460	Iron	100 m	0.3 mm
U8495550	Brass	50 m	0.3 mm
U8495490	Nickel	50 m	0.3 mm
U8495505	Chrome-Nickel	100 m	0.3 mm
U8495515	Chrome-Nickel	50 m	0.5 mm
U8495527	Constantan	100 m	0.2 mm
U8495532	Constantan	100 m	0.3 mm
U8495537	Constantan	50 m	0.4 mm
U8495540	Constantan	50 m	0.5 mm

Holder for Components

Holder on an acrylic base with two crocodile clips for connecting loose resistors and other electronic components or samples from the “Conductors and Insulators” set. Sockets for 4 mm safety plugs.

U8495610



U8495610



U8495310

Lamp Socket E10 on Acrylic Base

Lamp socket on transparent acrylic base with screw connection for ordinary commercial filament bulbs for E10 sockets. Sockets for 4 mm safety plugs.

U8495310



U8495320

Lamp Socket E14 on Acrylic Base

Lamp socket on transparent acrylic base with screw connection for ordinary commercial filament bulbs for E14 sockets. Sockets for 4 mm safety plugs.

U8495320



U8495910

Toggle Switch on Acrylic Base

Switch mounted on a transparent acrylic base for the alternate opening and closing of two electric circuits. Sockets for 4 mm safety plugs.

U8495910



U8495930

Momentary Contact Switch on Acrylic Base

Switch mounted on a transparent acrylic base for the momentary closing of circuits. Sockets for 4 mm safety plugs.

U8495930



U8495920

Single-Throw Switch on Acrylic Base

Switch mounted on a transparent acrylic base for the alternate opening and closing of a circuit. Sockets for 4 mm safety plugs.

U8495920

Set of "Conductors and Non-Conductors"

Samples of eight materials for experiments to investigate the electrical conductivities of different materials. In a storage container.

Materials: Iron, aluminium, copper, steel, wood, glass, plastic, cotton
 Sample length: approx. 200 mm
 Weight: approx. 200 g

U8495350

Additionally recommended:
U8495610 Holder for Components



U8495350



U29509



Rod Clamp with Insulator

Clamp for the insulated securing of electrical components with 4mm connectors. A PVC isolator is used to isolate sections from each other. Upper section features two 4 mm cross bore holes and one 6mm hole with clamping screw. Lower section with two 4 mm cross holes.

Total length: approx. 205 mm
 Stem diameter: approx. 10 mm
 Weight: approx. 135 g

U8713100

Set of 10 E10 Lamp Sockets

Set of 10 screw-in sockets for lamps with E10 screw thread. Electrical contact is made via uninsulated wires passing through the connecting eyelets in the base or via crocodile clips.

Base: 28 mm diam.

U29509

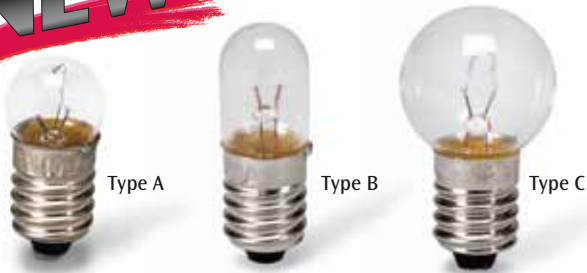
Contact Stand with Terminal Sockets

Connection rod on insulated base with three 4mm cross holes and one axial 4 mm bore hole used to secure components with 4mm connectors or to plug in 4 mm cables. At the top end spring-loaded terminal socket used as a wire clamp.

Height: approx. 130 mm
 Shaft: approx. 105x10 mm²
 Base: approx. 25x70 mm²
 Weight: approx. 210 g

U8497740

NEW



U29512 – U29593

Set of 10 E10 Bulbs

Set of 10 bulbs with E10 screw-in threads. Lamp design A.

Art. No.	Tension	Current
U29514	3.5 V	100 mA
U29515	3.5 V	200 mA
U29589	3.8 V	300 mA
U29590	4 V	40 mA
U29591	6 V	50 mA
U29516	6 V	100 mA
U29517	6 V	350 mA
U29512	12 V	100 mA
U29513	12 V	500 mA

Set of 10 E10 Bulbs, 6 V, 1 A

Set of 10 6 V, 1 A bulbs with E10 screw-in threads. Lamp design C.

U29592

Set of 10 E10 Bulbs, 1.3 V, 60 mA

Set of 10 1.3 V, 60 mA bulbs with E10 screw-in threads. Lamp design B.

U29593



U15321

U15320

U8713100

U8497740

Insulator with Clamp

Metal stem with knurled screw and 4 mm bore hole on acrylic rod, as insulated holder for wires, e.g. when conducting experiments on the optical bench are performed.

Diameter: approx. 10 mm
 Length: approx. 100 mm

U15321

Insulated Slider

Insulated slider for measuring the electrical resistance as a function of the length, cross section and material. The slider is mounted with two insulated contacts as voltage dividers on riders on the optical bench. Acrylic rod with metal stud and 4 mm bore hole.

Diameter: approx. 10 mm
 Length: approx. 100 mm

U15320



U29577



U29579



1012696



U29518



U29530



U29527



U29529



U29510



U29511



U29524

LED on 3B Box

LED in an electrically safe box for assembling simple electric circuits using safety experiment leads. Featuring built-in current limiting resistor and printed circuit symbol.

Maximum voltage: 12 V
Maximum current: 20 mA
Dimensions: 135x85x40 mm³

Red LED on 3B Box

U29577

Green LED on 3B Box (not shown)

U29578

Battery Holder in 3B Box

Battery holder in an electrically safe box for assembling simple electric circuits using safety experiment leads. Printed circuit symbol and battery direction. Batteries not included.

Battery: 4.5 V, 3R12, flat battery
Dimensions: 135x85x40 mm³

U29579

Volta's Pile on 3B Box

Replica of Alessandro Volta's apparatus consisting of series-connected galvanic cells to make up a source of electricity. Zinc and copper plates stacked in alternation on top of each other are separated in each case by a piece of felt soaked in an electrolyte (salt water or acid). The electrolyte makes it possible for electricity to pass between the layers, allowing a voltage to be measured between the plates at the ends.

Connectors: two 4-mm safety sockets
Electrode diameter: 40 mm
Case dimensions: 135x85x40 mm³

U29504

Button on 3B Box

Normally open push-button switch attached to a safe box for building simple electric circuits using safety experiment leads. Printed with a circuit symbol.

Maximum voltage: 12 V
Maximum current: 5 A
Dimensions: 135x85x40 mm³

U29518

Knife-Edge Switch on 3B Box

Knife-edge switch attached to a safe box for building simple electric circuits using safety experiment leads. Printed with a circuit symbol.

Maximum voltage: 12 V
Maximum current: 5 A
Dimensions: 135x85x40 mm³

U29524

Crocodile Clips on 3B Box

Pair of crocodile clips for connecting loose resistors and other electronic components or samples from the "Conductors and Non-Conductors" set. Attached to a safe box for building simple electric circuits using safety experiment leads. Printed with a circuit symbol.

Maximum voltage: 12 V
Maximum current: 2 A
Dimensions: 135x85x40 mm³

U29527

Additionally recommended:

Steel wool

U8495350 "Conductors and Non-Conductors" Set

Diode in 3B Box

1N4002 semiconductor in an electrically safe box for assembling simple electric circuits using safety experiment leads. Featuring printed circuit symbol.

Maximum voltage: 12 V
Maximum current: 1 mA
Dimensions: 135x85x40 mm³

U29529

ELV Motor on 3B Box

Low-voltage motor with pulley for simple experiments on mechanical and electrical energy. The relationship between current direction and direction of rotation is immediately obvious. Built onto an electrically safe box for assembling simple electric circuits using safety experiment leads. Printed circuit symbol.

Voltage: 4 – 6 V DC
Box dimensions: 135x85x40 mm³

U29530

E10 Lamp Socket on 3B Box

E10 lamp socket attached to a safe box for building simple electric circuits using safety experiment leads. Printed with a circuit symbol and supplied with 5 E10 bulbs.

Maximum voltage: 12 V
Maximum current: 2 A
Dimensions: 135x85x40 mm³

U29510

Switch on 3B-Box

Switch attached to a safe box for building simple electric circuits using safety experiment leads. Printed with a circuit symbol.

Maximum voltage: 12 V
Maximum current: 2 A
Dimensions: 135x85x40 mm³

U29511



Coil with 600 Windings on 3B-Box

600-winding coil without core attached to a safe box and featuring safety sockets. For experiments on induction, a bar magnet can be passed through the coil.

Dimensions: 135x85x40 mm³

1011346

Additionally recommended:

U11170 Zero-Point Galvanometer, CA 403

U20550 Bar Magnet

Fuse Holder on 3B Box

Fuse holder attached to a safe box for building simple electric circuits using safety experiment leads. Printed with a circuit symbol.

Fuses: 20 mm x 5 mm diam.

Maximum voltage: 12 V

Maximum current: 5 A

Dimensions: 135x85x40 mm³

U29526

Change-Over Switch (SPDT) on 3B Box

Single-pole double-throw change-over switch attached to a safe box for building simple electric circuits using safety experiment leads. Printed with a circuit symbol.

Maximum voltage: 12 V

Maximum current: 5 A

Dimensions: 135x85x40 mm³

1012694

Universal Holder on 3B Box

Universal holder for two-pole components (resistors, capacitors, diodes, LEDs) attached to a safe box for building simple electric circuits using safety experiment leads. Printed with a circuit symbol.

Dimensions: 135x85x40 mm³

U29528

LED Graetz Bridge in 3B Box

Bridge rectifier circuit consisting of four LEDs connected in Graetz configuration. Inside a safe box for building simple electric circuits using safety experiment leads. Printed with circuit symbols.

Maximum voltage: 12 V

Maximum current: 20 mA

Dimensions: 135x85x40 mm³

1012696

Graetz Bridge in 3B Box

Bridge rectifier circuit consisting of four semiconductor diodes connected in Graetz configuration. Inside a safe box for building simple electric circuits using safety experiment leads. Printed with circuit symbols.

Maximum voltage: 12 V

Maximum current: 20 mA

Dimensions: 135x85x40 mm³

1012695

Current Direction Indicator in 3B Box

Circuit comprised of two LEDs for indicating the direction of current. Inside a safe box with sockets for safety experiment leads. Printed with circuit symbols.

Maximum voltage: 12 V

Maximum current: 20 mA

Dimensions: 135x85x40 mm³

1012697

Ohm's Law Apparatus in 3B Box

Classic set-up for verifying Ohm's law for a two-pole resistor. Inside a safe box with sockets for safety experiment leads. Printed with circuit symbols.

Maximum voltage: 12 V

Maximum current: 2 A

Dimensions: 135x85x40 mm³

1012698

Unknown Resistors in 3B Box

Four unknown resistors which can be connected separately in two series circuits. Inside a safe box with sockets for safety experiment leads. Printed with circuit symbols.

Maximum voltage: 12 V

Maximum current: 200 mA

Dimensions: 135x85x40 mm³

1012699

NEW

NEW



U8551002

Resistance Bridge

Resistance Bridge used to measure resistances in bridge circuits and investigate voltage drops across wires. The device is only suitable for low voltages. It consists of a rail with a scale mounted at two points and a resistance wire stretched between two connecting sockets. A sliding contact on the resistance wire is used to set the resistance of the resultant two wire sections. A Wheatstone bridge circuit is configured to determine unknown resistances.

- Dimensions: approx. 1300x100x90 mm³
- Rail: approx. 30x30 mm²
- Scale: 0 – 1000 mm
- Scale divisions: mm
- Resistance wire: 1 m, 0.5 mm diam.
- Material: NiCr
- Resistance: 5.3 Ω
- Connection: 4 mm safety jacks
- Maximum permissible voltage: 8 V
- Maximum permissible current: 1.5 A

U8551002

Additionally recommended:

- U11170 Zero Galvanometer CA 403**
- U11180 Resistance Decade 1 Ω**
- U11181 Resistance Decade 10 Ω**
- U11182 Resistance Decade 100 Ω**
- U51004 High-Precision Resistor 1 Ω**
- U51005 High-Precision Resistor 10 Ω**
- U117601-230 AC/DC Power Supply Unit 0 – 12 V, 3 A (230 V, 50/60 Hz)**
- or
- U117601-115 AC/DC Power Supply Unit 0 – 12 V, 3 A (115 V, 50/60 Hz)**

Electrical Circuits

NEW



1000689

Capacitor 2200 µF

Capacitor in plastic housing with 4mm safety plugs.
 Capacitance: 2200 µF
 Tolerance: 20%
 Max. permissible voltage: 40 V
 Dimensions: approx. 122x70x50 mm³

1000689



U51005

High Precision Resistors

High precision resistors in plastic housing with 4 mm safety plugs.
 Dimensions: approx. 122x70x50 mm³

Art. No.	Resistance	Tolerance	Load rating
U51004	1 Ω	1%	4 W
U51005	10 Ω	1%	4 W
U51006	100 Ω	1%	4 W
U51007	1 kΩ	1%	4 W
U51008	10 kΩ	1%	4 W
U51009	100 kΩ	1%	1 W
U51013	300 kΩ	5%	1 W
U51010	1 MΩ	1%	1 W
U51011	10 MΩ	1%	1 W

Electricity and Magnetism

Resistance Apparatus

Apparatus to investigate the dependency of electrical resistance on conductor length, conductor cross-section and material. Six wires are laid out side by side on a metal base and both ends connect to 4 mm sockets.

- Wire specimens: Constantan 1.0 mm diam.,
Constantan 0.7 mm diam. (2x),
Constantan 0.5 mm diam.,
Constantan 0.35 mm diam.,
Brass 0.5 mm diam.
- Wire lengths: 1000 mm
- Dimensions: approx. 1085x120x50 mm³
- Weight: approx. 1.35 kg

1009949

NEW





U11185

Resistance Decade, 1 Ω – 10 k Ω

Four resistance decades in a single housing, can be used individually or in combination, e.g. for setting up a Wheatstone bridge. Can be set using control knob, with decade scale.

Output: via 4 mm safety sockets
 Max. current: 700 mA (1 Ω – 10 Ω),
 200 mA (10 Ω – 100 Ω),
 70 mA (100 Ω – 1 kΩ),
 20 mA (1 kΩ – 10 kΩ)

Accuracy: 1%
 Dimensions: approx. 310x90x80 mm³
 Weight: approx. 1 kg

U11185



U17350 – U17357

Rheostats

Slide-contact resistors of high current-bearing capacity in housings that are safe to touch, for experiments with safety low voltage circuits, to be used as continuously variable resistors or voltage dividers. With built-in earth sockets.

Resistance tolerance: 10% from nominal value
 Max. permissible power: 320 W (continuous operation),
 640 W (max. 15min)

Max. permissible voltage: 600 V
 Terminals: 4 mm safety sockets
 Dimensions: approx. 446x93x150 mm³
 Weight: approx. 2.85 kg to 3.25 kg

Art. No.	Resistance	Max. current rating (continuous)	Max. current rating (15 min)
U17350	1 Ω	18 A	25 A
U17351	3.3 Ω	10 A	12 A
U17352	10 Ω	5.7 A	12 A
U17353	33 Ω	3.1 A	4.4 A
U17354	100 Ω	1.8 A	2.5 A
U17355	330 Ω	1 A	1.4 A
U17356	1000 Ω	0.57 A	0.8 A
U17357	3300 Ω	0.31 A	0.44 A



U11190 – U11191

Capacitance Decades

Capacitance decades which can be mechanically connected to one another. With colour-coded safety sockets and control knob for setting capacitances in 10 steps. Includes 25 cm safety patch cord.

Nominal voltage: 350 V DC
 Connections: 4 mm safety sockets

Dimensions: approx. 72x72x90 mm³
 Weight: approx. 220 g

Art. No.	Measurement range	Step size	Accuracy
U11190	0.01 μF – 0,1 μF	0.01 μF	2%
U11191	0.1 μF – 1 μF	0.1 μF	2%

Resistance Decades

Resistance decades which can be mechanically connected to one another, e.g. in order to assemble a Wheatstone bridge. With colour-coded safety sockets and control knob for setting measurement resistances in 10 steps. Includes 25 cm safety patch cord.

Connections: 4 mm safety sockets
 Dimensions: approx. 72x72x90 mm³
 Weight: approx. 220 g

Art. No.	Measurement range	Step size	Max. current	Accuracy
U11180	0.1 Ω – 1 Ω	0.1 Ω	1 A	1% ±5 mΩ
U11181	1 Ω – 10 Ω	1 Ω	750 mA	1% ±5 mΩ
U11182	10 Ω – 100 Ω	10 Ω	250 mA	0.5%
U11183	100 Ω – 1 kΩ	100 Ω	75 mA	0.5%
U11184	1 kΩ – 10 kΩ	1 kΩ	25 mA	0.5%



U11180 – U11184



Assembly Kit “Bell, Relay and Bimetallic Switch”

Equipment kit comprising materials to assemble electromagnetic switches and bimetallic switches.

Base plate: approx. 200x140x40 mm³
 Weight: approx. 1.6 kg

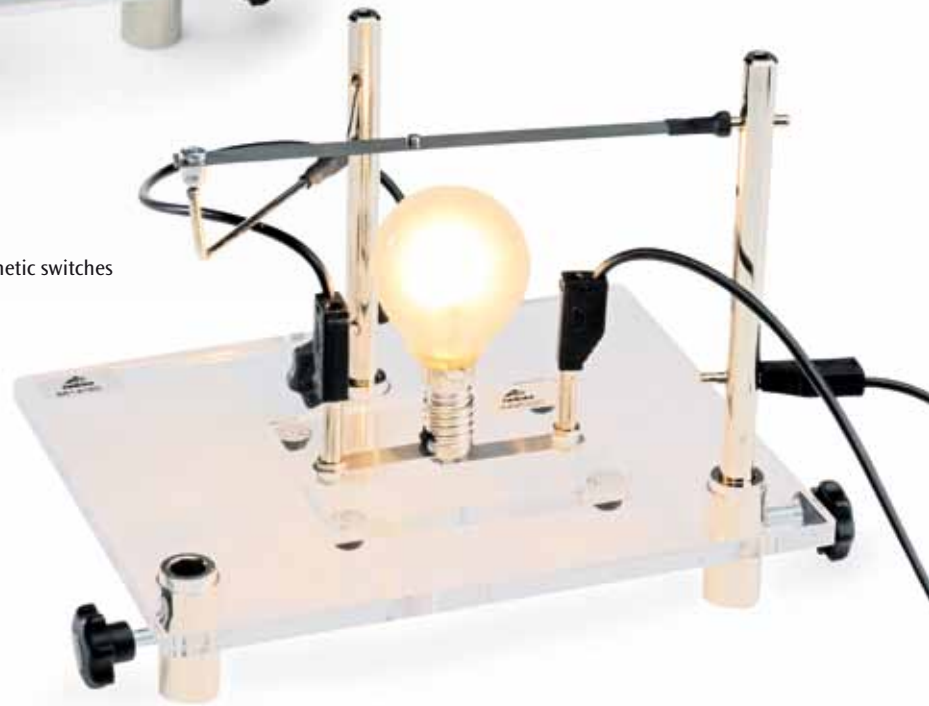
Contents:

- 1 Stand plate with 3 clamps
- 1 Bell, 70 mm in diameter
- 2 Contact rods with three 4 mm cross holes
- 1 Leaf spring with connector
- 1 Bimetallic strip with connector
- 1 Armature with connector
- 1 Contact pin with connector
- 1 U-core, 20x20 mm²
- 1 Coil, 800 turns

U8497700

Additionally required:

- Bulb, 12 V, 25 W, Type E14**, to replace blown components
- U8495320 Lamp Socket E14**
- U33300-230 Transformer with Rectifier (230 V, 50/60 Hz)**
- or
- U33300-115 Transformer with Rectifier (115 V, 50/60 Hz)**



Inductance Decade

Variable inductance decade in impact-resistant plastic housing. This series incorporates mechanically stable components, a slide switch for setting measurement ranges and coloured 4 mm sockets with clips for connecting wires.

Measuring range: 10 μ H – 111.1 mH
 Increment: 10 μ H
 Accuracy: 5%
 Number of decades: 4
 Limiting values: max. 1 V / 10 mA
 Dimensions: approx. 147x117x33 mm³
 Weight: approx. 310 g

U11820

Capacitance Decade

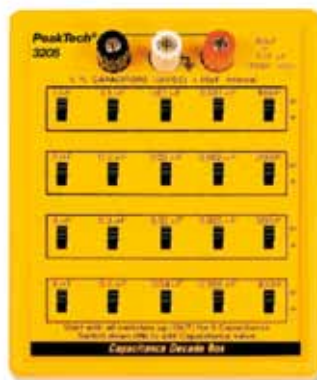
Capacitance decade in impact-resistant plastic housing. This series incorporates mechanically stable components, a slide switch for setting measurement ranges and coloured, 4mm sockets with clips for connecting wires.

Measuring range: 100 pF – 11.111 μ F
 Increment: 100 pF
 Accuracy: 5%
 Number of decades: 5
 Limiting values: max. 50 V DC
 Dimensions: approx. 147x117x33 mm³
 Weight: approx. 310 g

U11821



U11820



U11821

Experiment Topics:

- Ohm's law
- Parallel resistor circuits
- Series resistor circuits
- Unknown resistance
- Potentiometers
- Voltage dividers with no load
- Voltage dividers with load
- Discharge of a capacitor
- Bridge rectifiers
- Half-wave rectifiers
- Characteristic curve for a lamp
- Characteristic curve for an LED
- Characteristic curve for a silicon diode
- Characteristic curve for a zener diode
- LC parallel resonant circuit
- LC series resonant circuit
- RLC series resonant circuit

Basic Experiment Board

Experiment board with basic circuits for electricity and electronics: circuit components, Ohm's law, Kirchhoff's laws, rheostat and potentiometer circuits, two way switching, charging and discharging curves of a capacitor, inductive effects in DC and AC circuits. Simple semiconductor circuits for determining diode characteristics, rectifier circuits, filter factors.

The board contains:

- 13 0.5 W resistors ranging from 100 Ω – 100 k Ω
- 1 Potentiometer, 1 k Ω
- 3 Filament lamps, 12 V
- 2 Slide switches
- 5 Capacitors (2x 2.2 μ F, 1x 100 μ F [bipolar], 1x 1000 μ F)
- 5 1 A rectifier diodes
- 1 Zener diode
- 1 Red light emitting diode
- 1 Neon fluorescent light
- 1 Transformer, 12 V

The components can be interconnected via 2 mm sockets using jumpers and experiment leads. Six 2 mm/4 mm safety socket adapters are provided for connecting 4 mm experiment leads. Includes 10 jumpers and 10 leads (5 red and 5 blue) with 2 mm plugs, 20 cm long, plus 8 V AC/500 mA mains power supply.

Dimensions: approx. 233x160 mm²

Basic Experiment Board (230 V, 50/60 Hz)

U11380-230

Basic Experiment Board (115 V, 50/60 Hz)

U11380-115

Additionally recommended:

U17450 Analogue Multimeter AM50

or

U11310 3B NETlab™

U11300-230 3B NETlog™ (230 V, 50/60 Hz)

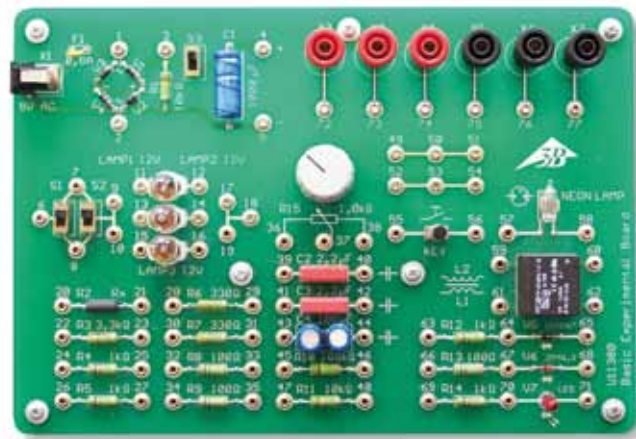
or

U11300-115 3B NETlog™ (115 V, 50/60 Hz)

U8533600-230 Function Generator FG 100 (230 V, 50/60 Hz)

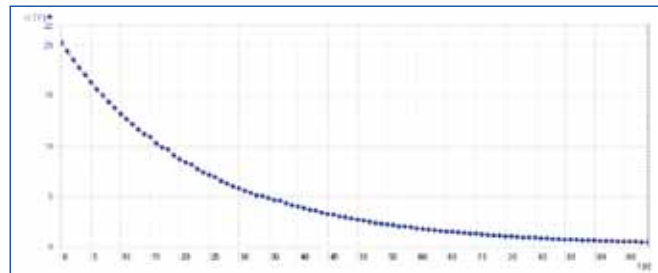
or

1009956 Function Generator FG 100 (115 V, 50/60 Hz)

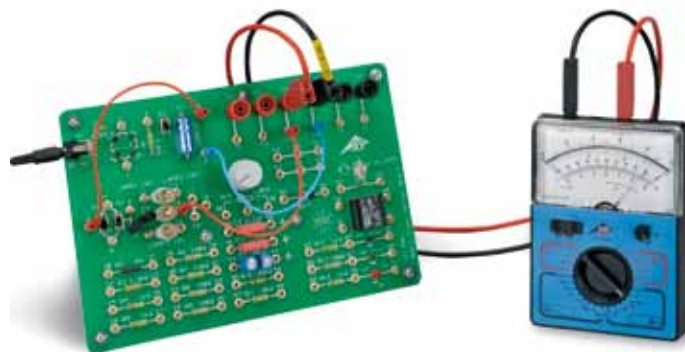


U11380-230

U11380-115



Discharge curve of a capacitor



Measurement of the discharge of a capacitor



Measurement of the discharge of a capacitor



Characteristic curve for a zener diode

Plug-in Board and Components for Building Electrical and Electronic Circuits in Demonstrations or Students' own Experiments

NEW

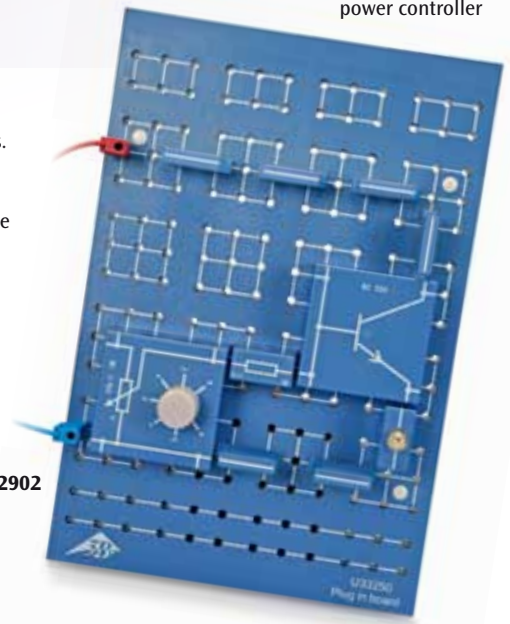
Plug-in board with components to build a power controller

Plug-in Board for Components

Plug-in board for assembling electrical and electronic circuits using components in plug-in housings. Features 4-mm sockets on the front and rear, each internally connected to a square of 9 sockets plus two continuous serial layouts each with 19 sockets. Can be used laid horizontally on a table or vertically in mountings for a whiteboard (U10381 resp. U10382). Two adjacent plug-in boards can be connected together via plug-in components to make a board that is twice as big.

Connector squares: 16 complete squares and four half-squares
 Socket separation: 19 mm from edge to edge of connector squares
 50 mm from centre to centre of connector squares
 Dimensions: 300x200x24 mm³

1012902



1012902

Components in Plug-in Housings with Two Plugs Separated by 19 mm

Capacitors

Art. No.	Capacitance	Tolerance	Max. tension
1012947	100 pF	20 %	160 V
1012948	470 pF	20 %	160 V
1012949	1 nF	20 %	100 V
1012950	2.2 nF	20 %	160 V
1012951	4.7 nF	2.5 %	100 V
1012952	10 nF	20 %	100 V
1012943	22 nF	20 %	100 V
1012944	47 nF	5 %	100 V
1012945	0.22 µF	5 %	250 V
1012946	4.7 µF	5 %	63 V
1012953	0.1 µF	20 %	100 V
1012954	0.47 µF	20 %	100 V
1012955	1 µF	20 %	100 V
1012956	2.2 µF	5 %	63 V



1012910



1012947



1012959

Electrolytic Capacitors

Art. No.	Capacitance	Tolerance	Max. tension
1012957	10 µF	20 %	35 V
1012958	47 µF	20 %	35 V
1012959	100 µF	20 %	35 V
1012960	470 µF	20 %	16 V

Linear Resistors

Art. No.	Resistance	Tolerance	Max. power
1012903	1 Ω	5 %	2 W
1012904	10 Ω	5 %	2 W
1012905	10 Ω	5 %	10 W
1012906	5.1 Ω	5 %	2 W
1012907	22 Ω	5 %	2 W
1012908	47 Ω	5 %	2 W
1012909	68 Ω	5 %	2 W
1012910	100 Ω	5 %	2 W
1012911	150 Ω	5 %	2 W
1012912	220 Ω	5 %	2 W
1012913	330 Ω	5 %	2 W
1012914	470 Ω	5 %	2 W
1012915	680 Ω	1 %	2 W
1012916	1 kΩ	5 %	2 W
1012917	1.5 kΩ	5 %	2 W
1012918	2.2 kΩ	5 %	2 W
1012919	3.3 kΩ	5 %	2 W
1012920	4.7 kΩ	5 %	2 W
1012921	6.8 kΩ	5 %	2 W
1012922	10 kΩ	5 %	0.5 W
1012923	15 kΩ	5 %	0.5 W
1012924	22 kΩ	5 %	0.5 W
1012925	33 kΩ	5 %	0.5 W
1012926	47 kΩ	5 %	0.5 W
1012927	68 kΩ	1 %	0.5 W
1012928	100 kΩ	5 %	0.5 W
1012929	220 kΩ	5 %	0.5 W
1012930	330 kΩ	5 %	0.5 W
1012931	470 kΩ	5 %	0.5 W
1012932	1 MΩ	5 %	0.5 W
1012933	10 MΩ	5 %	0.5 W



1012972



1012966



1012964



1012988



1012983



1012990

LEDs

Art. No.	Colour	Orientation
1012962	red	upward facing
1012971	green	upward facing
1012972	red	side facing

Zener Diodes

Art. No.	Type	Max. power dissipation
1012965	ZPD 3.3	0.5 W
1012966	ZPD 9.1	0.5 W
1012967	ZPD 6.2	0.5 W
1012968	ZPY 5.6	1.3 W
1012969	ZPY 8.2	1.3 W
1012970	ZPD 18	0.5 W

Semiconductor Diodes

Art. No.	Type	Material	Cut-off voltage	Max. long-term current
1012964	1N 4007	Si	1000 V	1 A
1012961	BY 255	Si	1300 V	3 A
1012963	AA 118	Ge	90 V	50 mA

Thermistors

Max. temperature:

Art. No.	Type	Resistance (25°C)	Resistance (100°C)
1012941	NTC	2.2 kΩ	120 Ω
1012942	PTC	100 Ω	

LDR 05 Photoresistor

Resistance: 100 Ω (bright light)
... 10 MΩ (dark)

Max. power dissipation: 0.2 W

1012940

BR 100 Diac

BR100 diac in a plug-in housing printed with the appropriate circuit symbol.

Breakdown voltage: 32 V approx.
Breakdown current: 50 μA approx.

1012973

Single-Pole Push-Button Switches

Art. No.	Type
1012988	Normally open
1012989	Normally closed

Coils

Art. No.	Type	Inductance
1012983	Coil	10 mH
1012984	High-Frequency Coil	33 mH

Single-Pole Rocker Switch

1012990

Micromotor 1.5 V DC

Miniature motor with gearbox permanently fixed to the side.
Operating voltage: 0.5 – 1.5 V DC
Gear ratio: 40 : 1

1012995



1012995

E 10 Socket

Art. No.	Type
1012986	Socket side facing
1012987	Socket upward facing

Additionally required:

E10 bulb from U29512, U29513, U29514, U29515, U29516, U29517, U29589, U29590, U29591, U29592 or U29593

Set of 10 Jumpers

Set of 10 jumpers with printed lines showing the connection between the two plugs, for assembling circuits on the plug-in component board (1012902).

Max. permitted current: 25 A
Plug separation: 19 mm

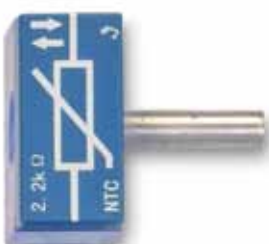
1012985

Battery Holder

Open housing with connectors for type IEC R 20 1.5-V batteries.

Plugs: 2
Plug separation: 50 mm

1012994



1012941



1012940



1012973



1012987



1012985



1012994

NEW

Components in Plug-in Housings with Four Plugs Separated by 50 mm.



1012939



1012974



1012975

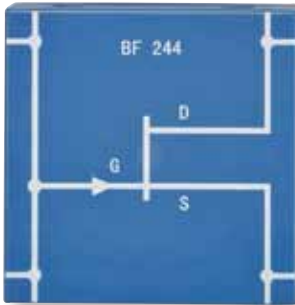
Potentiometers

Art. No.	Resistance	Max. power
1012934	220 Ω	1 W
1012935	470 Ω	1 W
1012936	1 k Ω	1 W
1012937	10 k Ω	1 W
1012938	4.7 k Ω	1 W
1012939	100 k Ω	1 W

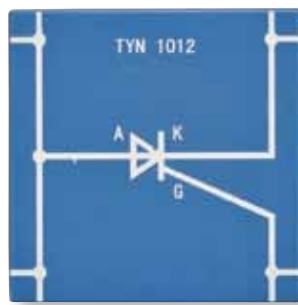
Transistors

Art. No.	Type	Current gain	Power dissipation
1012974	NPN BD137	40–250	5 W
1012976	NPN BC550	420–800	0.5 W

Art. No.	Type	Current gain	Power dissipation
1012975	PNP BD138	40–250	5 W
1012977	PNP BC560	420–800	0.5 W



1012978



1012979



1012980



1012981

BF 244 Field Effect Transistor

Type: BF244,
N-channel-FET

Power
dissipation: 300 mW

1012978

TYN 1012 Thyristor

Type: TYN 1012,
N-channel FET

Cut-off current: 8 A

1012979

BT 137/800 Triac

Type: BT 137/800

Cut-off current: 3 A

1012980

LM 741 Operational Amplifier

Operating voltage: ± 15 V DC

Output current: 15 mA

1012981

Double-Pole Change-Over Switch

Mechanical rocker switch with two switch positions on a square plug-in housing printed with the appropriate circuit symbol. Internal mechanical coupling with two change-over switches for each of the three switch positions to be reproduced in two circuits.

Switch functions: 2 x ON-OFF, 2 x OFF-ON, 2 x ON-OFF-ON, 2 x Change-over

1012991

Relay with Change-Over Contacts

Control voltage: 4–16 V DC

Coil resistance: 150 Ω approx.

Maximum
switched power: 50 VA

1012992

Low-Frequency Transformer, 1:2

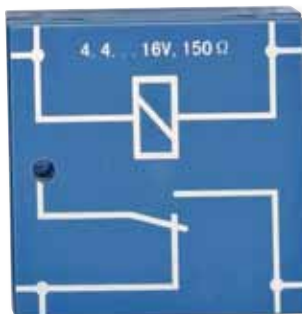
1012982

Single-Pole Change-Over Switch

1012993



1012991



1012992



1012982



1012993

Experiment Topics:

- Measurement at galvanic voltage sources
- Daniell cell, series and parallel circuits
- Electrochemical potentials (voltage sequence)
- Determination of the standard potentials of different metals and non metals
- How potentials depend on concentration
- How potentials depend on temperature
- Charge and discharge of a steel accumulator
- Leclanché cell
- Measurement of pH values



U11110

BEST SELLER

Electrochemistry Case

A complete equipment set in a case for basic experiments on electrochemistry. A cell block made of tough plastic, which can be unscrewed into two halves for ease of cleaning, allows four galvanic cells to be connected in parallel. A piece of filter paper stretched between the two halves of the cell acts as a diaphragm. Includes a handy, high-resistance meter for measuring potential differences with very little current and measuring pH values with the help of the supplied pH measuring probe.

Measurement device:

7 segment display:	3 digit
Height:	13 mm
Voltage ranges:	2 V DC and 20 V DC
Resolution:	1 mV
Input resistance:	200 MΩ
pH measuring range:	0,0 ... 14,0 pH
Power supply:	Plug-in power supply, 12 V/0.5 A (as supplied) or 9-V block battery
Dimensions:	approx. 175x105x55 mm ³

pH Combined Electrode

pH combined electrode with shaft made of plastic with a BNC plug and highly flexible cable.

Length of cable:	approx. 1 m
Dimensions:	approx. 120 mm x 12 mm diam.

U11111

U11111



Contents:

- 1 foam lined case
- 1 measurement device
- 1 pH combined electrode with BNC plug
- 1 plug-in power unit 12 V DC / 500 mA for 115/230 V AC mains voltage
- 1 Cell block, fitted with filter paper
- 2 Ag-electrodes, 42x28 mm²
- 1 Pt-electrode, 42x28 mm²
- 4 Zn-electrodes, 42x28 mm²
- 2 Fe-electrodes, 42x28 mm²
- 2 C-electrodes, 42x28 mm²
- 2 Al-electrodes, 42x28 mm²
- 2 Ni-electrodes, 42x28 mm²
- 4 Cu-electrodes, 42x28 mm²
- 1 Mg-electrode, 42x28 mm²
- 1 set of filter papers (50 units)
- 1 Sanding block for cleaning electrodes
- 3 experiment cables with crocodile clips, 20 cm, red
- 3 experiment cables with crocodile clips, 20 cm, blue
- 1 experiment cable with crocodile clip and 2 mm plug, 30 cm, red
- 1 experiment cable with crocodile clip and 2 mm plug, 30 cm, blue
- 2 graduated plastic beakers, 25 ml
- 2 drip pipettes with suction bulbs
- 1 Storage box with loose insert
- 1 operating instructions on CD-ROM

U11110

Additionally required:

Chemicals

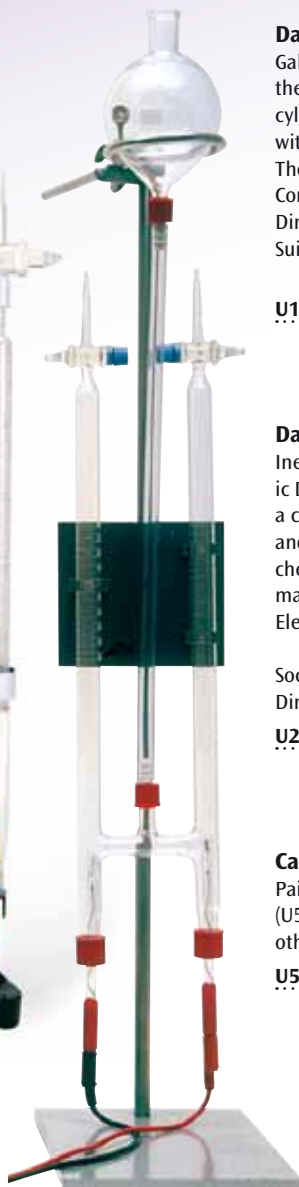


U14331

U58010



U14332



U29503



U58011

NEW

Hofmann's Voltmeter

Apparatus for electrolysis of water, the quantitative determination of the gases formed and establishing Faraday's laws. Consists of two scaled gas collection tubes connected by flexible plastic hose with levelling bulb for pressure compensation and hence for the exact measurement of gas volumes, on stand with retaining plate. GL threads provide secure mounting for electrodes.

Dimensions: approx. 800x150 mm²
 Baseplate area: approx. 250x160 mm²
 Rod: 750 mm x 12 mm diam.
 Retaining plate: approx. 120x110 mm²

Contents:

- 1 gas collection tubes
- 2 platinum electrodes with 4 mm sockets
- 1 plastic hose with levelling bulb
- 1 stand ring for holding levelling bulb
- 1 universal bosshead
- 1 stand baseplate with rod and retaining plate

U14332

Additionally recommended:

- U33020-230 DC Power Supply 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz)
- or
- U33020-115 DC Power Supply 0–20 V, 0 – 5 A (115 V, 50/60 Hz)

- U21020-230 Power and Energy Meter (230 V, 50/60 Hz)
- or
- U21020-115 Power and Energy Meter (115 V, 50/60 Hz)

See
physics experiments
catalogue

Daniell Cell

Galvanic cell (Daniell cell) named after John Frederic Daniell for studying the properties of an electrochemical cell. The Daniell cell consists of a cylindrical zinc and copper electrode, a clay vessel and a battery glass. Filled with cell electrolyte the Daniell cell supplies a voltage of approx. 1.1 volts. The cell is delivered empty.

Connections: 4 mm jacks
 Dimensions: approx. 105 mm x 65 mm diam.
 Suitable filling: Copper sulphate solution (CuSO₄), 10% concentration,
 Zinc sulphate solution (ZnSO₄), 10% concentration

U14331

Daniell Cell F

Inexpensive galvanic cell assembled in the layout known after John Frederic Daniell. Assembled from inside to outside using a copper electrode with a connector socket, a clay vessel, a zinc electrode with a connector socket and a glass beaker. The cell is supplied empty and does not include any chemicals. When filled with electrolyte, it can supply a voltage of approximately 1.1 V.

Electrolyte: 10% copper sulphate solution (CuSO₄),
 10% zinc sulphate solution (ZnSO₄)
 Sockets: 4 mm
 Dimensions: 140 mm x 75 mm diam. approx.

U29503

Carbon Electrodes

Pair of graphite electrodes for use with the Hofmann's voltameter S (U58010) for the analysis of ammonia solutions, solutions of table salt or other solutions with chloride radicals.

U58011

Hofmann's Voltmeter S

Hofmann's voltameter is used for determining the chemical composition of water by volume. The apparatus consists of three vertical glass tubes connected to each other at the bottom. Taps at the top ends of the outside tubes are closed whilst the inner cylinder is open at the top to allow the addition of water via a reservoir. Gold sheet electrodes are fitted to the lower ends of the outside tubes and connected to a low-voltage power supply. The proportion of hydrogen and oxygen produced by electrolysis from the water can be read from the graduations on the side tubes. By opening the taps at the top of the tubes, gases can be collected for analysis. Carbon electrodes are also available for analysis of solutions where gold is unsuitable.

Dimensions: approx. 580x150 mm²
 Stand base, A-shaped: 115 mm leg length
 Operating voltage: 4 – 12 V DC

U58010

Additionally required:

- U33020-230 DC Power Supply, 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz)
- or
- U33020-115 DC Power Supply, 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz)

Additionally recommended:

- U21020-230 Power and Energy Meter (230 V, 50/60 Hz)
- or
- U21020-115 Power and Energy Meter (115 V, 50/60 Hz)
- U58011 Carbon electrodes

Equipment Set for Electrochemistry

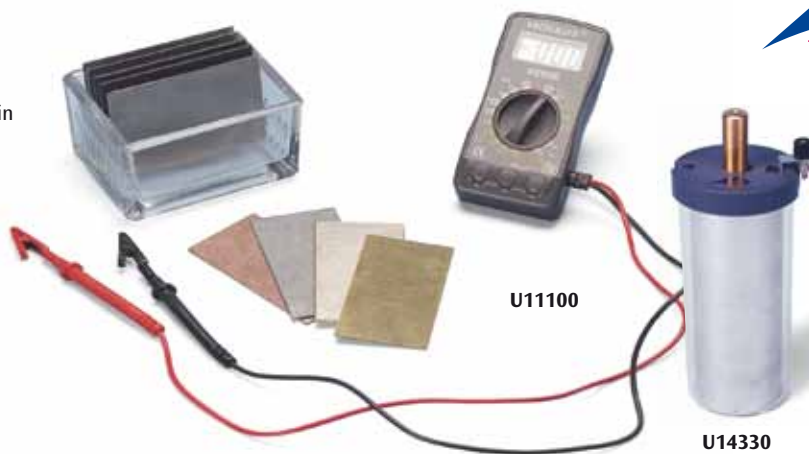
Set for measuring electrochemical potentials of various metals in experiments intended for students. Includes digital multimeter.

Trough: approx. 85x70x45 mm³
 Electrodes: approx. 76x40 mm²

Contents:

- 1 flat trough
- 1 copper plate
- 1 zinc plate
- 1 iron plate
- 2 nickel plates
- 1 aluminum plate
- 2 electrolyte-carbon plates
- 1 digital multimeter with 2 cables with crocodile clamps

U11100



Electrode plates

(not shown)

Spare electrodes for the electrochemistry equipment set (U11100).

Dimensions: approx. 76x40 mm²

Art.-No.	Material
U11101	Set of 10 Copper Plates
U11102	Set of 10 Zinc Plates
U11103	Set of 10 Iron Plates
U11104	Set of 5 Nickel Plates
U11105	Set of 10 Aluminum Plates
U11106	Set of 5 Carbon Plates

Leclanché Cell

This model of a dry battery was invented by the French chemist Georges Leclanché in the 1860s. It consists of a cylindrical zinc electrode, a rod shaped carbon electrode, a clay vessel and a battery glass. Filled with cell electrolyte, the Leclanché cell supplies a voltage of approximately 1.5 volts. The cell is delivered empty.

Connections: 4 mm jacks
 Dimensions: approx. 175 mm x 65 mm diam.
 Suitable filling: Ammonium chloride solution (NH₄Cl), approx. 20% concentration

U14330

Experiment Topics:

- Conductors and non-conductors
- Determining electrolytes
- Distinguishing between 5 typical electrolytes
- Conductivity of melted salts

Conductivity Tester

Easy to use meter for determining conductivity of electrolytes (in water courses) and distinguishing between distilled water, rain water, tap water, brine and sea water, as well as between acids and alkalis. The display indicates the levels "very low", "low", "medium", "high" and "very high" and has LED backlighting. Even the very low conductivity of distilled water is displayed. The device is protected against spray and can therefore be used without difficulty in the open air. It can be powered either by a 9-V block battery (not included) or by the supplied 12-V/500-mA plug-in power supply.

Measuring ranges: 2 ... 20 µS/cm (very low),
 20 ... 100 µS/cm (low),
 100 ... 500 µS/cm (medium),
 500 ... 3000 µS/cm (high),
 > 3000 µS/cm (very high)

Dimensions: 85x35x170 mm
 Battery capacity: 10 hours approx.

1012890

Additionally required:

1012889 Conductivity Electrode

or

1012888 Conductivity Electrode for Molten Salts



Conductivity Electrode

Conductivity electrode for use with conductivity tester (1012890). With platinum wires and 0.8 m of cable tipped by two 4-mm plugs.

Cell constant: 1/cm approx.
 Dimensions: 130 mm x 15 mm diam.

1012889

Conductivity Electrode for Molten Salts

Conductivity electrode for use with conductivity tester (1012890) to demonstrate the conductivity of molten salts. With 4 interchangeable flexible copper wires for immersion in the molten salts plus 0.8 m of cable tipped by two 4-mm plugs.

Copper wires: 200 mm x 2 mm diam.

1012888

Magnetic Equipment Set

A selection of various magnets for introducing the subject of magnetism. Complete with a specially molded storage tray.

Contents:

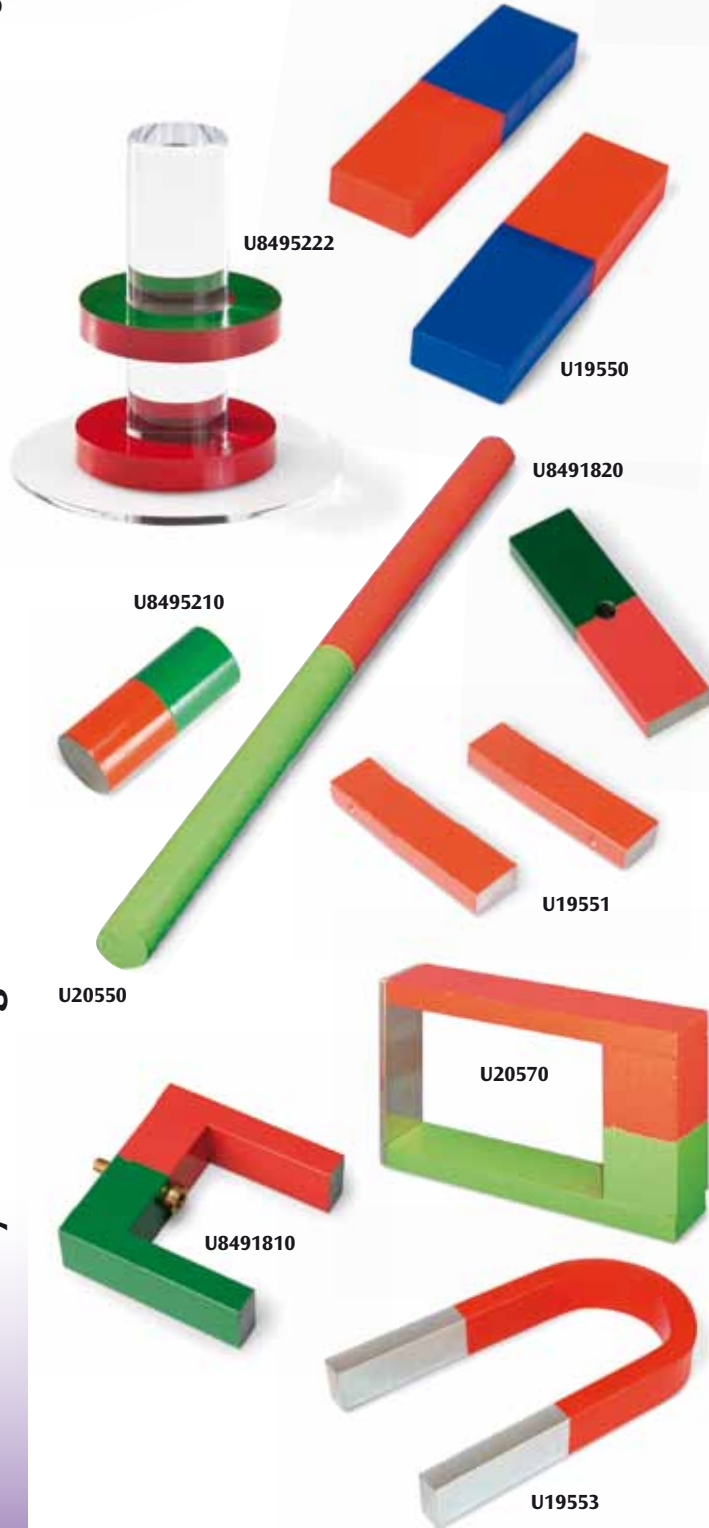
- 3 AlNiCo round magnets: 12 mm, 19 mm, 24 mm diam.
- 1 AlNiCo horseshoe magnet, 25 mm long
- 1 Chromium-steel horseshoe magnet, 100 mm long
- 2 Chromium-steel bar magnets, 100 mm x 6 mm diam.
- 2 Bar magnets in a protective plastic case, 80 mm long
- 5 Iron ring magnets, 25 mm diam.
- 5 Iron magnets, 19x19x5 mm³
- 1 Natural magnet
- 4 Coloured magnetic foils, 50x50 mm²
- 2 Drawing compasses, 19 mm diam.
- 2 Drawing compasses, 16 mm diam.

U19555



BEST SELLER

U19555



U8495222

U19550

U8491820

U8495210

U19551

U20550

U20570

U8491810

U19553

Pair of Bar Magnets, 80 mm

Pair of bar magnets with poles marked red and blue. In plastic protective cover.
Dimensions: approx. 80x22x10 mm³

U19550

Cylindrical Bar Magnet 50x20

Round bar magnet with poles marked red and green.
Dimensions: approx. 50 mm x 20 mm diam.

U8495210

Cylindrical Bar Magnet 200x10

Round bar magnet with poles marked red and green.
Dimensions: approx. 200 mm x 10 mm diam.

U20550

Horseshoe Magnet, 70 mm

Horseshoe shaped AlNiCo magnet with screw. Poles marked red and green.
Pole area: approx. 20x10 mm²
Distance between poles: approx. 50 mm
Length of shank: approx. 70 mm
Weight: approx. 400 g

U8491810

Horseshoe Magnet 130 mm, with Yoke

Horseshoe shaped magnet with yoke. Poles coloured red/green.
Pull-off force of yoke: 250 N
Pole spacing: approx. 60 mm
Length: approx. 130 mm

U20570

Suspended Magnet

Apparatus for demonstrating repulsion forces between magnets. Two ring magnets facing each other with identical poles are slid on a rod.
Base: approx. 100 mm diam.
Rod: approx. 100 mm x 30 mm diam.
Weight: approx. 410 g

Contents:

- 1 Rod with Base
- 2 Ring magnets

U8495222

Bar Magnet, AlNiCo, 70 mm

AlNiCo bar magnet with poles marked red and green.
Dimensions: approx 70x20x8 mm³
Weight: approx. 80 g

U8491820

Pair of Bar Magnets, AlNiCo, 60 mm, with Two Iron Yokes

Pair of AlNiCo bar magnets, red, with north pole marked. Including two iron yokes.
Dimensions: approx. 60x15x5 mm³

U19551

Horseshoe Magnet 140 mm, with Yoke

Horseshoe shaped chromium steel magnet with yoke, poles coloured red and silver.
Pole area: approx. 20x10 mm²
Distance between poles: approx. 60 mm
Length of shank: approx. 140 mm

U19553

Equipment Kit "Hysteresis Curve"

Apparatus for recording the magnetic flux density as a function of the magnetic field strength in different iron specimens.

Dimensions of the iron samples: approx. 140 mm x 10 mm diam.
 Number of turns: 600
 Internal resistance: 1.5 Ω
 Inductance without core: 3.5 mH
 Dimensions: approx. 200x145x65 mm³
 Total weight: approx. 950 g

Contents:

Base plate with coil and holder for Hall sensors
 3 iron samples as coil cores (stainless steel, hard metal and iron)

U8496112

Additionally recommended:

U8533510-230 Power Function Generator (230 V, 50/60 Hz)

or

U8533510-115 Power Function Generator (115 V, 50/60 Hz)

U11360 Magnetic Field Sensor

U11300-230 3B NETlog™ (230 V, 50/60 Hz)

or

U11300-115 3B NETlog™ (115 V, 50/60 Hz)

U11310 3B NETlab™



U8496112



U19556



U19557

Soft-Iron Bars

Set of 5, non-magnetic soft-iron bars for magnetic induction experiments.

Dimensions: approx. 155 mm x 10 mm diam.

U19556

Lodestone

Unfinished, walnut-sized stone made of magnetic iron ore (magnetite).

U19557

Diamagnetic Levitation Apparatus

The physicist S. Earnshaw proposed the following theorem in 1848: "It is not possible for charges or magnets to be placed in a stable levitated state in a static field obeying an inverse square law." He further stated, however, that it would be possible to achieve this with the help of diamagnetic materials. The availability of very powerful rare-earth metal magnets has made it possible to design a cheap levitation apparatus such as this using graphite as the diamagnet. Diamagnetic materials are repelled from both magnetic poles. A gold-coated NdFeB magnet is allowed to levitate freely between two graphite plates in a space enclosed by transparent acrylic. The gravitational force acting on the magnet is almost entirely counteracted by the force of attraction from a ring magnet located above the plastic covering. Two diamagnetic graphite plates, one above and one below the NdFeB magnet, compel it into a stable equilibrium since both poles of the magnet are repelled by the graphite plates (diamagnetism).

Dimensions:

Base plate: approx. 95x95x135 mm³

Contents:

1 Levitation apparatus
 2 Transparent acrylic plates
 1 Socket wrench

U45051



U45051



1013123

Globe with Bar Magnet

Globe of the world with bar magnet along the axis of the poles on acrylic base, for demonstrating the shape of the Earth's magnetic field. A compass (U19561) or a magnetic field indicator (U8491900) can be seen to align at the surface of the globe in accordance with a magnetic field parallel to the lines of longitude. The inclination can also be determined using the magnetic field sensor.

Dimensions: 220x160x200 mm³
 Diameter (globe): approx. 150 mm
 Weight: approx. 340 g

1013123

Additionally recommended:

- U8491900 Magnetic Field Indicator**
- U19561 Compass**

“Oersted’s Needle” Device

Compact and easily understood apparatus to demonstrate Oersted’s experiment. An electric current passing through a piece of enamelled copper wire creates a magnetic field around the wire, which can deflect a magnetic compass needle from its normal position.

Dimensions of base: 200x80 mm²
 Copper wire: 3 mm diam.
 Electrical connections: 4-mm safety sockets
 Maximum permissible current: 5 A

U29310

Additionally recommended:

- U33020-230 DC-Power Supply 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz)**
- or
- U33020-115 DC-Power Supply 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz)**



U29310

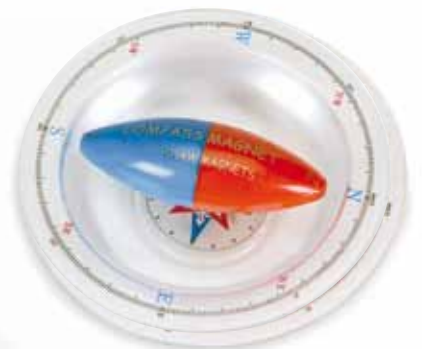
NEW

Compass Magnet with Plastic Bowl

Very powerful neodymium magnet covered with a plastic case can float on the surface of water and faces North South when it comes to rest. Complete with translucent plastic bowl marked with compass points.

Dimensions:
 Magnet: 80 mm x 30 mm max diam.
 Bowl: approx. 40 mm x 115 mm diam.

U19563



U19563

Compass

Compass in a stable housing, low friction needle bearing, including a compass card and angle scale.

Scale division: 2°
Diameter: approx. 55 mm

U19561



U19561

U216031

Magnetic Needle, 80 mm

Magnetic needle mounted on base with pivot point.

Length: approx. 80 mm
Height: approx. 110 mm

U216031



U8491900

Magnetic Field Indicator

Bar magnet, with poles identified by colour and free to turn in space, for three-dimensional mapping of magnetic fields. On agate gimbal bearings pivot allowing free rotation in space, small bar magnet with colour pole coding. Handle and cardanic suspension made of plastic to alleviate any adverse effects on magnetic field.

Magnet: approx. 25x3x3 mm³
Handle length: approx. 95 mm

U8491900

Inclination Instrument

Instrument for measuring the inclination of the Earth's magnetic field and also for mapping the magnetic field of a current-carrying conductor. An aluminum conductor loop with 4 mm safety sockets, a magnetic needle with a pointed axle rotates on bearings above a full circle in transparent material with an angle scale, rotating about the horizontal axis and mounted on acrylic base.

Diameter of circle: approx. 110 mm
Length of magnetic needle: approx. 100 mm
Strap length: approx. 150 mm
Terminal: 4 mm safety sockets
Base dimensions: approx. 100x90x185 mm³

U21900

Additionally recommended:

U33020-230 DC-Power-Supply 0–20 V, 0–5 A (230 V, 50/60 Hz)

or

U33020-115 DC-Power-Supply 0–20 V, 0–5 A (115 V, 50/60 Hz)



1006799

Inclination and Declination Instrument

Instrument for measuring the inclination and declination of the Earth's magnetic field and also for mapping the magnetic field of a current-carrying conductor. The bearings are of agate upon which the magnetic needle is mounted in a frame with reference circle. The frame is equipped with an additional reference circle. There are two 4 mm sockets included for power supply.

Length of magnetic needle: approx. 100 mm
Dimensions: approx. 180x100x220 mm³
Weight: approx. 620 g

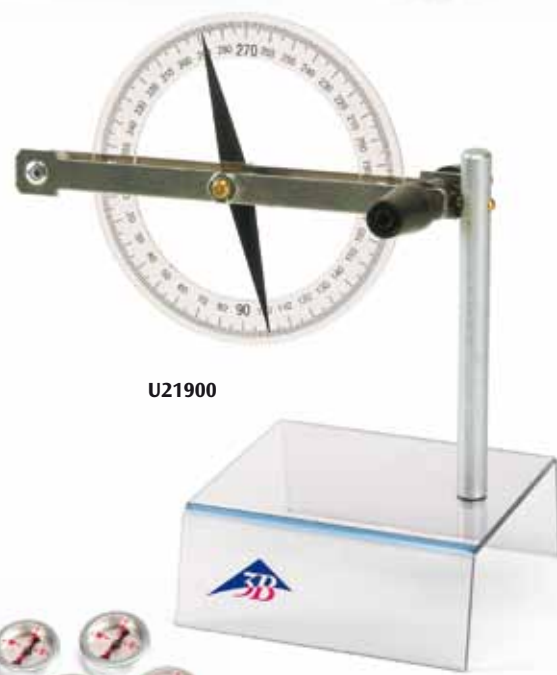
1006799

Additionally recommended:

U33020-230 DC-Power-Supply 0–20 V, 0–5 A (230 V, 50/60 Hz)

or

U33020-115 DC- Power-Supply 0–20 V, 0–5 A (115 V, 50/60 Hz)



U21900

Set of 10 Tracing Compasses

Set of 10 compasses for tracing field lines. Aluminum housing, glazed on both sides. Markings for indicating compass directions.

Diameter: approx. 19 mm

U19562



U19562



U8491925

U11451



U11452



U19560



Magnetic Field Lines Device, Three-Dimensional

Instrument for three-dimensional mapping of the magnetic field lines of a cylindrical bar magnet. The plexiglas housing is filled with a special, highly viscous liquid and iron filings. After the magnet has been inserted into the central hole, the iron filings, which had previously been distributed randomly in the liquid, align themselves according to the direction of the field. An enclosed air bubble ensures that a good shake of the device causes the iron shavings to be evenly distributed.

Diameter of the hole: approx. 21 mm
 Dimensions: approx. 140x140x120 mm³
 Weight: approx. 0.8 kg

U8491925

Additionally required:

U8495210 Cylindrical Bar Magnet 50x20 mm

Magnetic Field Line Apparatus, Two-Dimensional

Demonstration apparatus for two-dimensional display of magnetic field lines in combination with an overhead projector. It consists of a transparent plastic vessel filled with a liquid containing magnetic powder. Magnets and an experiment manual in English are included.

Dimensions: approx. 220x120x10 mm³

U19560

Additionally required:

U30150-230 Overhead projector (230 V, 50/60 Hz)

or

U30150-115 Overhead projector (115 V, 50/60 Hz)

Hexagonal Magnet Model

Demonstration apparatus for the properties of the crystal lattice of ferromagnetic materials, particularly Weiss domains, Barkhausen jumps, saturation, hysteresis and Curie temperature. 117 freely moving magnetic needles are supported in a hexagonal arrangement between two connected transparent acrylic plates. For projection on the overhead projector.

Length of magnetic needles: approx. 17 mm
 Dimensions of plate: approx. 150x150 mm²

U15350

Additionally recommended:

U30150-230 Overhead projector (230 V, 50/60 Hz)

or

U30150-115 Overhead projector (115 V, 50/60 Hz)

U8495185 Pair of Flat Coils

Magnet Model, Cubic

Like U15350, but with magnets in a square arrangement.

U15351

Additionally recommended:

U30150-230 Overhead projector (230 V, 50/60 Hz)

or

U30150-115 Overhead projector (115 V, 50/60 Hz)

U8495185 Pair of Flat Coils

Iron Filings

250 g of iron filings for displaying magnetic field lines. In a storage flask.

U11451

Additionally recommended:

U11452 Shaker

Shaker

Plastic flask with a fine hole for scattering iron filings evenly.

U11452

Pair of Flat Coils

Pair of coils for generating a near-uniform magnetic field for the hexagonal and cubic magnet models (U15350 and U15351). This makes it possible to observe changes in the magnetic flux when the magnetisation is changed.

Number of turns: 125
 Resistance: 7 Ω approx.
 Permitted current: 1 A
 Dimensions: 150x30x18 mm³ approx.
 Weight: 85 g approx.

U8495185

Additionally recommended:

U33020-230 DC-Power-Supply 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz)

or

U33020-115 DC-Power-Supply 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz)



U15351



U15350



U8495185

Experiment Topics:

- Magnetic flux lines of bar and horseshoe magnets
- Magnetic screening
- Magnetic induction
- To display the shapes adopted by magnetic field lines around a straight conductor, a conductor loop, a cylindrical coil, and an electromagnet

Set of Apparatus for Displaying Magnetic Fields

Equipment set for demonstration experiments designed to make visible the magnetic field distribution of permanent magnets and current carrying conductors. Also compatible for use with a daylight projector. The acrylic glass boxes containing iron filings are equipped with a pouring lip so that the used fillings can easily be refilled into the storage bottle.

Acrylic glass boxes: approx. 185x125x40 mm³

Storage tray: approx. 430x380x25 mm³

Weight: approx. 1.5 kg



U8491790

Magnetic Fields

Contents:

- 1 Straight conductor mounted on box made of transparent acrylic
- 1 Ring-shaped conductor mounted on box made of transparent acrylic
- 1 Cylindrical coil mounted on box made of transparent acrylic
- 1 Magnetic overlay with guide studs on acrylic box
- 1 Acrylic plastic box with smooth surface for scattering materials
- 2 Soft iron bars
- 1 Flat soft iron bar
- 2 Permanent flat bar magnets
- 1 Soft iron ring
- 1 Magnetic needle with holder
- 1 Scattering bottle with iron filings
- 1 Pre-molded storage tray

U8491790

Additionally required:

U117361 DC-Power Supply, 0 – 16 V, 0 – 20 A (115 – 230 V, 50/60 Hz)

Additionally recommended:

U30150-230 Overhead Projector (230 V, 50/60 Hz)

or

U30150-115 Overhead Projector (115 V, 50/60 Hz)

BEST SELLER



Current Conductor on Acrylic Base

Current Conductor for demonstrating the magnetic fields of current-carrying conductors. The magnetic field can be made visible with iron powder. Acrylic glass base with two 4 mm safety sockets. For projection on the overhead projector.

Dimensions of

acrylic glass base: approx. 185x150x30 mm³

Straight Conductor on Acrylic Base

U8491791

Loop-Shaped Conductor on Acrylic Base

U8491792

Coil on Acrylic Base

Number of turns: 7

Coil diameter: approx. 35 mm

Coil length: approx. 65 mm

U8491793



U8491792

U8491793

U8491791

Additionally required:

U117361 DC-Power Supply, 0 – 16 V, 0 – 20 A (115 – 230 V, 50/60 Hz)

U11451 Iron Filings

U11452 Shaker

Electricity and Magnetism

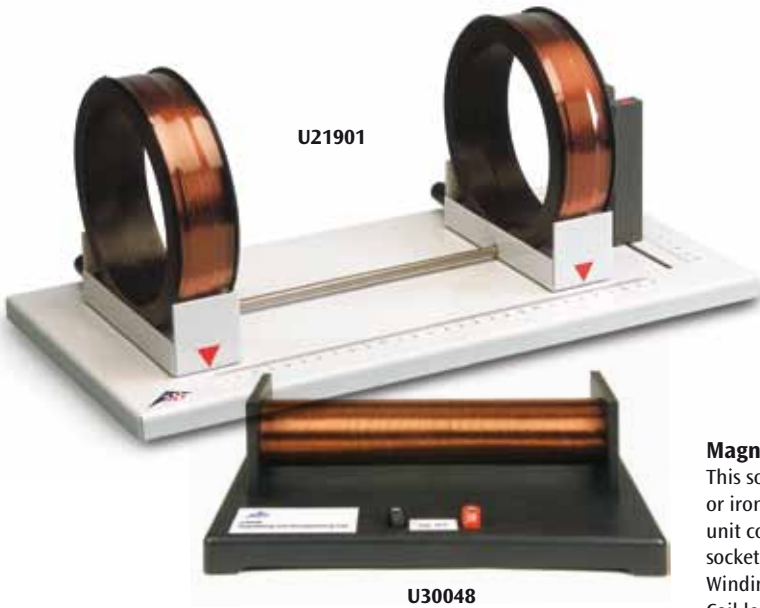
Pair of Helmholtz Coils on Mounting Plate

Pair of coils with variable separation for determining the optimum Helmholtz configuration and for quantitative testing of the uniformity of the magnetic field. The apparatus comprises a pair of coils arranged parallel to each other mounted on a robust metal base plate with a holder for a magnetic field meter to measure the magnetic field. One coil and its holder are moveable. There are two scales printed on the base plate to allow coil separation to be read off and to determine how far the measurement probe's position deviates laterally from the coil axis respectively.

- Average coil diameter: 125 mm
- Number of turns: 100 each
- Max. coil separation: 240 mm
- Max. permissible current: 5 A
- Terminals: 4 mm safety sockets
- Base plate: approx. 400x200 mm²

U21901

Additionally recommended:
U11360 Magnetic Field Sensor



Coil with Variable Number of Turns per Unit Length

Cylindrical coil of variable length for investigating the magnetic field strength as a function of the closeness of the turns.

- Coil diameter: 100 mm
- Number of turns: 30
- Coil length: 490 mm
- Max. Current: 10 A, for short periods 20 A
- Terminal: 4 mm safety sockets

U8496175

Additionally recommended:
U8496150 Stand for Cylindrical Coils
U11360 Magnetic Field Sensor

U8496175



U12253



U12252

Magnetizing Coil

This solenoid allows you to magnetize and demagnetize ordinary magnets or iron bars in addition to conducting inductance experiments. The rugged unit consists of insulated copper winding mounted on a base with 4 mm sockets and a switch.

- Windings: 1000
- Coil length: 250 mm
- Coil radius: 35 mm internal
- Operating Voltage: max. 12 V DC or 12 V AC
- Dimensions: 305x200x100 mm³
- Mass: 2 kg

U30048

Field Coils

Cylindrical coils for experiments investigating magnetic field intensity as a function of the current and the number of turns, for demonstrating that the field intensity is independent of the coil cross section. Coil bobbins made of acrylic.

- Number of turns: 120
- Coil length: 490 mm
- Max. current: 10 A, for short periods 20 A
- Terminal: 4 mm safety sockets

Field Coil 100 mm diam.

U12252

Field Coil 120 mm diam.

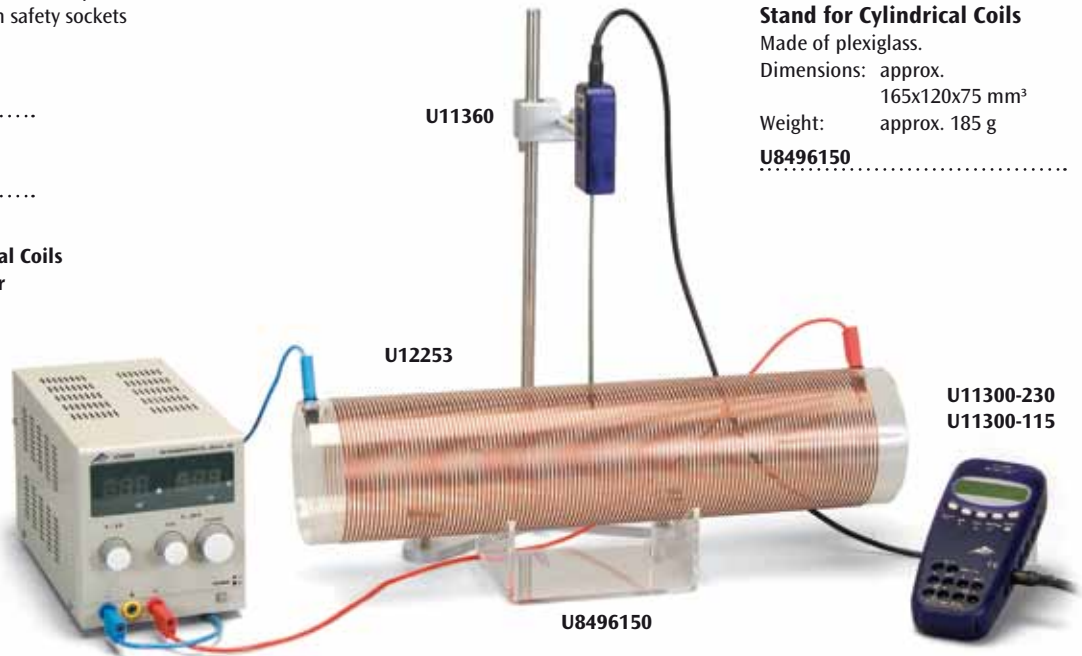
U12253

Additionally recommended:
U8496150 Stand for Cylindrical Coils
U11360 Magnetic Field Sensor

Stand for Cylindrical Coils

- Made of plexiglass.
- Dimensions: approx. 165x120x75 mm³
- Weight: approx. 185 g

U8496150



Measurement of the magnetic field around a current carrying coil

Teslameter, 200 mT

This economical digital teslameter will allow students to incorporate quantitative measurements into their magnetism experiments. The unit includes a Hall sensor probe for measuring axial and tangential magnetic fields up to 200 mT. The probe also serves as a ruler as it includes a metric scale. There are two measuring ranges, 0 – ±20 mT and 0 – ±200 mT. The teslameter can be calibrated by the user. In addition to having a digital display, the unit outputs a voltage proportional to the magnetic field which can be measured with a data logger, XY-recorder or analogue multimeter.

Measurement ranges: 0 – ±20 mT, 0 – ±200 mT
 Resolution: 0.01 mT, 0.1 mT
 Digital Display: 3½ digit LCD
 Height of digits: 13 mm
 Input: BNC socket
 Output: 4 mm safety sockets
 Dimensions of unit: 205x230x85 mm³
 Dimensions of probe: 360x15x25 mm³



U33110-230
U33110-115

Teslameter, 200 mT (230 V, 50/60 Hz)

U33110-230

Teslameter, 200 mT (115 V, 50/60 Hz)

U33110-115

Teslameter E

Hand-held meter for measuring magnetic flux density B or magnetic field strength H in conjunction with an axial-tangential field sensor (U8533997) or a flexible magnetic field sensor (1012892). The measurements are shown on a digital display and also converted into equivalent voltage outputs, which can be accessed from the analogue output connection.

LCD display: 3½-digit, 10 mm high
 Power supply: Rechargeable 9-V block battery providing about 20 hours of operation

Sensor connection: DIN socket
 Offset compensation: ±0.150 mT

Measuring modes:

DC-B Flux B of uniform fields
 AC-B Flux B of alternating fields (1 Hz ... 10 kHz)
 AC-H Field strength H of alternating fields (1 Hz ... 10 kHz)

Measuring ranges:

Flux B: ±2.000/±20.00/±200.0/±2000 mT
 Field strength H: ±2.000/±20.00/±200.0/±2000 A/m
 Analogue output:
 Connector: 4-mm socket
 Range: 0 ... ±2 V

U8533982

Additionally required:

U8533997 Magnetic Field Sensor, Axial/Tangential
 or
 1012892 Flexible Magnetic Field Sensor

Flexible Magnetic Field Sensor

Flexible magnetic field sensor with built-in Hall sensor for measuring tangential magnetic fields in connection with the E-model teslameter (U8533982).

Sensitivity: 1 mV/mT
 Length of probe (without handle): 75 mm
 Thickness of probe: 0,6 mm
 Hall sensor: Monocrystalline InAs
 Sensor surface: 1 mm²
 Connection: DIN plug

1012892

Magnetic Field Sensor, Axial/Tangential

Magnetic field sensor with two built in Hall sensor probes for measuring axial and tangential magnetic fields in conjunction with the teslameter (U8533982). A slider switch provides for switching between axial and tangential measuring modes.

Sensitivity: 1 mV/mT
 Length of probe (without handle): approx. 125 mm
 Thickness of probe: 4 mm
 Hall sensors: Monocrystalline InAs
 Sensor surface: 1 mm²
 Connection: DIN plug

U8533997



U8533982

U8533997

1012892

NEW

Current Balance According to Langensiepen

Complete equipment set for experiments in electrostatics and the Lorentz force. Set of equipment for compensation measurement of forces acting on conductor loops in a magnetic field.

Contents:

- 1 Stand with ball socket made of agate to receive the balance beam
- 1 Balance beam with pointer and clamp holder for the current conductor
- 1 Set of 5 current conductor loops (comprising various forms and lengths)
- 1 Pointer for the zero setting (fastened to the stand)
- 1 Hydrodynamic frictional brake
- 250 ml glycerin
- 1 Set of drive weights
- 1 Transformer core with yoke and clamp
- 1 Pole piece set
- 2 Coils, 600 turns
- 1 Dynamometer 0.1 N
- 2 Weights 100 g
- 1 Weight 200 g
- 10 Spacer rings

U8496820

Additionally required:

- U13265 Barrel Foot, 1 kg
- U15002 Stainless Steel Rod, 470 mm

Additionally recommended:

- U33020-230 DC Power Supply
0 – 20 V, 0 – 5 A
(230 V, 50/60 Hz)
- or
- U33020-115 DC Power Supply
0 – 20 V, 0 – 5 A
(115 V, 50/60 Hz)

Experiment Topics:

- Effect of force acting on a current-carrying conductor in a magnetic field
- Measurement of the magnetic flux density
- Effect of induction acting on a single conductor in the magnetic field
- Force between two parallel linear conductors
- Definition of ampere



U8496820



U8496820



U30065

Lorentz Force Apparatus

The apparatus consists of a powerful U shaped magnet, a pair of brass rails complete with 4mm sockets and a brass axle. A power supply unit is connected to the rails. When the axle is placed on the rails the electric circuit is completed and the axle is repelled along the rails in a direction either towards or away from the magnetic field. Reversing the current will have the opposite effect.

Dimensions: 175x65x70 mm³

U30065

Additionally required:

- U33020-230 DC Power Supply 0–20 V, 0–5 A (230 V, 50/60 Hz)
- or
- U33020-115 DC Power Supply 0–20 V, 0–5 A (115 V, 50/60 Hz)

Experiment Topics

- Diamagnetism and paramagnetism
- Waltenhofen's pendulum
- Force on a conductor in a magnetic field in parallel and transverse configurations
- Measuring currents with a current balance

Equipment Set Electromagnetism

This equipment consists of a stable, firm, anodized-aluminum tripod with pre-defined magnet positions and accessory mountings. The deflection of the conductor swing can be adjusted in steps of 0, 15, 30 and 45 mm for current balance experiments.

Contents:

- 1 Aluminum tripod, anodized
- 1 Conductor swing with 4 mm safety jacks
- 2 Waltenhofen pendulums (solid and slotted)
- 1 Glass rod and polyester thread with hook
- 1 Aluminum rod and polyester thread with hook
- 1 Knurled screw

U10371

Additionally required:

- U10370 Permanent Magnet with Adjustable Pole Spacing**
- U33020-230 DC Power Supply 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz)** or
- U33020-115 DC Power Supply 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz)**



See physics experiments catalogue

U10371

U10370

Lorentz Motor

Comprising a motor armature without an iron core, this device is intended for installation inside the permanent magnet with adjustable pole spacing (U10370). The coil is rotated purely by the Lorentz force, its direction of rotation depending on the direction of the current.

U10372

Additionally required:

- U10370 Permanent Magnet with Adjustable Pole Spacing**
- U33020-230 DC Power Supply 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz)** or
- U33020-115 DC Power Supply 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz)**

Permanent Magnet with Adjustable Pole Spacing

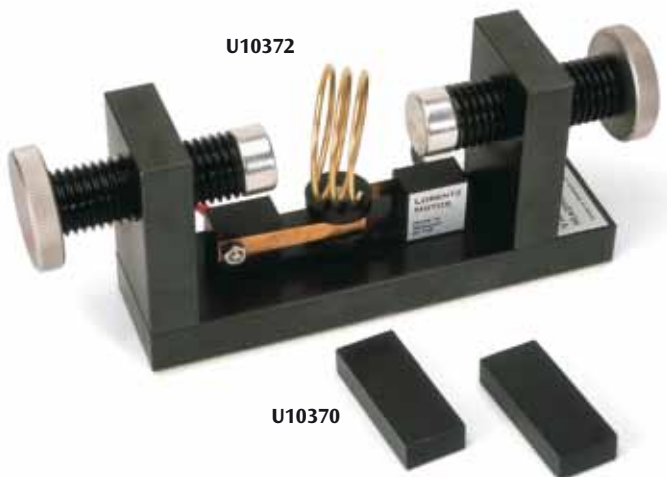
This permanent magnet has an adjustable pole spacing and a high field strength arising from the use of two neodymium magnet elements. It comes with a black-finished iron yoke, knurled handles made of high-grade steel and attachable pole shoes. This magnet system can be installed horizontally or vertically.

Magnet:	20x10 mm ²
Pole shoes:	20x50 mm ²
Pole spacing:	2–80 mm
Field strength at centre of gap:	20 mT–1000 mT

U10370



U10372



U10372

U10370

Demonstration Dynamo

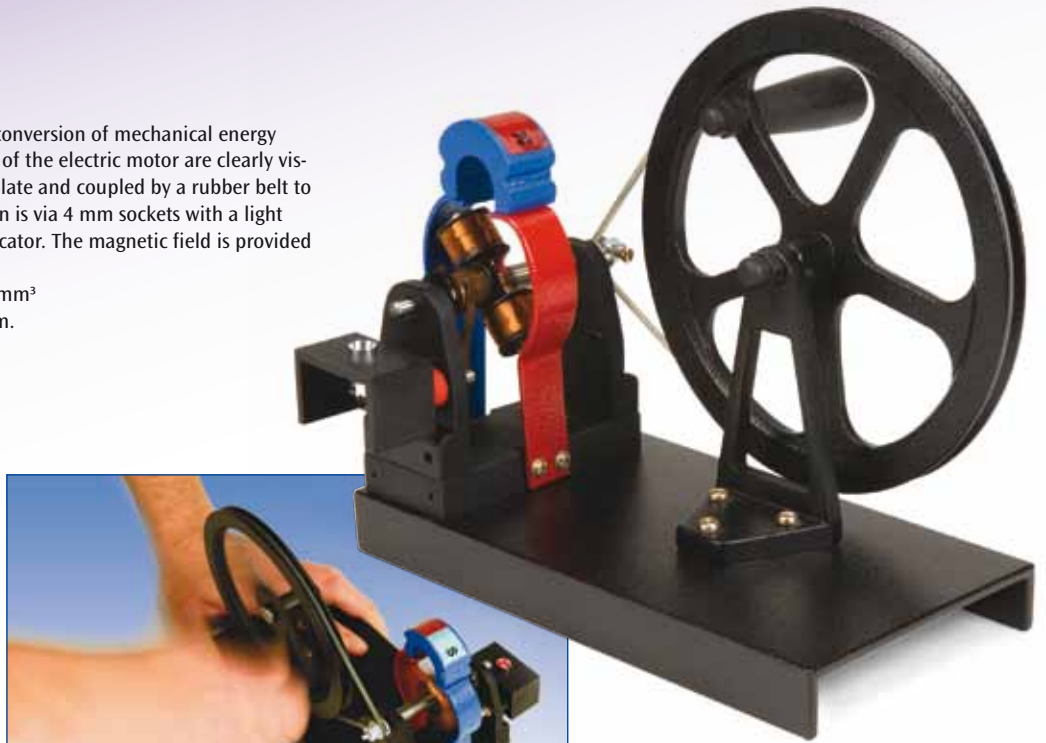
This model dynamo demonstrates the conversion of mechanical energy into electrical energy. All working parts of the electric motor are clearly visible. The motor is mounted on a base plate and coupled by a rubber belt to a hand-drive pulley. External connection is via 4 mm sockets with a light emitting diode acting as an output indicator. The magnetic field is provided by a permanent magnet.

Base plate: 200x100x20 mm³
 Hand-drive pulley: 150 mm diam.
 Height: 180 mm

Contents:

- 1 Apparatus on base plate
- 1 Removable magnet
- 1 Stackable light emitting diode
- 1 Small dynamo pulley

U30066



U30066



Induction Apparatus

Apparatus for demonstrating the induced voltage in a frame coil that is moved through the magnetic field produced by a magnet plate of limited area or by the rotation of a current-carrying conductor in the magnetic field of the magnet plate. By varying the speed of motion of the frame coil, the direction of motion and the number of turns in the coil, the induction law can be derived experimentally and quantitatively. The transparent design of the magnetic plate and coils means that they can be demonstrated on the overhead projector. An unfoldable support permits inclined set-up.

Operating voltage: 2–12 V DC
 Frame coil: approx. 185x125 mm²
 Total dimensions: approx. 585x200x55 mm³
 Weight: approx. 3 kg

Contents:

- 1 Induction apparatus with retractable magnetic plate
- 1 Frame coil
- 1 Rolling conductor loop

U8496270

Additionally required:

U33020-230 DC-Power Supply Unit 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz)

or

U33020-115 DC-Power Supply Unit 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz)

U17450 Analogue Multimeter AM50

Additionally recommended:

U30150-230 Overhead Projector (230 V, 50/60 Hz)

or

U30150-115 Overhead Projector (115 V, 50/60 Hz)



BEST SELLER



**U33020-230
U33020-115**



U17450



U8496270

Flat Coil in a Rotatable Frame

Flat coil in a plexiglas frame, mounted so that it can be rotated, for use in combination with 300 mm Helmholtz coils (U8481500). When the flat coil is rotated in the magnetic field of the Helmholtz coils, an alternating voltage is induced. The electrical connection to the coil is established via sliding contacts. A hand crank and pulley on the rotary frame's axle are used to drive the coil.

Number of turns: 4000
 Effective area: 42 cm²
 Dimensions: approx. 110x80x11 mm³
 Weight: approx. 360 g

1013131

Additionally required:

- U8481500 Helmholtz Coils, 300 mm**
 - U17450 Analogue Multimeter AM50**
 - U33020-230 DC-Power Supply Unit 0 – 20 V, 0 – 5 A**
(230 V, 50/60 Hz)
- or
- U33020-115 DC-Power Supply Unit 0 – 20 V, 0 – 5 A**
(115 V, 50/60 Hz)



Helmholtz Coils 300 mm

Pair of coils with large diameter in Helmholtz configuration used to produce a homogeneous magnetic field. The coils can be switched in parallel or in series. A spring clip on the top crossbar is used to mount the Hall sensor during measurements of the magnetic field.

Coil diameter: approx. 300 mm
 Number of turns per coil: 124 each
 DC resistance: 1.2 Ω each
 Maximum coil current: 5 A each
 Terminals: 4 mm safety sockets
 Weight: 4.1 kg approx.
 Max. field: 3.8 mT

U8481500

Additionally recommended:

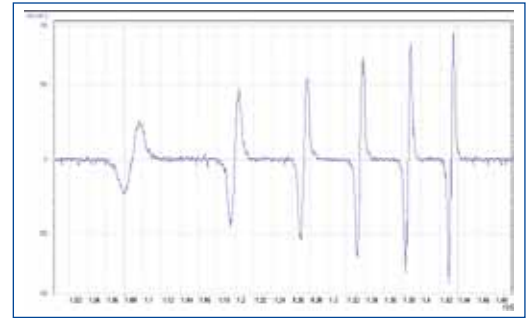
- U11360 Magnetic Field Sensor**

Tube with Six Induction Coils

Plastic tube with six identical induction coils connected in series. When the bar magnet provided is allowed to fall through the tube, a voltage is induced in each of the coils in turn. As the velocity of the magnet increases with time during its fall, the amplitudes of the voltage peaks also increase, and their width decreases. The area under each voltage peak remains constant.

Coil width: 10 mm
 Distance between coils: 190 mm
 Dimensions: approx. 1500 mm x 20 mm diam.
 Weight: approx. 500 g

U8511200



The induced voltage as a function of time.



Electromotor and Generator

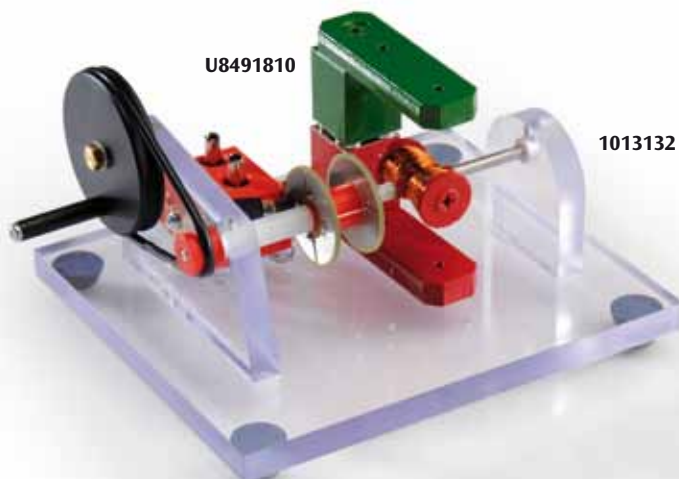
Functioning model to demonstrate how a direct current motor and direct current generator alternating current generator respectively operates. The model is equipped with a commutator and slip-rings and mounted on an acrylic plate with connection sockets, drive pulley and rubber belt.

Dimensions: approx. 200x140x60 mm³
 Weight: approx. 370 g

1013132

Additionally required:

- U8491810 Horseshoe Magnet 70 mm**





Waltenhofen's Pendulum

Equipment set for the demonstration of the effects of eddy currents and braking. A pendulum object composed of a solid steel plate swings back and forth between the poles of an electromagnet with the power switched off. When the magnet is switched on, the pendulum motion of the object comes to an almost immediate halt. If the plate contains slots more time elapses before the plate stops moving, i.e. the braking effect is severely reduced. The equipment set consists of a pendulum rod and four aluminium pendulum plates with various shapes: rectangle, rectangle with slits, circular disk, ring and ring with slits.

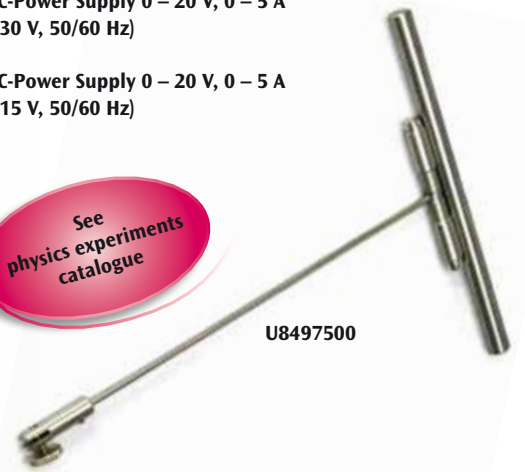
- Rectangular: approx. 100x60 mm²
- Ring: approx. 30 mm diam. (interior),
approx. 60 mm diam. (exterior)

U8497500

Additionally required:

- U8497180 Transformer Core D**
 - U8497200 Pair of Pole Pieces**
 - U8497440 Coil with 1200 Turns (2x)**
 - U33020-230 DC-Power Supply 0 – 20 V, 0 – 5 A**
(230 V, 50/60 Hz)
- or
- U33020-115 DC-Power Supply 0 – 20 V, 0 – 5 A**
(115 V, 50/60 Hz)

See physics experiments catalogue



Set of 3 Induction Coils

Coils for experiments on induction in combination with the 120 mm diameter field coil (U12253) and for experiments on resonant electric circuits. The coils are only designed for safety extra low voltage (SELV). The spools are made of transparent acrylic plastic.

- Connection: 4 mm safety sockets
- Coil length: 170 mm
- Coil 1**
- Number of turns: 300 with taps at 100 and 200 turns
- Coil cross section: 50x50 mm²
- Coil 2**
- Number of turns: 300
- Coil cross section: 50x30 mm²
- Coil 3**
- Number of turns: 300
- Coil cross section: 50x20 mm²

U122501

Additionally recommended:
U12253 Field Coil 120 mm diam.



Variable Inductance Coil

Coils for measuring inductance and self-inductance of a current-carrying coil depending on the insertion of an iron core and for investigating AC circuits. Coil of copper wire in a shock-resistant plastic casing with lifting handles. A coated iron core is mounted on a worm screw for moving in and out of the coil. With printed scale in cm for reading the length of core inserted into the coil.

- Number of windings: 3000
- Max. permissible voltage: 30 V AC, 60 V DC
- Max. permissible current: 2 A
- Inductance at 1 A: approx. 0.15 – 1.4 H, continuously adjustable
- Resistance: 12.5 Ω
- Terminals: 4 mm safety plugs
- Dimensions: approx. 265x145x130 mm³
- Weight: approx. 6.2 kg

U21903



No batteries,
a simple shake
is enough.

Induction Torch

Tough torch with bright LED. Shaking the torch causes a magnet to move back and forth inside a coil, thus generating a current in accordance with Faraday's laws of induction. The current charges a built-in storage cell. One minute of shaking is enough to provide about five minutes of light.

Dimensions: 175 mm x 40 mm diam.
Weight: 125 g

U29615



U29615

NEW

Lenz's Law Copper Tube

Handy demonstration apparatus for illustrating Lenz's law and induction of eddy currents. A small steel cylinder and a magnet of the same dimensions fall at different speeds through a copper tube because the motion of the magnet causes eddy currents to be induced, resulting in a magnetic field which slows the fall of the magnet. Includes 2 plastic caps so that the tube can be used as a container.

Length: 320 mm approx.
Diameter: 15 mm approx.

U30086



U30086

Lenz's Law Apparatus

Instrument for demonstrating Lenz's Law qualitatively by bringing a magnet close to it. One closed and one open conductor loop, with point bearing on base.

Length: approx. 195 mm
Height: approx. 110 mm

1009959

Additionally required:

U20550 Cylindrical Bar Magnet 200x10



1009959

Bicycle Dynamo, Transparent

Bicycle dynamo in transparent housing. It is possible to observe the movement of the generator components while the dynamo is in operation.

Generated voltage: 6 V approx.
Generated power: 3 W
Dimensions: 95x34x25 mm³ approx.

U29538



U29538

NEW

Experiment Motor with Gearbox

Experiment motor for universal use in experiments on rotational motion, e.g. for experiments using the rings demonstrating flattening of the earth (U8403120) or Watt's governor (U8403115). Can also be used as a generator in conjunction with the included hand crank. Robust clockwise and counter-clockwise rotating IDC motor with epicyclic gearbox and quick-action chuck in a tough anodized aluminum casing with removable and adjustable stainless steel stand rod. Can also be mounted on the clamp for the projectile launcher (U10361). Speed of rotation is adjusted by altering the supply voltage. Adjustable torque. Includes 3 belt pulleys of different diameters on a mounting axle.

Speed without load: approx. 480 rpm at 12 V
Speed sensitivity: approx. 40 rpm per V
Span of chuck: 0.8 to 10 mm
Stand rod: 12 mm diam.
Pulleys: 10 mm diam., 20 mm diam., 40 mm diam.
Axle: 10 mm diam.
Drive belt: 130 mm diam. x 4 mm
Nominal voltage: 12 V DC, 5A
Connection: via 4-mm safety sockets
Dimensions: 210x95x60 mm³
Mass: 1.2 kg

U10375



U10375

Contents:
Experiment motor
Stand rod with knurled screws

Hand crank
Pulleys
Drive belt

Additionally required:

U33020-230 DC Power Supply 0 – 20 V, 5 A (230 V, 50/60 Hz)
or
U33020-115 DC Power Supply 0 – 20 V, 5 A (115 V, 50/60 Hz)

Additionally recommended:

U40160-230 Digital Stroboscope (230 V, 50/60 Hz)
or
U40160-115 Digital Stroboscope (115 V, 50/60 Hz)

Experiment topics:

- Voltage transformation
- Transformer under load
- Current transformation
- Autotransformer
- Leakage field experiments
- Induction oven
- Point welding
- Fusing experiments



Primary or Secondary Coils for Transformer Core D

Coils, covered with impact resistant plastic so that they are safe to touch, for use as primary or secondary coils in combination with transformer core D (U8497180). With safety connection sockets. As secondary coils these can output either low or high voltage, depending on the primary voltage, and therefore they cannot be used in student experiments.

	U8497430	U8497440	U8497450
Number of turns	600	1200	6000
Taps	200/600	400/1200	2000/6000
Resistance	3 Ω	12 Ω	300 Ω
Max. current	2.2 A	1.2 A	0.2 A
Inductance	15 mH	60 mH	1,5 H

Low Voltage Coil D

Secondary coil for use with a transformer core D (U8497180) to generate low voltages up to 28 V. With five tapping points. Covered by impact resistant plastic, safe to touch.

Terminals: Safety sockets
 Number of turns: 72
 Taps: 6/ 30/ 54/ 66/ 72
 Resistance: 0.1 Ω
 Max. current: 12 A
 Inductance: 0.23 mH

U8497410

Additionally required:

U8497180 Transformer Core D

U8497420-230 Mains Coil with Connecting Lead (230 V, 50/60 Hz)

or

U8497420-115 Mains Coil with Connecting Lead (115 V, 50/60 Hz)

Mains Coil with Connecting Lead

Coil that is safe to touch with mains connecting lead for use as primary coil in combination with the transformer core D (U8497180). Covered by impact resistant plastic, safe to touch.

- High voltage experiments



U8497180, U8497420-230/U8497420-115, U8497410

Transformer Core D

U shaped core made of high grade laminated transformer plates, with removable yoke. Provided with two clips for securing the yoke or attaching special pole shoes with drilled holes (U8497200).

Cross-section of core: 40x40 mm²

U-core: approx. 150x130 mm²

Length of yoke: approx. 150 mm

Weight: approx. 6 kg

U8497180

High Voltage Coil Including 2 Horn Shaped Electrodes

Secondary coil for transformer core D (U8497180), generating high voltages which can cause spark discharges between two shielded horn electrodes. Covered with impact resistant plastic, safe to touch.

Number of turns: 24000

Open-circuit voltage: approx. 9200 V

Resistance: 10 kΩ

Max. current: 0.02 A

Inductance: 28 H

U8497460

Additionally required:

U8497180 Transformer Core D

U8497420-230 Mains Coil with Connecting Lead (230 V, 50/60 Hz)

or

U8497420-115 Mains Coil with Connecting Lead (115 V, 50/60 Hz)

High Current Coil for Nail Fusing Experiment

Secondary coil for use with the transformer core D (U8497180) to generate a large current sufficient to melt nails. Covered by impact resistant plastic.

Number of turns: 6

Resistance: 3 mΩ

Max. current: 60 A

Inductance: 0.25 mH

U8497406



	U8497420-230	U8497420-115
Description	Mains Coil with Connecting Lead (230 V, 50/60 Hz)	Mains Coil with Connecting Lead (115 V, 50/60 Hz)
Number of turns	600	300
Resistance	3 Ω	0.75 Ω
Max. current	2.2 A	4.4 A
Inductance	15 mH	7.5 mH

NEW



1012859

Coil D, 900 Turns

Coil with 900 turns and thermal overload protection. For generating powerful magnetic fields in conjunction with the U-core (U8497215).

Number of turns: 900
 Inductance: approx. 34 mH
 Resistance: approx. 4.8 Ω (at room temperature)
 approx. 6.0 Ω (at maximum amperage)

Maximum permissible amperage: 5 A (for approx. 7 minutes)
 Waiting time for reactivation after thermal overload: approx. 10 minutes
 Weight: approx. 1.6 kg

1012859



U8497331

U8497470

Metal Ring

Metal ring for performing Thomson's ring experiment in conjunction with the mains coil (U8497420-230 resp. U8497420-115) and the transformer core D (U8497180). First the metal ring is fitted around one stem of a U core and allowed to rest on the mains coil. The stem of the U core is extended by the yoke positioned vertically on top of it. When the mains coil is switched on the ring jumps into the air.

Diameter: 55 mm

U8497470

Additionally required:

U8497180 Transformer Core D
U8497420-230 Mains Coil with Connecting Lead (230 V, 50/60 Hz)
 or
U8497420-115 Mains Coil with Connecting Lead (115 V, 50/60 Hz)

High Current Coil with Five Turns

Secondary coil for transformer core D (U8497180), generating high voltages which can be used for spot-welding of metal sheets up to 2 mm thick.

Number of turns: 5
 Short-circuit current: approx. 260 A
 Coil diameter: 57 mm
 Weight: approx. 650 g

U8497320

Additionally required:

U8497330 Set of Metal Strips
U8497180 Transformer Core D
U8497420-230 Mains Coil with Connecting Lead (230 V, 50/60 Hz)
 or
U8497420-115 Mains Coil with Connecting Lead (115 V, 50/60 Hz)



U8497320

Set of Metal Strips

Five metal strips used to demonstrate spot welding techniques in conjunction with a coil with 5 turns (U8497320).

Dimensions: 120x10 mm²

U8497330



U8497330

Set of 20 Nails for Nail Fusing Experiment

20 nails for experiments involving fusing using high current coil (U8497406).

U8497331



U8497310

Fusion Ring

Circular aluminium channel with insulated handle for demonstrating the principle of induction melting, when used as a secondary coil with the transformer core D (U8497180).

Max. current: approx 1300 A
 Internal diameter: approx. 57 mm
 Weight: approx. 80 g

Suitable melting materials:

Wood's Alloy, Tin

U8497310

Additionally required:

U8497180 Transformer Core D
U8497420-230 Mains Coil with Connecting Lead (230 V, 50/60 Hz)
 or
U8497420-115 Mains Coil with Connecting Lead (115 V, 50/60 Hz)



U8497220



U8497200

Pair of Pole Shoes

Pair of pole shoes with conical ends for generating a highly non uniform magnetic field when fitted onto the U core (U8497215). Provided with holes for optical experiments in a magnetic field.

Pole shoe: approx. 40x40 mm²
Weight: approx. 1.7 kg

U8497200



U8497215



U8497181

Pole Shoe Fitting

Pole shoe fitting with adjustable separation for generating a uniform magnetic field on a U-shaped core (U8497215). Includes two 20-mm spacers, four 10 mm spacers and four 5 mm spacers.

Dimensions: 150x120x40 mm
Weight: 5.7 kg

U8497220

U Core

U shaped transformer core D (U8497180).

U8497215

Pair of Clamps

Pair of clamps from the transformer core D (U8497180).

U8497181



1009935

NEW



U8498112

Pair of Pole Shoes and Clamping Brackets for Hall Effect

Pair of pole pieces for experiments on the semiconductor Hall effect. Including clamping brackets for mounting on the U-core (U8497215).

Pole shoe dimensions: 40x40x75 mm³
Total weight: approx. 2 kg

1009935

Transformer Core S

U-core with removable yoke made of high quality transformer laminate.

Core cross section: 20x20 mm approx.
U-core: 70x70 mm approx.
Length of yoke: 70 mm approx.

U8498112



U8498090, U8498070

High Current Coil S

Secondary coil for transformer core S (U8498112) for generating high current output.

No. of windings: 22
Max. Current: 10 A

U8498065



U8498070-U8498090

U8498065

Transformer Coils S

Impact resistant plastic covered coils, safe to touch, for assembling a transformer in conjunction with the transformer core S (U8498112).

Maximum voltage: 50 V (safety extra-low voltage)
Terminals: 4 mm safety sockets
Opening for iron cores: approx. 20x20 mm²

Art. No.	Number of turns	Taps	Inductance
U8498070	600	200/400/600	approx. 6 mH
U8498080	800	400/800	approx. 10 mH
U8498085	1200	400/800/1200	approx. 25 mH
U8498090	2400	800/1600/2400	approx. 100 mH

Experiment Topics:

- Hertzian waves (high frequency electromagnetic waves)
- Absorption and transmission
- Corona discharge
- Spark discharge
- Wireless transmission of energy to a fluorescent lamp
- Standing waves on a Tesla coil

BEST SELLER

Tesla Transformer

Classic Tesla transformer for the generation of a safe high frequency high voltage starting from approx. 100 kV. The well-conceived, open configuration of all components facilitating demonstration of both design and function. The apparatus is rendered shock proof on account of its extra low voltage operation.

No. of turns in the primary coil:	2–10
No. of turns in the secondary coils:	1150
Primary voltage:	20 V AC
Secondary voltage:	>100 kV
Transformer:	approx. 330x200x120 mm ³
Secondary coils:	approx. 240 mm x 75 mm diam.
Weight:	approx. 3 kg

Contents:

- 1 Tesla transformer, basic apparatus
- 1 Hand coil
- 1 Secondary coil
- 1 Spherical electrode, short
- 1 Spherical electrode, long
- 1 Needle electrode with spray wheel
- 1 Fluorescent tube
- 1 Reflector

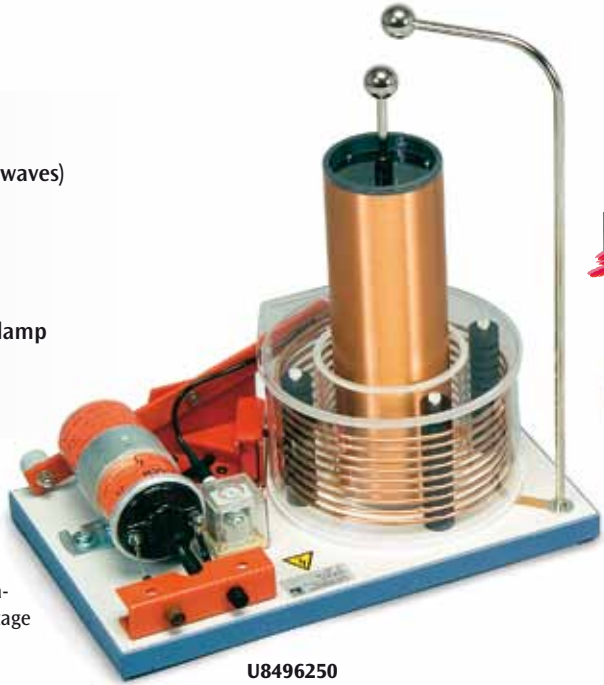
U8496250

Additionally required:

U33035-230 AC/DC Power Supply 0 – 30 V, 6 A (230 V, 50/60 Hz) or
U33035-115 AC/DC Power Supply 0 – 30 V, 6 A (115 V, 50/60 Hz)

Additionally recommended:

U8496255 Additional Coil for Tesla Transformer



U8496250



Tesla Transformer

AC/DC Power Supply, 0–30 V, 0–6 A

Combined power supply with separate AC and DC outputs plus separate displays of output voltage and current. The DC output can be used as a voltage source or current source and can be set to any value within its range. The AC output features current limiting and is electronically protected against overload.

DC voltage:	0...30 V
DC current:	0...6 A
AC voltage:	0...30 V
AC current:	max. 6 A
Dimensions:	380x140x300 mm ³
	approx.
Weight:	12 kg approx.

AC/DC Power Supply, 0 – 30 V, 0 – 6 A (230 V, 50/60 Hz)

U33035-230

AC/DC Power Supply, 0 – 30 V, 0 – 6 A (115 V, 50/60 Hz)

U33035-115

U33035-230
U33035-115

Additional Coil for Tesla Transformer

Additional secondary coil for Tesla transformer (U8496250).

Dimensions: approx.
 240 mm x 75 mm diam.

U8496255



U8496255

NEW



Experiment topics:

- Thermionic emission of electrons
- Linear propagation of electrons in field free spaces
- Deflection in magnetic and electric fields
- Determination of the polarity of electron charges
- Determination of specific charge e/m
- Inelastic electron collisions
- Luminescence
- Wave and particle nature of electrons

TELTRON® Electron Tubes D

Electron tubes with thermionic cathodes for experimental investigations of the properties of electrons and various topics in atomic physics as well as for applications in standard cathode ray tube technology. Some electron tubes are operated at voltages up to 500 V, others at high voltages. During operation at high voltages of up to 5 kV, no ionizing radiation occurs outside the tubes, thus eliminating the need for radiation protection measures. All the tubes in the D series can be inserted into the tube holder D (U191001, to which it is possible to add the pair of Helmholtz coils D (U191051) necessary to generate a uniform magnetic field.

Electron Diffraction Tube D

Highly evacuated electron tube for demonstrating the wave nature of electrons through the observation of interference caused by passage of electrons through a polycrystalline graphite lattice (Debye-Scherrer diffraction) and rendered visible on a fluorescent screen. Also intended for determining the wavelength as a function of the anode voltage from the radii of the diffraction rings and the lattice plane spacing of graphite, as well as confirming de Broglie's hypothesis.

Filament voltage:	6.3 V AC
Max. anode voltage:	5000 V
Anode current:	approx. 0.1 mA at 4000 V
Focussing voltage:	0 – 50 V
Lattice constant of graphite:	$d_{10} = 0.213 \text{ nm}$, $d_{11} = 0.123 \text{ nm}$

U19171

Additionally required:

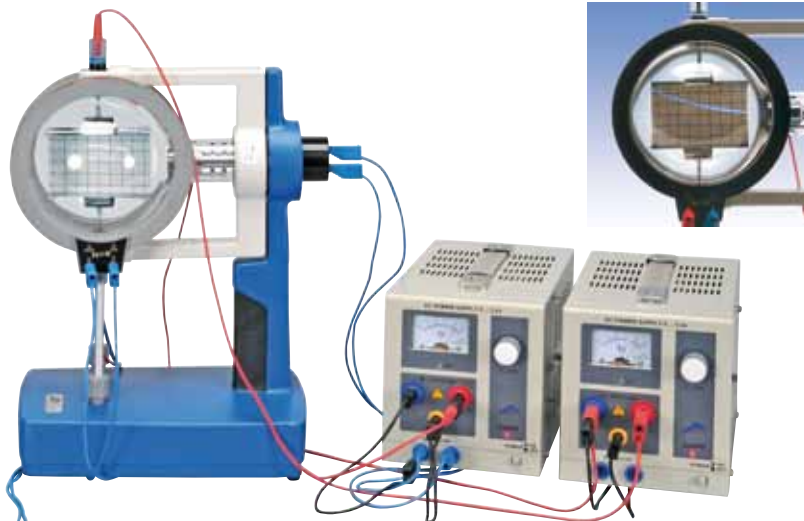
- U191001 Tube Holder D**
- U138101 Set of Leads for Electron Tube Experiments**
- U33010-230 High Voltage Power Supply, 5 kV**
(230 V, 50/60 Hz) or
- U33010-115 High Voltage Power Supply, 5 kV**
(115 V, 50/60 Hz)

Additionally recommended:

- 1009960 Three-Pole Protective Adapter**

Note:

When using just one high-voltage power supply, the anode voltage and capacitor voltage cannot be selected independently of one another.



U19155



U19171

Electron Deflection Tube D

Highly evacuated electron tube with focusing electron gun and fluorescent screen inclined relative to the beam axis, so that the path of the beam can be seen and the effects of electric and magnetic fields can be studied. The electron beam can be deflected electrically in the electric field of the built-in plate capacitor, and magnetically by using the Helmholtz pair of coils D (U191051). By adjusting the electric field so that it cancels the magnetic deflection, it is possible to determine the specific charge e/m and the velocity of the electrons.

Filament voltage:	6.3 V AC
Max. anode voltage:	5000 V
Anode current:	approx. 0.1 mA at 4000 V
Max. capacitor voltage:	5000 V
Fluorescent screen:	approx. 90x60 mm ²
Glass bulb:	approx. 130 mm diam.
Total length:	approx. 260 mm

U19155

Additionally required:

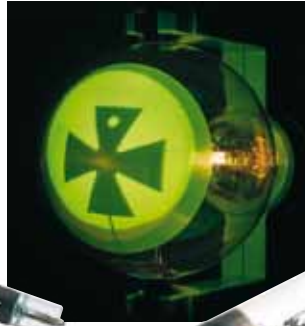
- U191001 Tube Holder D**
- U138101 Set of Leads for Electron Tube Experiments**
- U191051 Helmholtz Pair of Coils D**
- U33010-230 High Voltage Power Supply, 5 kV**
(230 V, 50/60 Hz) (2x)
- U33020-230 DC-Power Supply 0 – 20 V, 0 – 5 A**
(230 V, 50/60 Hz) or
- U33010-115 High Voltage Power Supply, 5 kV**
(115 V, 50/60 Hz) (2x)
- U33020-115 DC-Power Supply 0 – 20 V, 0 – 5 A**
(115 V, 50/60 Hz)

Additionally recommended:

- 1009961 Two-Pole Protective Adapter**



U19154



U19153

Perrin Tube D

Highly evacuated electron tube with focusing electron gun, fluorescent screen, and Faraday cage positioned on one side. For demonstrating the negative polarity of electrons and estimating the specific electron charge (charge-to-mass ratio) e/m by magnetic deflection into the Faraday cage, which is connected to an electroscope (U17250). It is also possible to investigate the deflection of electrons by two magnetic fields at right-angles to each other and to demonstrate the effects, for example by generating Lissajou figures.

- Filament voltage: 6.3 V AC
- Max. anode voltage: 5000 V
- Anode current: approx. 0.1 mA at 4000 V
- Beam current: 4 μ A at 4000V
- Glass bulb: approx. 130 mm diam.
- Luminescent screen: 85 mm diam.
- Total length: approx. 250 mm

U19154

Additionally required:

- U191001 Tube Holder D**
- U138101 Set of Leads for Electron Tube Experiments**
- U191051 Helmholtz Pair of Coils D**
- U33010-230 High Voltage Power Supply, 5 kV**
(230 V, 50/60 Hz)
- U33020-230 DC-Power Supply 0 – 20 V, 0 – 5 A**
(230 V, 50/60 Hz) or
- U33010-115 High Voltage Power Supply, 5 kV**
(115 V, 50/60 Hz)
- U33020-115 DC-Power Supply 0 – 20 V, 0 – 5 A**
(115 V, 50/60 Hz)

Additionally recommended:

- U17250 Electroscop**
- U19106 Auxiliary Coil**
- 1009961 Two-Pole Protective Adapter**

Luminescence Tube D

Highly evacuated electron tube with divergent electron gun and three fluorescent strips in red, green and blue. For demonstrating stimulated light emission during and after electron bombardment.

- Filament voltage: 6.3 V AC
- Max. anode voltage: 5000 V
- Anode current: approx. 0.1 mA at 4000 V
- Glass bulb: approx. 130 mm diam.
- Total length: approx. 260 mm

U19152

Additionally required:

- U191001 Tube Holder D**
- U138101 Set of Leads for Electron Tube Experiments**
- U33010-230 High Voltage Power Supply, 5 kV**
(230 V, 50/60 Hz) or
- U33010-115 High Voltage Power Supply, 5 kV**
(115 V, 50/60 Hz)

Additionally recommended:

- 1009961 Two-Pole Protective Adapter**

Maltese-Cross Tube D

Highly evacuated electron tube with divergent electron gun, fluorescent screen and Maltese cross. For demonstrating the straight line propagation of electrons in the absence of any electric or magnetic field by projecting the shadow of a Maltese cross onto the fluorescent screen and for introducing students to electron optics.

- Filament voltage: 6.3 V AC
- Max. anode voltage: 5000 V
- Anode current: approx. 0.1 mA at 4000 V
- Glass bulb: approx. 130 mm diam.
- Luminescent screen: 85 mm diam.
- Total length: approx. 260 mm

U19153

Additionally required:

- U191001 Tube Holder D**
- U138101 Set of Leads for Electron Tube Experiments**
- U33010-230 High Voltage Power Supply, 5 kV**
(230 V, 50/60 Hz) or
- U33010-115 High Voltage Power Supply, 5 kV**
(115 V, 50/60 Hz)

Additionally recommended:

- 1009961 Two-Pole Protective Adapter**
- U191051 Helmholtz Pair of Coils D**
- U33020-230 DC-Power Supply 0 – 20 V, 0 – 5 A**
(230 V, 50/60 Hz) or
- U33020-115 DC-Power Supply 0 – 20 V, 0 – 5 A**
(115 V, 50/60 Hz)



U19152



**Triode D**

Highly evacuated electron tube with thermionic cathode, control grid and anode for quantitative investigation of controllable high vacuum tubes, plotting the characteristics of a triode, demonstrating the negative polarity of the electron charge, studying the practical applications of a triode as an amplifier and generating undamped oscillations in LC circuits.

Max. heater voltage: 7.5 V AC/DC

Max. anode voltage: 500 V

Anode current: approx. 2 mA at 200 V anode voltage

Glass bulb: approx. 130 mm diam.

Total length: approx. 260 mm

U19151

Additionally required:

U191001 Tube Holder D

U138101 Set of Leads for Electron Tube Experiments

U17450 Analogue Multimeter AM50

U33000-230 DC Power Supply, 0 – 500 V (230 V, 50/60 Hz)

or

U33000-115 DC Power Supply, 0 – 500 V (115 V, 50/60 Hz)

Additionally recommended:

1009961 Two-Pole Protective Adapter

Diode D

Highly evacuated electron tube with thermionic cathode and anode for investigating the thermoelectric effect (Edison effect) and measuring the emission current as a function of the heating power applied to the cathode. Also for plotting diode characteristics and for demonstrating the rectifying effect of a diode.

Max. heater voltage: 7.5 V AC/DC

Max. anode voltage: 500 V

Anode current: approx. 2 mA at 200 V Anode voltage

Glass bulb: approx. 130 mm diam.

Total length: approx. 260 mm

U191501

Gas Triode D

Electron tube filled with low pressure helium gas, with thermionic cathode, control grid, and anode for quantitative investigations of the typical properties of a gas-filled triode, recording the $I_A - U_A$ characteristics of a thyatron, observing independent and dependent discharges as well as discontinuous energy release of He atoms during inelastic collisions with free electrons.

Max. heater voltage: 7.5 V AC/DC

Max. anode voltage: 500 V

Anode current: approx. 10 mA at 200 V anode voltage

Glass bulb: approx. 130 mm diam.

Total length: approx. 260 mm

U19157

Additionally required:

U191001 Tube Holder D

U138101 Set of Leads for Electron Tube Experiments

U17450 Analogue Multimeter AM50

U33000-230 DC Power Supply, 0 – 500 V (230 V, 50/60 Hz)

or

U33000-115 DC Power Supply, 0 – 500 V (115 V, 50/60 Hz)

Additionally recommended:

1009961 Two-Pole Protective Adapter

Additionally required:

U191001 Tube Holder D

U138101 Set of Leads for Electron Tube Experiments

U17450 Analogue Multimeter AM50

U33000-230 DC Power Supply, 0 – 500 V (230 V, 50/60 Hz)

or

U33000-115 DC Power Supply, 0 – 500 V (115 V, 50/60 Hz)

Additionally recommended:

1009961 Two-Pole Protective Adapter

Known throughout the world
TELTRON®

		U191501	U19151	U19157
		Diode D	Triode D	Gas Triode D
U191001	Tube Holder D	required	required	required
U138101	Set of Leads for Electron Tube Experiments	required	required	required
U33000-230 or U33000-115	Power Supply, 500 V DC	required	required	required
U33010-230 or U33010-115	High Voltage Power Supply, 5 kV	–	–	–
U191051	Helmholtz Pair of Coils D	–	–	–
U33020-230 or U33020-115	DC-Power Supply 20 V	–	–	–
U17450	Analogue Multimeter AM50	required	required	required
1009961	Two-Pole Protective Adapter	recommended	recommended	recommended
1009960	Three-Pole Protective Adapter	–	–	–
U19106	Auxiliary Coil	–	–	–
U17250	Electroscope	–	–	–

Dual Beam Tube D

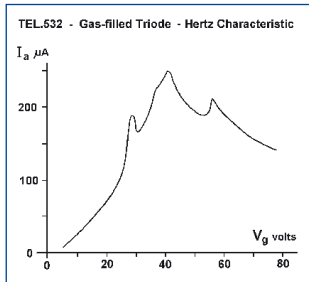
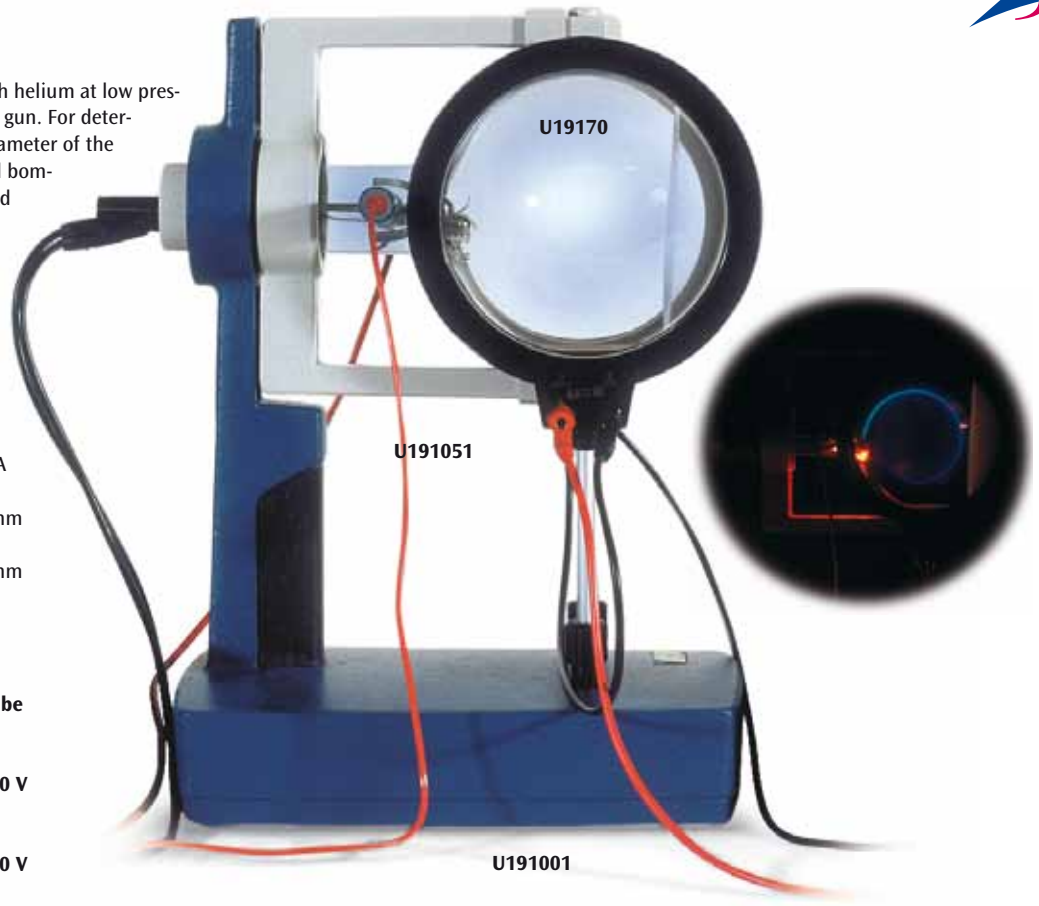
Part evacuated electron tube, filled with helium at low pressure, with tangential and axial electron gun. For determining specific charge e/m from the diameter of the filament beam in the case of tangential bombardment and a perpendicularly aligned magnetic field, and observing spiral paths of electrons in the case of axial bombardment and a co-axial magnetic field. The electron paths are rendered visible in the form of fine luminescent beams through impact excitation of the helium atoms.

- Max. filament voltage: 7.5 V
- Max. anode voltage: 100 V DC
- Anode current: approx. 30 mA
- Max. deflection voltage: 50 V DC
- Glass bulb: approx. 130 mm diam.
- Total length: approx. 260 mm

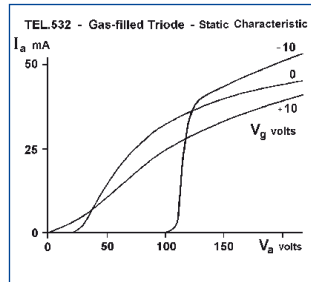
U19170

Additionally required:

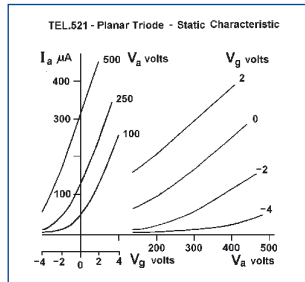
- U191001 Tube Holder D**
- U138101 Set of Leads for Electron Tube Experiments**
- U191051 Helmholtz Pair of Coils D**
- U33000-230 DC Power Supply, 0 – 500 V (230 V, 50/60 Hz)**
- or
- U33000-115 DC Power Supply, 0 – 500 V (115 V, 50/60 Hz)**



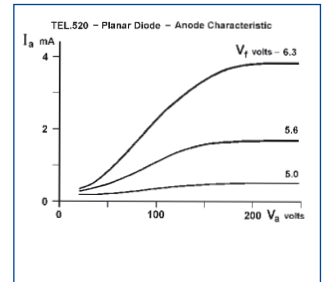
U19157: Anode current I_A as a function of the anode voltage U_A at different grid voltages U_G



U19157: Electron collision excitation in Helium as a function of the acceleration voltage U_C



U19151: Anode current I_A as a function of the grid voltage U_G and as a function of the anode voltage U_A at different grid voltage U_G



U191501: Anode current I_A as a function of the anode voltage U_A

U19170	U19152	U19153	U19154	U19155	U19171
Dual Beam Tube D	Luminescence Tube D	Maltese Cross Tube D	Perrin Tube D	Electron Deflection Tube D	Electron Diffraction Tube D
required	required	required	required	required	required
required	required	required	required	required	required
required	–	–	–	–	–
–	required	required	required	2x required	required
required	–	recommended	required	required	–
–	–	recommended	required	required	–
–	–	–	–	–	–
–	recommended	recommended	recommended	recommended	–
–	–	–	–	–	recommended
–	–	–	recommended	–	–
–	–	–	recommended	–	–

NEW



1009961

Protective Adapter, 3-Pole

Adapter for electron refraction tube D (U19171) for connection of the heater voltage via safety experiment leads. Includes internal protective circuitry to protect the heating filament against excess voltage. Dimensions match the three-pole connector for the tube.

1009960

Protective Adapter, 2-Pole

Adapter for electron tubes D for connection of the heater voltage via safety experiment leads. Includes internal protective circuitry to protect the heating filament against excess voltage. Dimensions match the two-pole connector for the tubes.

1009961

Auxiliary Coil

Extra coil for generating an additional magnetic field in a Perrin tube, for example, to demonstrate the principle of an oscilloscope and for generating Lissajou's figures.

- Number of turns: 1000
- DC resistance: approx. 7 Ω
- Load rating: max. 2 A
- Connections: 4 mm jacks
- Dimensions: approx. 33 mm x 80 mm diam.

U19106



U191051

Helmholtz Pair of Coils D

Pair of coils for generating a uniform magnetic field perpendicular to the axis of a tube when using the tube holder D (U191001). In plastic sleeve on an insulated stand rod.

- Coil diameter: 136 mm
- Number of turns: 320 each
- Effective resistance: approx. 6.5 Ω each
- Load rating: 1.5 A each
- Terminals: 4 mm sockets
- Rod: approx. 145 mm x 8 mm diam.

U191051

Additionally recommended:

U33020-230 DC-Power Supply 0 – 20 V, 0 – 5 A
(230 V, 50/60 Hz)

or

U33020-115 DC-Power Supply 0 – 20 V, 0 – 5 A
(115 V, 50/60 Hz)



1009960



U191001

Tube Holder D

Tube holder made of robust plastic for holding electron tubes of the D series and the optical equivalent (U19172). With 360° rotating clamp made of heat-resistant plastic and two holes for fixing the Helmholtz coil pair D (U191051). On rubber feet to prevent slipping.

- Dimensions: approx. 230x175x320 mm³
- Weight: approx. 1.5 kg

U191001



U19106

Experiment topics:

- Thermionic emission of electrons
- Linear propagation of electrons in field free spaces
- Deflection in magnetic and electric fields
- Determination of the polarity of electron charges
- Determination of specific charge e/m
- Luminescence
- Excitation spectra of noble gases
- Inelastic electron collisions
- Resolution of primary and secondary quantum numbers of atomic excitation levels
- Wave and particle nature of electrons



U18555

Thomson Tube S

Highly evacuated electron tube with focusing electron gun and fluorescent screen inclined relative to the beam axis, so that the path of the beam can be seen and the effects of electric and magnetic fields can be studied. The electron beam can be deflected electrically in the electric field of the built-in plate capacitor, and magnetically by using the Helmholtz coil pair S (U185051). By adjusting the electric field so that it cancels the magnetic deflection, it is possible to determine the specific charge e/m and the velocity of the electrons.

Filament voltage: 6.3 V AC
 Max. anode voltage: 5000 V
 Anode current: approx. 0.1 mA at 4000 V
 Max. Capacitor voltage: 500 V
 Glass bulb: approx. 130 mm diam.
 Total length: approx. 250 mm

U18555

Additionally required:

U185001 Tube Holder S

U138021 Set of 15 Safety Experiment Leads, 75 cm

U185051 Helmholtz Pair of Coils S

U33010-230 High Voltage Power Supply, 5 kV
 (230 V, 50/60 Hz)

U33010-230 Power Supply, 500 V DC (230 V, 50/60 Hz)
 or

U33010-115 High Voltage Power Supply, 5 kV
 (115 V, 50/60 Hz)

U33000-115 Power Supply, 500 V DC (115 V, 50/60 Hz)

TELTRON® Electron Tubes S

Electron tubes with thermionic cathodes for experimental investigations of the properties of electrons and various topics in atomic physics as well as for applications in standard cathode ray tube technology. Some electron tubes are operated at voltages up to 500 V, others at high voltages. During operation at high voltages of up to 5 kV, no ionizing radiation occurs outside the tubes, thus eliminating the need for radiation protection measures. All the tubes in the S series can be inserted into the tube holder S (U185001), to which it is possible to add the pair of Helmholtz coils S (U185051) necessary to generate a uniform magnetic field.

BEST SELLER

See physics experiments catalogue



...going one step further

BEST SELLER



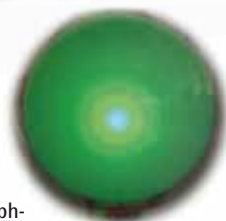
U18553



U18554



U18571



Free Electrons in Gases and in Vacuum

Maltese Cross Tube S

Highly evacuated electron tube with divergent electron gun, fluorescent screen and Maltese cross. For demonstrating the straight line propagation of electrons in the absence of any electric or magnetic field by projecting the shadow of a Maltese cross onto the fluorescent screen and for introducing students to electron optics.

- Filament voltage: 6.3 V AC
- Max. anode voltage: 5000 V
- Anode current: approx. 0.1 mA at 4000 V
- Glass bulb: approx. 130 mm diam.
- Luminescent screen: approx. 85 mm diam.
- Total length: approx. 250 mm

U18553

Additionally required:

- U185001 Tube Holder S**
- U138021 Set of 15 Safety Patch Cords, 75 cm**
- U33010-230 High Voltage Power Supply, 5 kV (230 V, 50/60 Hz)**
- or
- U33010-115 High Voltage Power Supply, 5 kV (115 V, 50/60 Hz)**

Additionally recommended:

- U185051 Helmholtz Pair of Coils S**
- U33020-230 DC-Power Supply 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz)**
- or
- U33020-115 DC-Power Supply 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz)**

Luminescence Tube S

Highly evacuated electron tube with divergent electron gun and three fluorescent strips in red, green and blue. For demonstrating stimulated light emission during and after electron bombardment.

- Filament voltage: 6.3 V AC
- Max. anode voltage: 5000 V
- Anode current: approx. 0.1 mA at 4000 V
- Glass bulb: approx. 130 mm diam.
- Total length: approx. 250 mm

U18552

Additionally required:

- U185001 Tube Holder S**
- U138021 Set of 15 Safety Patch Cords, 75 cm**
- U33010-230 High Voltage Power Supply, 5 kV (230 V, 50/60 Hz)**
- or
- U33010-115 High Voltage Power Supply, 5 kV (115 V, 50/60 Hz)**

Electricity and Magnetism

Electron Diffraction Tube S

Highly evacuated electron tube for demonstrating the wave nature of electrons through the observation of interference caused by passage of electrons through a polycrystalline graphite lattice (Debye-Scherrer diffraction) and rendered visible on a fluorescent screen. Also intended for determining the wavelength as a function of the anode voltage from the radii of the diffraction rings and the lattice plane spacing of graphite, as well as confirming de Broglie's hypothesis.

- Filament voltage: 6.3 V AC
- Max. anode voltage: 5000 V
- Anode current: approx. 0.1 mA at 4000 V
- Lattice constant of graphite: $d_{10} = 0.213 \text{ nm}$, $d_{11} = 0.123 \text{ nm}$

U18571

Additionally required:

- U185001 Tube Holder S**
- U138021 Set of 15 Safety Experiment Leads, 75 cm**
- U33010-230 High Voltage Power Supply, 5 kV (230 V, 50/60 Hz)**
- or
- U33010-115 High Voltage Power Supply, 5 kV (115 V, 50/60 Hz)**

Perrin Tube S

Highly evacuated electron tube with focusing electron gun, fluorescent screen, and Faraday cage positioned on one side. For demonstrating the negative polarity of electrons and estimating the specific electron charge (charge to mass ratio) e/m by magnetic deflection into the Faraday cage, which is connected to an electroscopes (U17250). It is also possible to investigate the deflection of electrons by two alternating magnetic fields at right-angles to each other or by parallel electric and magnetic fields and to demonstrate the effects, for example by generating Lissajous figures.

- Filament voltage: 6.3 V AC
- Max. anode voltage: 5000 V
- Anode current: approx. 0.1 mA at 4000 V
- Beam current: 4 μA at 4000V
- Glass bulb: approx. 130 mm diam.
- Luminescent screen: approx. 85 mm diam.
- Total length: approx. 250 mm

U18554

Additionally required:

- U185001 Tube Holder S**
- U138021 Set of 15 Safety Patch Cords, 75 cm**
- U185051 Helmholtz Pair of Coils S**
- U33010-230 High Voltage Power Supply, 5 kV (230 V, 50/60 Hz)**
- U33020-230 DC-Power Supply 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz)**
- or
- U33010-115 High Voltage Power Supply, 5 kV (115 V, 50/60 Hz)**
- U33020-115 DC-Power Supply 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz)**

Additionally recommended:

- U17250 Electroscopes**
- U19106 Auxiliary Coil**



U18552



Diode S

Highly evacuated electron tube with thermionic cathode and anode for investigating the thermoelectric effect (Edison effect) and measuring the emission current as a function of the heating power applied to the cathode. Also for plotting diode characteristics and for demonstrating the rectifying effect of a diode.

- Max. heater voltage: 7.5 V AC/DC
- Max. anode voltage: 500 V
- Anode current: approx. 2 mA at 200 V Anode voltage
- Glass bulb: approx. 130 mm diam.
- Total length: approx. 250 mm

U185501

Additionally required:

- U185001 Tube Holder S**
- U138021 Set of 15 Safety Patch Cords, 75 cm**
- U17450 Analogue Multimeter AM50**
- U33000-230 Power Supply, 500 V DC (230 V, 50/60 Hz)**

or

- U33000-115 Power Supply, 500 V DC (115 V, 50/60 Hz)**



Triode S

Highly evacuated electron tube with thermionic cathode, control grid and anode for quantitative investigation of controllable high vacuum tubes, plotting the characteristics of a triode, demonstrating the negative polarity of the electron charge, studying the practical applications of a triode as an amplifier and generating undamped oscillations in LC circuits

- Max. heater voltage: 7.5 V AC/DC
- Max. anode voltage: 500 V
- Anode current: approx. 2 mA at 200 V anode voltage
- Glass bulb: approx. 130 mm diam.
- Total length: approx. 250 mm

U18551

Additionally required:

- U185001 Tube Holder S**
- U138021 Set of 15 Safety Patch Cords, 75 cm**
- U17450 Analogue Multimeter AM50**
- U33000-230 Power Supply, 500 V DC (230 V, 50/60 Hz)**

or

- U33000-115 Power Supply, 500 V DC (115 V, 50/60 Hz)**

Gas Triode S

Electron tube filled with low pressure helium gas resp. neon gas, with thermionic cathode, control grid, and anode for quantitative investigations of the typical properties of a gas-filled triode, recording the $I_A - U_A$ characteristics of a thyatron, observing independent and dependent discharges as well as discontinuous energy release of He or Ne atoms during inelastic collisions with free electrons.

- Max. heater voltage: 7.5 V AC/DC
- Max. anode voltage: 500 V
- Anode current: approx. 10 mA at 200 V anode voltage
- Glass bulb: approx. 130 mm diam.
- Total length: approx. 250 mm

Gas Triode S with He Filling

U18557

Gas Triode S with Ne Filling

U18558

Additionally required:

- U185001 Tube Holder S**
 - U138021 Set of 15 Safety Patch Cords, 75 cm**
 - U17450 Analogue Multimeter AM50**
 - U33000-230 Power Supply, 500 V DC (230 V, 50/60 Hz)**
- or
- U33000-115 Power Supply, 500 V DC (115 V, 50/60 Hz)**



U18570

Dual Beam Tube S

Partly evacuated electron tube, filled with helium at low pressure, with tangential and axial electron gun. For determining specific charge e/m from the diameter of the filament beam in the case of tangential bombardment and a perpendicularly aligned magnetic field, and observing spiral paths of electrons in the case of axial bombardment and a co-axial magnetic field. The electron paths are rendered visible in the form of fine luminescent beams through impact excitation of the helium atoms.

- Max. filament voltage: 7.5 V AC/DC
- Max. anode voltage: 100 V DC
- Anode current: approx. 30 mA
- Max. deflection voltage: 50 V DC
- Glass bulb: approx. 130 mm diam.
- Total length: approx. 250 mm

U18570

Additionally required:

- U185001 Tube Holder S**
- U138021 Set of 15 Safety Patch Cords, 75 cm**
- U185051 Helmholtz Pair of Coils S**
- U33000-230 Power Supply, 500 V DC (230 V, 50/60 Hz)**
- or
- U33000-115 Power Supply, 500 V DC (115 V, 50/60 Hz)**

Helmholtz Pair of Coils S

Pair of coils for generating a uniform magnetic field perpendicular to the axis of a tube when using the tube holder S (U185001).

- Number of turns: 320 each
- Coil diameter: 138 mm each
- Load rating: 1.0 A (Continuous operation) each
1.5 A (Short-term operation)
- Effective Resistance: approx. 6,5 Ω each
- Terminals: 4 mm safety sockets

U185051

Additionally recommended:

- U33020-230 DC-Power Supply 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz)**
- or
- U33020-115 DC-Power Supply 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz)**



U185051

		U185501	U18551	U18557	U18558
		Diode S	Triode S	Gas Triode S with He Filling	Gas Triode S with Ne Filling
U185001	Tube Holder S	required	required	required	required
U138021	Set of 15 Safety Patch Cords, 75 cm	required	required	required	required
U13761	Experiment Lead, Safety Plug and Socket	–	–	–	–
U33000-230 or U33000-115	Power Supply, 500 V DC	required	required	required	required
U33010-230 or U33010-115	High Voltage Power Supply, 5 kV	–	–	–	–
U185051	Helmholtz Pair of Coils S	–	–	–	–
U33020-230 or U33020-115	DC-Power Supply, 20 V	–	–	–	–
U17450	Analogue Multimeter AM50	required	required	required	required
U19106	Auxiliary Coil	–	–	–	–
U17250	Electroscope	–	–	–	–

Gas Discharge Tube S

Evacuatable glass tube with fluorescent screens at both ends for observation of electrical discharges in gases under reduced pressure as well as for investigation of cathode beams and canal rays, which appear at low pressure outside the discharge path. Demountable design, installation in tube holder (U185001). Includes a needle ventilation valve and vacuum hoses.

Length: approx. 280 mm
 Polarization voltage: ≤ 5 kV
 Discharge current: approx. 1.2 mA
 Connections: 4 mm contact pins

U18580

Additionally required:

U185001 Tube Holder S

U13761 Experiment Lead, Safety Plug and Socket (2x)

U34000 Rotary-Vane Vacuum Pump, Two-Stage

U33010-230 High Voltage Power Supply, 5 kV
 (230 V, 50/60 Hz)

or

U33010-115 High Voltage Power Supply, 5 kV
 (115 V, 50/60 Hz)



Tube Holder S

Tube holder to support all S series electron tubes for easy and safe operation. The five pin sockets for the tube are concealed inside the tube holder. A cathode protection switch is integrated into the tube holder, to protect the heated cathode from excessive voltage. The base plate has a slot for attaching the Helmholtz pair of coils S (U185051).

Terminals : 4 mm safety sockets
 Dimensions: approx. 130x190x250 mm³
 Weight: approx. 570 g

U185001



U18570	U18552	U18553	U18554	U18555	U18571	U18580
Dual Beam Tube S	Luminescence Tube S	Maltese Cross Tube S	Perrin Tube S	Thomson Tube S	Electron Deflection Tube S	Gas Discharge Tube S
required	required	required	required	required	required	required
required	required	required	required	required	required	–
–	–	–	–	–	–	2x required
required	–	–	–	required	–	–
–	required	required	required	required	required	required
required	–	recommended	required	required	–	–
–	–	recommended	required	–	–	–
–	–	–	–	–	–	–
–	–	–	recommended	–	–	–
–	–	–	recommended	–	–	–

Dual Pole Tube

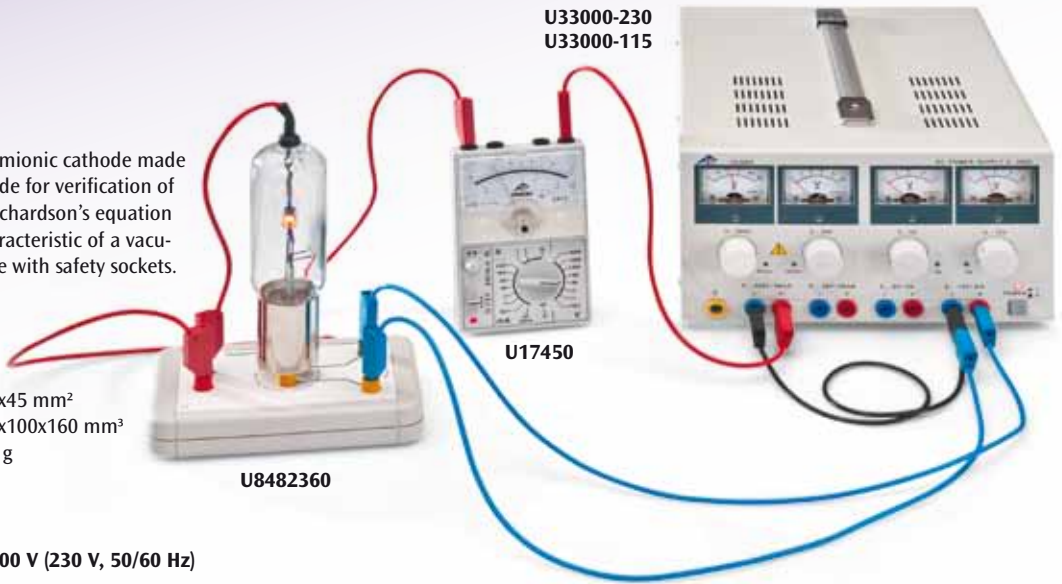
Evacuated electron tube with hot thermionic cathode made of tungsten wire and a cylindrical anode for verification of the Edison effect, demonstration of Richardson's equation and recording the current-voltage characteristic of a vacuum diode. Mounted on connector base with safety sockets.

- Cathode surface: 32 mm²
- Max. anode voltage: 400 V
- Heating voltage: 1.5 – 5.9 V
- Heating current: 2 – 5 A
- Dimensions of the tube: approx. 120x45 mm²
- Dimensions: approx. 155x100x160 mm³
- Weight: approx. 440 g

U8482360

Additionally required:

- U33000-230 DC Power Supply, 0 – 500 V (230 V, 50/60 Hz)**
- or
- U33000-115 DC Power Supply, 0 – 500 V (115 V, 50/60 Hz)**



Gas Discharge Tube

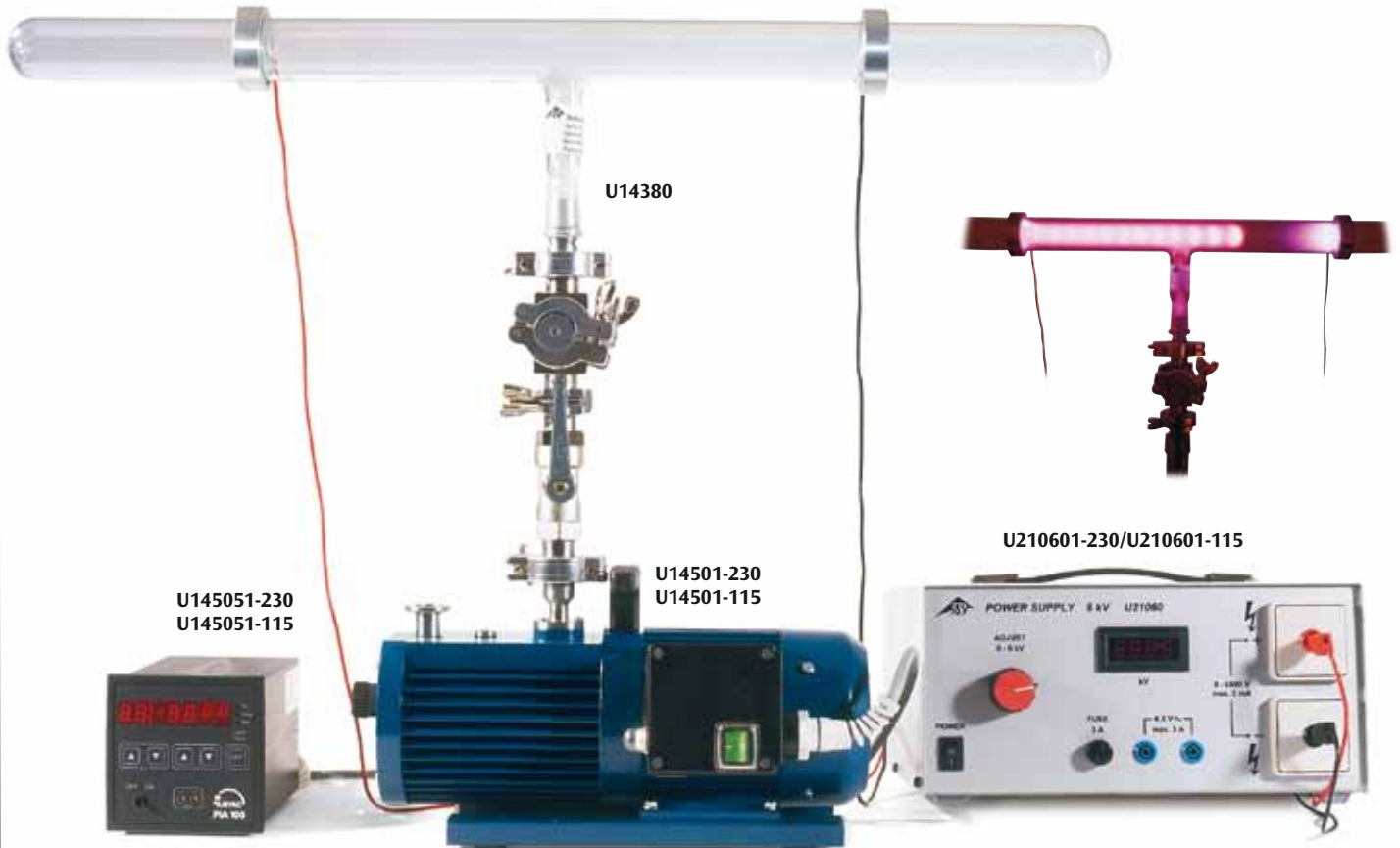
Evacuatable glass tube for observation of luminous effects of electrical discharges in gases under reduced pressure. Glass tube with graded seal, disc shaped, perforated electrodes and 4 mm jacks for connecting the voltage supply.

- Material: glass
- Dimensions: approx. 700 mm x 40 mm diam.
- Vacuum connection: graded seal NS 19/26

U14380

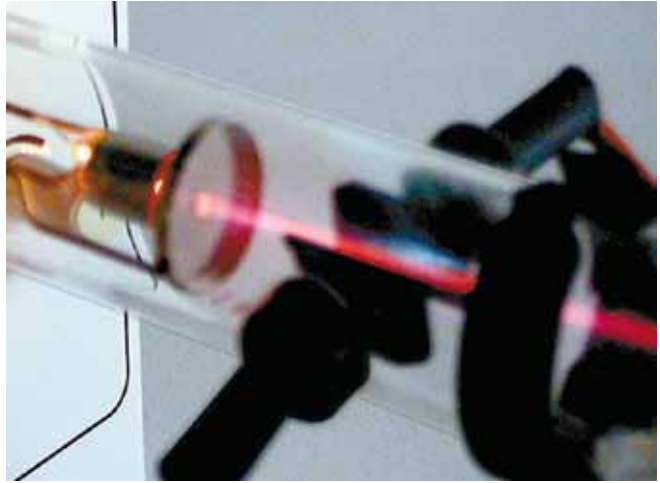
Additionally recommended:

- U33010-230 High Voltage Power Supply, 5 kV (230 V, 50/60 Hz)**
- U14501-230 Rotary Vane Pump PK 4D (230 V, 50/60 Hz)**
- U145051-230 Pirani Vacuum Gauge (230 V, 50/60 Hz)**
- or
- U33010-115 High Voltage Power Supply, 5 kV (115 V, 50/60 Hz)**
- U14501-115 Rotary Vane Pump PK 4D (115 V, 50/60 Hz)**
- U145051-115 Pirani Vacuum Gauge (115 V, 50/60 Hz)**
- U14510 2-Way Ball Valve DN 16 KF**
- U14511 Crosspiece DN 16 KF**
- U14516 Adapter Flange DN 16 – Core NS 19/26**



Experiment topics:

- Linear propagation of electrons in a zero-field space
- Deflection of electron beams in an electrical field
- Deflection of electron beams in a magnetic field
- Magnetic lens
- Phase displacement, superimposition of magnetic fields, Lissajous figures
- Determination of an electron's specific charge
- Determination of an electron's speed



Training Oscilloscope

Electron tube mounted on a terminal base for investigating the design and operation of a cathode ray tube. The electron beam can be deflected by an electric field produced by the deflection plates integrated into the tube, and by a magnetic field from three external coils mounted on a ring. A Wehnelt cylinder is used to focus the beam. The gas filling and the fluorescent screen make it possible to observe the beam in the tube. A continuously adjustable saw-tooth generator can be used to analyse and visualize time dependent processes. The device comes with a socket and printed wiring diagram.

Anode voltage:	250 – 400 V DC
Anode current:	1 mA
Filament voltage:	6 – 8 V AC/DC
Filament current:	0.3 A
Wehnelt voltage:	0 – 50 V DC
Deflection plate dimensions:	approx. 12x20 mm ²
Plate spacing:	approx. 12 mm
Electric deflection sensitivity:	0,2 mm/V

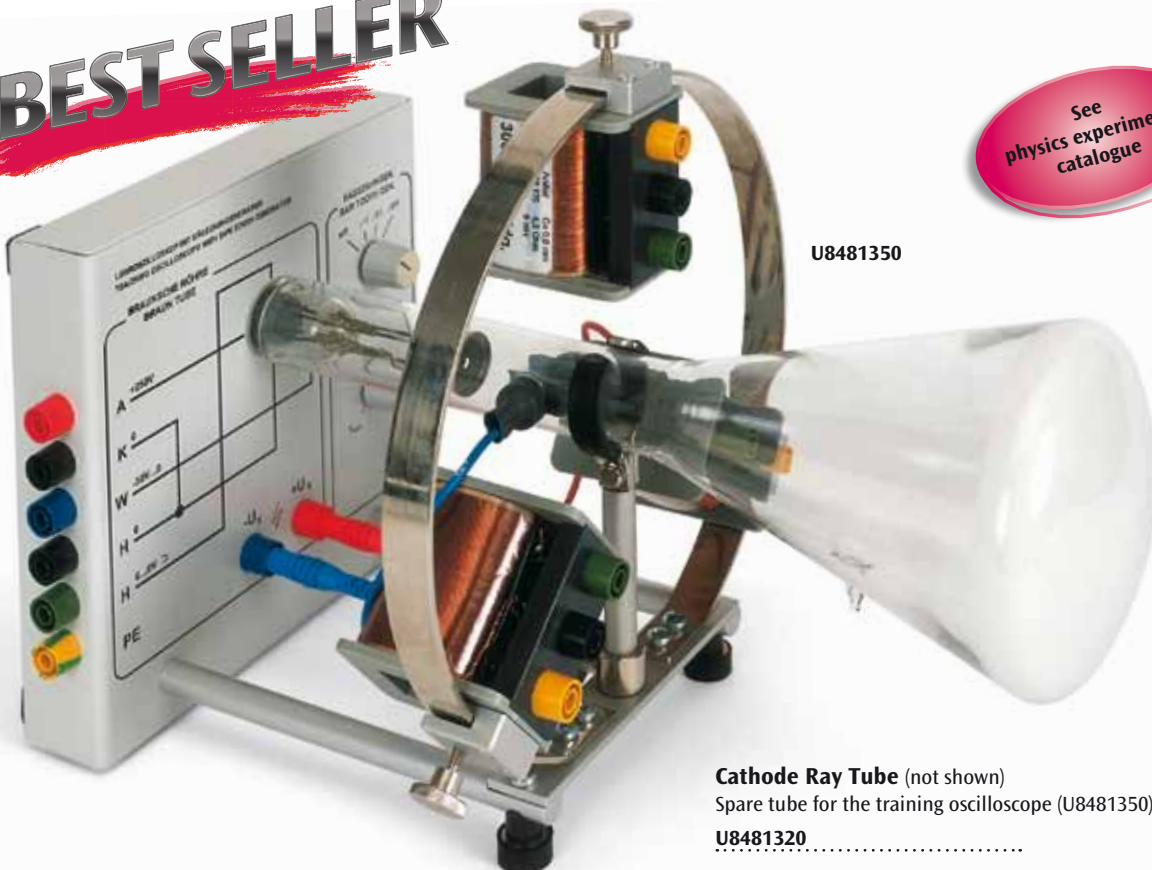
Screen diameter:	approx. 100 mm
Tube length:	approx. 260 mm
Residual gas:	Neon
Gas pressure:	10 ⁻⁴ hPa
Sweep frequency:	10 – 200 Hz, continuously adjustable
3 deflection coils:	600 turns each, with a centre pick up
Weight:	approx. 1.6 kg

U8481350

Additionally recommended:

- U33000-230 DC Power Supply, 0 – 500 V (230 V, 50/60 Hz)**
- U8533600-230 Function Generator FG100 (230 V, 50/60 Hz)**
- or
- U33000-115 DC Power Supply, 0 – 500 V (115 V, 50/60 Hz)**
- 1009956 Function Generator FG100 (115 V, 50/60 Hz)**

BEST SELLER



See physics experiments catalogue

U8481350

Cathode Ray Tube (not shown)
Spare tube for the training oscilloscope (U8481350).

U8481320

Experiment topics:

- Deflection of electrons in a closed circular path inside a magnetic field
- Determination of specific charge of an electron e/m

BEST SELLER

U8481430



U8481500

Fine Beam Tube on Connection Base

For examining the deflection of electron beams in a uniform magnetic field using a pair of Helmholtz coils (U8481500) and for the quantitative determination of the specific charge of the electron e/m . Glass vessel with integrated electron beam system, consisting of an indirectly heated oxide cathode, a Wehnelt cylinder and a perforated anode, in neon residual gas atmosphere with precisely set gas pressure and with integrated measurement marks for parallax-free determination of the diameter of the fine beam. Gas atoms are ionized along the electron path and produce a sharply defined, visible fluorescent beam. Tube mounted on base with colour coded connectors.

Gas filling:	Neon
Gas pressure:	1.3×10^{-5} hPa
Filament voltage:	4 – 10 V AC/DC
Filament current:	300 – 450 mA
Wehnelt voltage:	0 – -50 V
Anode voltage:	200 – 300 V
Anode current:	<0.3 mA
Circular path diameter:	20 – 120 mm
Division spacing:	approx. 20 mm
Tube diameter:	approx. 160 mm
Dimensions:	approx. 260x115x35 mm ³
Weight:	approx. 820 g

U8481430

Additionally required:

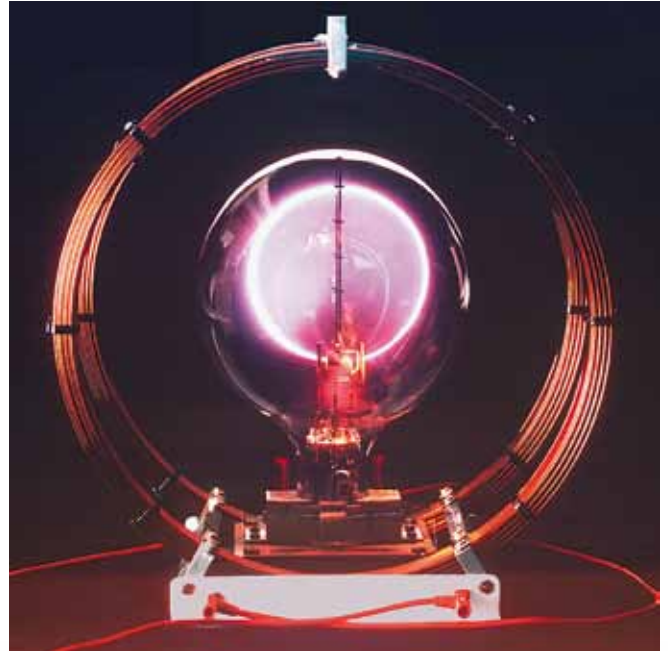
U8481500 Helmholtz Coils, 300 mm

Additionally recommended:

U33000-230 DC Power Supply, 0 – 500 V (230 V, 50/60 Hz)

or

U33000-115 DC Power Supply, 0 – 500 V (115 V, 50/60 Hz)



Experiment topics:

- Electron deflection in a uniform magnetic field
- Closed orbit or spiral path
- Determining an electron's specific charge e/m

Complete Fine Beam Tube System

This complete experimental system is used to determine an electron's specific charge and investigate the deflection of electron beams in a uniform magnetic field. The system comes complete with a fine-beam tube, Helmholtz coil pair for generating a uniform magnetic field, and operating unit for power supply. The fine beam tube and Helmholtz coil pair are mounted on the operating unit, the fine beam tube being rotatable around its vertical axis. The tube and coil pair are both connected internally to the operating unit without a need for external wiring. All supply voltages for the tube and the current through the Helmholtz coils are adjustable. The anode voltage and coil current are displayed digitally and can be tapped additionally as equivalent voltage values. Inside the fine beam tube, a sharply delimited electron beam is generated by a system comprising an indirectly heated oxide cathode, perforated anode and Wehnelt cylinder. Impact ionization of helium atoms creates a very bright, also sharply delimited trace of the electron path in the tube. If the tube is aligned optimally and an appropriate current flows through the Helmholtz coils, the electrons are deflected into a circular orbit, whose diameter can be easily determined when the electrons strike one of the equidistant measurement marks, causing its end to light up. Diameter, anode voltage and magnetic field are the parameters used to determine the electron's specific charge. The magnetic field can be calculated from the coil current, the geometry of the Helmholtz coil pair being known.

Fine-beam tube:
 Gas filling: Helium
 Gas pressure: 0.13 hPa
 Bulb diameter: 165 mm
 Orbit diameter: 20...120 mm
 Measurement markspacing: 20 mm

Helmholtz coil pair:
 Coil diameter: approx. 300 mm
 Winding count: 124
 Magnetic field: 0...3.4 mT (0.75 mT/A)

Operating unit:
 Coil current: 0...4.5 A, 3-figure digital display
 Measurement output: $1 V^* I_B / A$
 Anode voltage: 15...300 V, 3-figure digital display
 Measurement output: $0.01^* U_A$
 Heating voltage: 5...7 V
 Wehnelt voltage: 0...-50 V

General data:
 Tube's rotary angle: $-10^\circ \dots 270^\circ$
 Supply voltage: 100-240 V, 50/60 Hz
 Power supply cable: EU, UK and US
 Dimensions: approx. 310x275x410 mm³
 Weight: approx. 7.5 kg

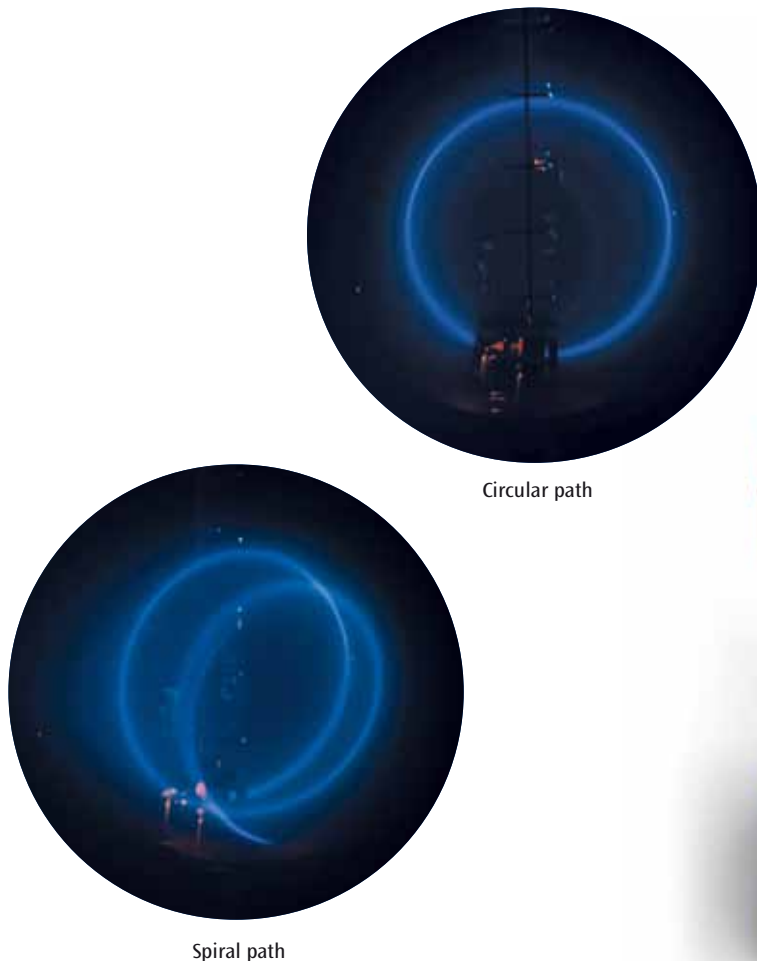
The complete fine-beam tube system consists of the following parts:

Fine Beam Tube T

U18575

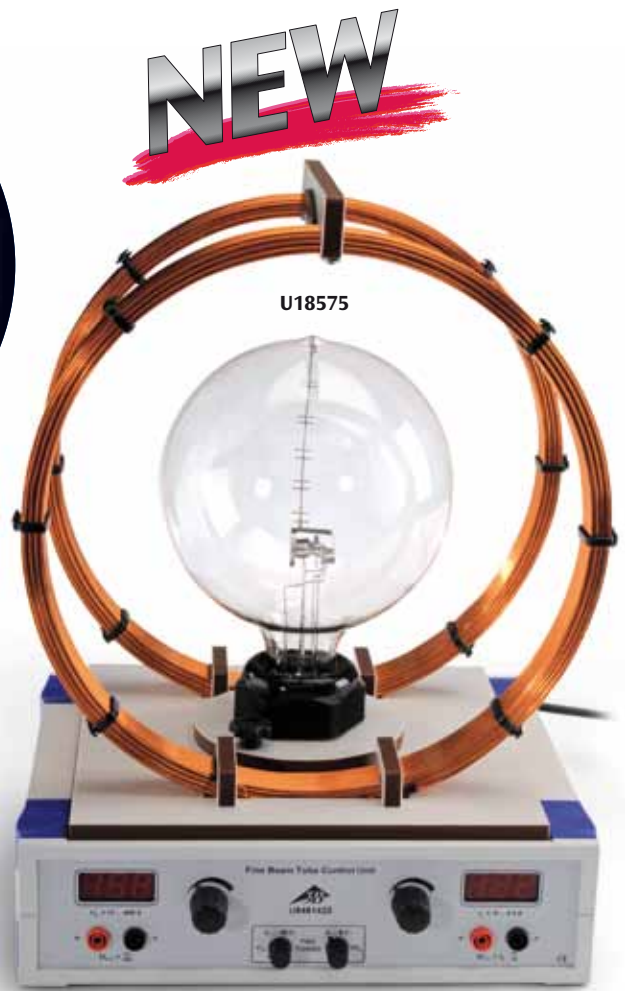
Operating Unit for Fine-Beam Tube

U8481435



Circular path

Spiral path



U8481435

Periodic Table of the Elements, with Electron Configurations
 Chart of the periodic table of the elements showing the configurations of electron shells. On strong plasticized material with rods and hanging cord. Bilingual.
 Dimensions: 1950x1380 mm² approx.
 Languages: English and German

U19700

Periodic Table of the Elements, with Pictures
 Chart of the periodic table of the elements with pictures of the elements. On strong plasticized material with rods and hanging cord. In four languages.
 Dimensions: 1950x1380 mm² approx.
 Languages: English, German, French, Spanish

U19705

PERIODENSYSTEM DER ELEMENTE																		PERIODIC TABLE OF THE ELEMENTS																		
Hauptgruppen I II																Main Group Elements III IV V VI VII VIII 0				Periodo Schale Shell																
1	2															3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	1				
3	4															5	6	7	8	9	10	11	12	13	14	15	16	17	18	2						
11	12	Nebengruppen IIIa														Transition Elements IVa Va VIa VIIa VIIIa I a IIa				13	14	15	16	17	18	3										
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	4
37	38	39	Lanthanoide und Actinoide Lanthanoids and Actinoids														49	50	51	52	53	54	5													
55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	6		
87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	7				

U19700

Periodensystem der Elemente																		Periodic System of the Elements																																																																																																							
Système périodique des éléments																		Sistema periódico de los elementos																																																																																																							
1	2															13	14	15	16	17	18	VIII 18																																																																																																			
3	4															5	6	7	8	9	10	11	12	13	14	15	16	17	18																																																																																												
11	12	IIIa IVa Va VIa VIIa VIIIa I a IIa														13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118
87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118																																																																																										

U19705



1012782

Insight into the World of Atoms

Experiment topics:

- Tunnel effect
- Representation of individual atoms
- Representation of lattice defects and dislocations
- Representation of charge density waves
- Dependence of tunnel current on distance between measuring tip and sample
- PID control of tunnel current

NEW

MoS₂ Sample (not shown)

Molybdenum-sulphide sample on a carrier for observing defects in crystal lattices with the scanning tunnelling microscope.

1012877

TaS₂ Sample (not shown)

Tantalum-disulfide sample on a carrier for observing the distribution of surface charge density (stationary charge-density waves) with a scanning tunnelling microscope.

1012876

TaSe₂ Sample (not shown)

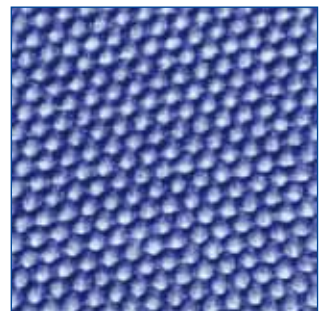
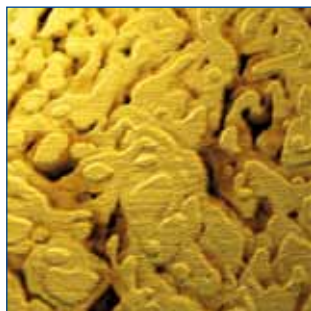
Tantalum-diselenide sample on a carrier for observing the distribution of surface charge density (stationary charge-density waves) with a scanning tunnelling microscope.

1012875

Representation of a gold surface

Representation of the hexagonal structure of a graphite surface

Representation of a TaS₂ surface by means of stationary charge-density waves



Scanning Tunnelling Microscope

Meant to resolve atomic structures at the surface of electrically conductive materials, this easy-to-use and compact, scanning tunnelling microscope is particularly suitable for training purposes. The complete system includes a probe for row-by-row scanning of sample surfaces with the measuring tip, vibration-absorbing pad, controller with computer interface, as well as graphite and gold samples.

System requirements:	Windows 2000 or higher
XYZ grid:	500x500x200 nm ³
Minimum increment XY:	7.6 µm
Minimum increment Z:	3 µm
Tunnel current:	0.100...100.000 nA (0.025 nA increment)
Voltage:	±10.000 V (0.005 V increment)
Maximum sample size:	10 mm diam.
Supply voltage:	90 – 240 V, 50/60 Hz
Connection:	USB

Contents:

- Controller
- Installation CD with measurement and control software
- Scanning probe with connection cable
- Cover with lens
- Experiment plate with vibration damping
- Tool kit for manufacturing the probe tip (side cutters, flat-nose pliers, pointed and rounded tweezers)
- Platinum-iridium wire, 0.25 mm diam., 300 mm
- Graphite (HOPG) sample on a carrier
- Gold (1.1.1) sample on a carrier
- Set of 4 sample carriers

1012782

WSe₂ Sample (not shown)

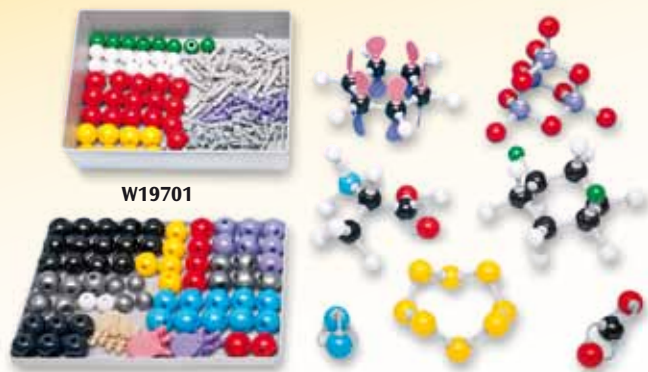
Tungsten-diselenide sample on a carrier for observing surface defects with a scanning tunnelling microscope.

1012874

Platinum-Iridium Wire (not shown)

Platinum-iridium wire, 0.25 mm Ø, 300 mm as spare wire for manufacturing measuring tips for the scanning tunnelling microscope.

1012878



W19701

Organic/Inorganic Molecule Set D

Molecule building set for assembling three-dimensional models of organic and inorganic molecules and for clarification of their spatial configurations. Many chemical compounds can be represented clearly. These include simple molecules such as hydrogen, oxygen and water, organic compounds such as ethane, ethene, ethyne, benzene, alanine, glucose, and cyclohexane and also more complex structures such as the tetrammino zinc ion or tetraphosphorous decoxide.

W19701

Contents:

Atoms						
14	C	black	4 wholes	tetrahedral	109°	
6	C	dark blue	5 wholes	tribipyramidal	90°, 120°	
12	H	white	1 whole	one sided		
2	H	white	1 whole	linear	180°	
16	O	red	2 wholes	angular	105°	
6	O	red	4 wholes	tetrahedral	109°	
6	N	blue	4 wholes	tetrahedral	109°	
4	N	blue	3 wholes	pyramidal	107°	
4	S	yellow	4 wholes	tetrahedral	109°	
1	S	yellow	6 wholes	octahedral	90°	
8	S	yellow	2 wholes	angular	105°	
8	Cl, (F)	green	1 wholes	one sided		
4	P	purple	4 wholes	tetrahedral	109°	
1	P	purple	5 wholes	tribipyramidal	90°, 120°	
2	P	purple	3 wholes	pyramidal	107°	
4	Na	grey	1 whole	one sided		
3	Ca, Mg	grey	2 wholes	angular	105°	
2	Al	grey	3 wholes	trigonal	120°	
4	Si, Cu	grey	4 wholes	tetrahedral	109°	
1	metal atom	grey	6 wholes	octahedral	90°	

Electron clouds		
6	lone pair	light beige
6	unhybridised p-lobe	purple
6	unhybridised p-lobe	pink

Links		
38	medium	light grey
12	medium	purple
36	long, flexible	grey

NEW



W19721

Organic Molecule Set S

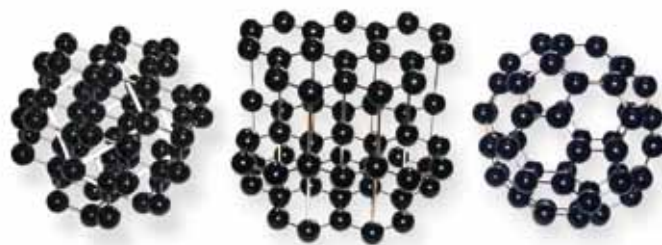
Molecule building set for assembling three-dimensional models of organic molecules and for clarification of their spatial configurations. Many chemical compounds can be represented clearly and phenomena such as structural isomerism, optical isomerism and geometric isomerism can be illustrated. The spectrum ranges from simple molecules such as alkanes, alkenes and alkynes, alcohols, aldehydes, ketones, carboxylic acids, esters, ethers, halogenated compounds, amines, amides, cycloalkanes to biochemical molecules, amino acids, aromatic molecules and polymers.

W19721

Contents:

Atoms						
12	C	black	4 wholes	tetrahedral	109°	
20	H	white	1 whole	one sided		
6	O	red	2 wholes	angular	105°	
2	N	blue	4 wholes	tetrahedral	109°	
2	N	blue	3 wholes	pyramidal	107°	
1	S	yellow	4 wholes	tetrahedral	109°	
1	S	yellow	6 wholes	octahedral	90°	
4	Cl, (F)	green	1 whole	one sided		
1	P	purple	4 wholes	tetrahedral	109°	
1	Na	grey	1 whole	one sided		

Links		
26	short	white
6	medium	light grey
12	long, flexible	grey



1012836

Set of 3 Carbon Configurations

Set of 3 easy-to-use models of various carbon crystal structures: diamond, graphite and fullerene, for demonstrating the fundamental differences between the structures.

Ball diameter: 25 mm approx.

Lengths of sides: 150 mm approx.

1012836

W19722



Organic/Inorganic Molecule Set S

Molecule building set for assembling three-dimensional models of organic and inorganic molecules and for clarification of their spatial configurations. Many chemical compounds can be represented clearly. These include inorganic molecules such as hydrogen, oxygen, water, acids, salts, metal oxides, and non metal oxides and also organic compounds such as ethane, ethene, ethyne, benzene, alanine, glucose, and cyclohexane.

W19722

Contents:

Atoms					
6	C	black	4 wholes	tetrahedral	109°
14	H	white	1 whole	one sided	
6	O	red	2 wholes	angular	105°
1	O	red	4 wholes	tetrahedral	109°
2	N	blue	4 wholes	tetrahedral	109°
1	N	blue	3 wholes	pyramidal	107°
1	S	yellow	4 wholes	tetrahedral	109°
1	S	yellow	6 wholes	octahedral	90°
6	Cl, (F)	green	1 wholes	one sided	
1	P	purple	5 wholes	tribipyramidal	90°, 120°
1	P	purple	3 wholes	pyramidal	107°
2	Na	grey	1 wholes	one sided	
2	Ca, Mg	grey	2 wholes	angular	105°
1	Be	grey	2 wholes	linear	180°
1	Al	grey	3 wholes	trigonal	120°
1	Si, Cu	grey	4 wholes	tetrahedral	109°
1	metal atom	grey	6 wholes	octahedral	90°
1	B	light beige	3 wholes	trigonal	120°
1	atom	beige	4 wholes	tetrahedral	109°
1	atom	beige	5 wholes	tribipyramidal	90°, 120°
1	atom	beige	6 wholes	octahedral	90°

Electron clouds

3	lone pair	light beige
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Links

20	medium	light grey
5	medium	purple
12	lang flexibel	grey

Set 14 Bravais Lattices

Set of easy to handle models of the 14 fundamental lattice types (Bravais lattices), from which Auguste Bravais postulated that practically all naturally occurring crystal lattices can be derived by shifting along the axes. Made of wooden balls in six different colours connected via metal rods. The six colours distinguish the six different systems into which the lattice types are categorised.

Diameter of balls: 25 mm approx.

Length of sides: 150 mm approx.

1012837

.....

W19700



Organic Molecule Set D

Molecule building set for assembling three-dimensional models of organic molecules and for clarification of their spatial configurations. Many chemical compounds can be represented clearly and phenomena such as structural isomerism, optical isomerism and geometric isomerism can be illustrated. The spectrum ranges from simple molecules such as alkanes, alkenes and alkynes, alcohols, aldehydes, ketones, carboxylic acids, esters, ethers, halogenated compounds, amines, amides, cycloalkanes to biochemical molecules, amino acids, aromatic molecules and polymers.

W19700

Contents:

Atoms					
24	C	black	4 wholes	tetrahedral	109°
6	C	dark grey	3 wholes	trigonal	120°
2	C	dark grey	2 wholes	linear	180°
6	C	dark blue	5 wholes	tribipyramidal	90°, 120°
40	H	white	1 whole	one sided	
12	O	red	2 wholes	angular	105°
4	N	blue	4 wholes	tetrahedral	109°
1	S	yellow	4 wholes	tetrahedral	109°
1	S	yellow	2 wholes	angular	105°
8	Cl, (F)	green	1 whole	one sided	
4	P	purple	4 wholes	tetrahedral	109°
2	Na	grey	1 whole	one sided	
1	Ca, Mg	grey	2 wholes	angular	105°

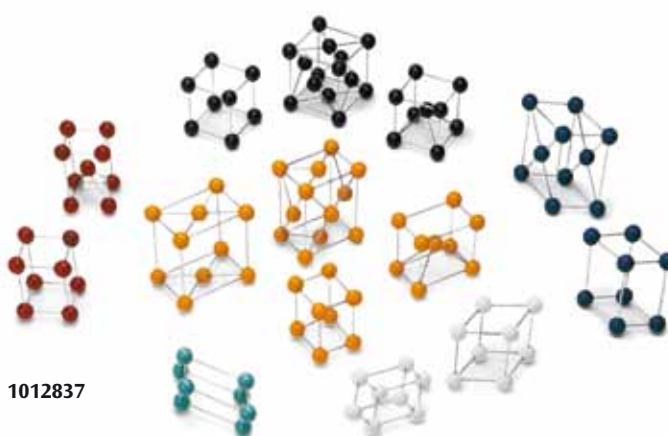
Electron clouds

6	lone pair	light beige
6	unhybridised p-lobe	purple
6	unhybridised p-lobe	pink

Links

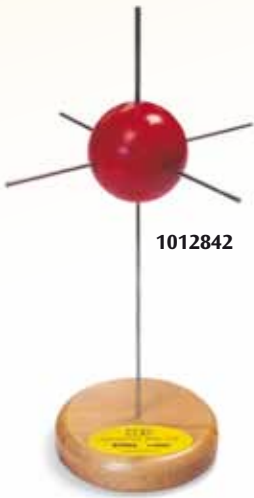
60	short	white
55	medium	light grey
25	long, flexible	grey

1012837



NEW

Atomic Orbitals

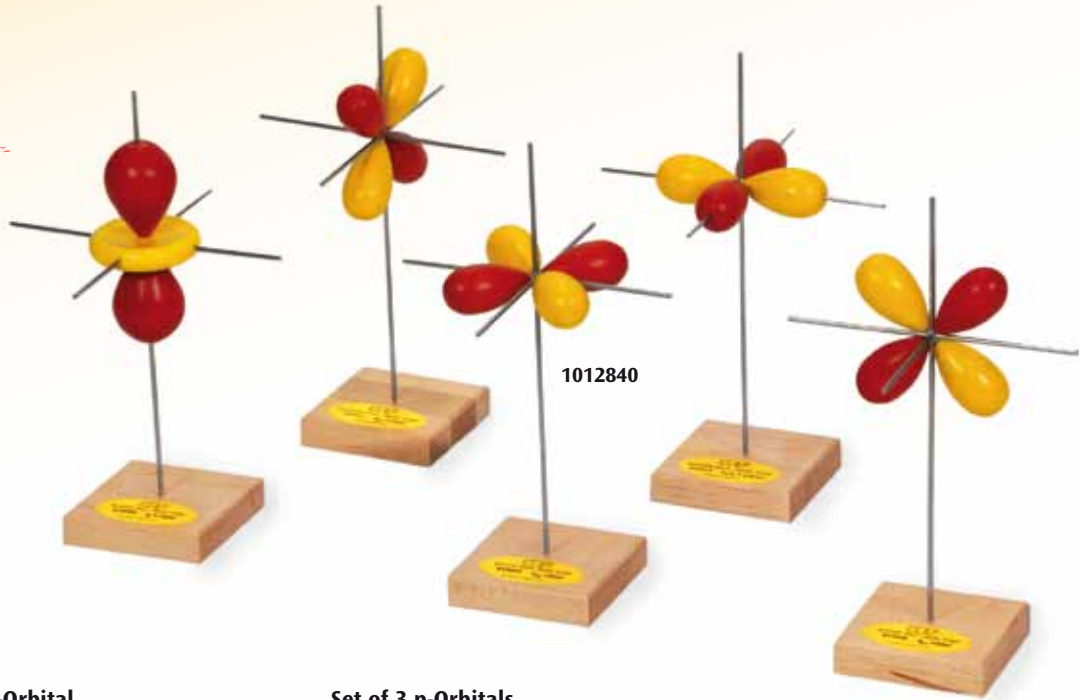


1012842

s-Orbital

Three-dimensional model of the s-orbital in the wave functions of hydrogen. With base. Made of hard wood mounted on a nickel coated steel axle.
Height: 250 mm approx.

1012842



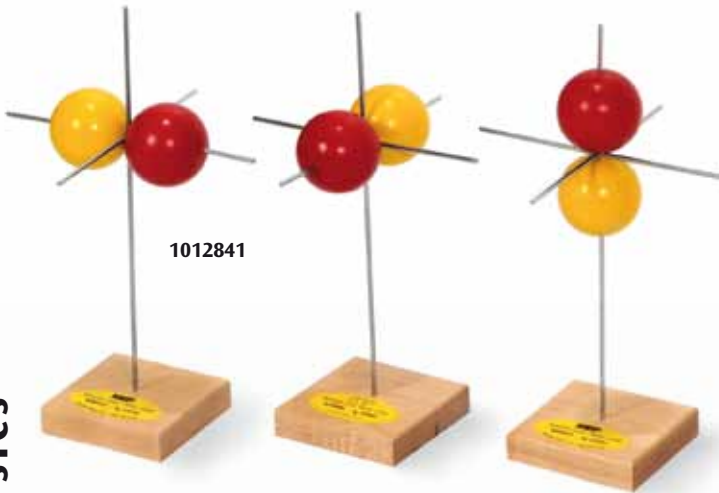
1012840

Set of 3 p-Orbitals

Set of three-dimensional models of the three p-orbitals in the wave functions of hydrogen. With base. Made of hard wood mounted on a nickel coated steel axle. Two colours to indicate the change in sign in the wave functions.

Height: 250 mm approx.

1012841



1012841

Set of 5 d-Orbitals

Set of three-dimensional models of the five d-orbitals in the wave functions of hydrogen. With base. Made of hard wood mounted on a nickel coated steel axle. Two colours to indicate the change in sign in the wave functions.

Height: 250 mm approx.

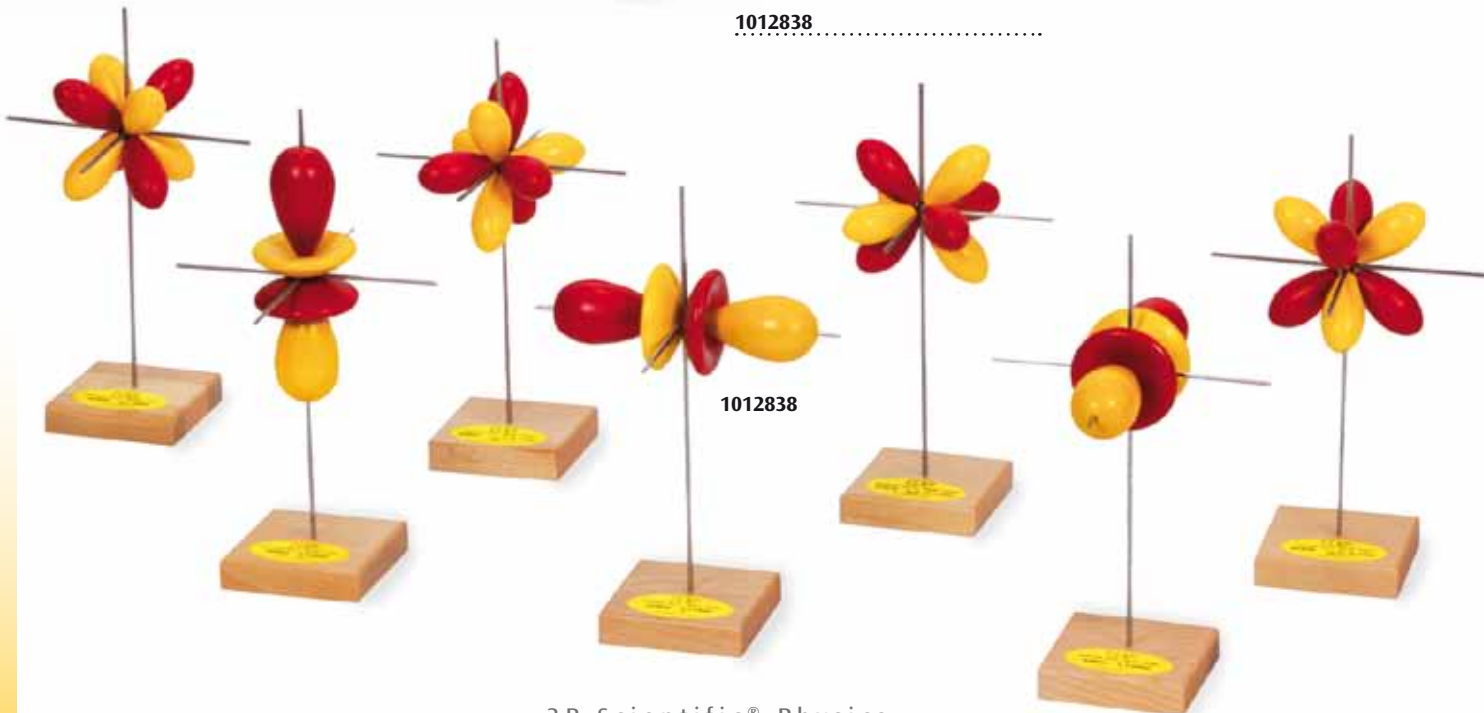
1012841

Set of 7 f-Orbitals

Set of three-dimensional models of the seven f-orbitals in the wave functions of hydrogen. With base. Made of hard wood mounted on a nickel coated steel axle. Two colours to indicate the change in sign in the wave functions.

Height: 250 mm approx.

1012838



1012838

Atomic and Nuclear Physics

Experiment topics:

- Millikan's experiment
- Elementary electric charge
- Charged oil droplets in an electric field
- Stokes viscous drag, weight, buoyancy
- Measurements of the equilibrium voltage and the velocity of fall
- Measurements of the velocity of fall, the velocity of rise, and the associated plate voltages

Millikan's Apparatus

Compact apparatus for demonstrating the discrete nature (quantisation) of electric charge and for determining the elementary charge of an electron. The experiment is set up on a height-adjustable tripod and consists of a plate capacitor under a plastic cover, measuring microscope, lighting apparatus and an oil atomiser. Includes a plastic bottle containing oil.

Distance between plates: 6 mm
 Plate diameter: 80 mm
 Halogen lamp: 12 V / 10 W
 Objective magnification: 2x
 Eyepiece magnification: 10x
 Micrometer range: 10 mm
 Scale divisions: 0.1 mm
 Connections: 4 mm sockets
 Dimensions: 250x300x450 mm³ approx.
 Weight: 4.0 kg approx.

U13100

Additionally required:

U13105-230 Power Supply for Millikan's Apparatus
 (230 V, 50/60 Hz)

or

U13105-115 Power Supply for Millikan's Apparatus
 (115 V, 50/60 Hz)



U13100

Power Supply for Millikan's Apparatus

Operating equipment supplying voltages for the plate capacitor and the halogen lamp used in Millikan's apparatus (U13100). With digital voltage read-out, rotary potentiometer for adjusting voltage, a switch for enabling the two stopwatch outputs for measurements with one stopwatch (falling from equilibrium method) or with two stopwatches (rising and falling method) and a switch for turning the capacitor voltage on and off with simultaneous switching between the two stopwatch outputs. Includes mains-powered supply unit.

Output connections: 4 mm safety sockets
 Plate capacitor: 0 – 600 V
 Halogen lamp: 12 V / 10 W
 Voltage readout: 3-digit, height of numerals: 14 mm
 Operating voltage: 12 V, 20 W, from the mains-powered unit that is provided
 Dimensions: 190x150x110 mm³ approx.
 Weight: 1 kg approx.

Power Supply for Millikan's Apparatus (230 V, 50/60 Hz)

U13105-230

Power Supply for Millikan's Apparatus (115 V, 50/60 Hz)

U13105-115

Additionally recommended:

U8533341-230 Digital Counter (230 V, 50/60 Hz)

or

U8533341-115 Digital Counter (115 V, 50/60 Hz)



U13105-230

Light Emitting Diodes for Determination of h

Mounting plate with six coloured light-emitting diodes with different emission wavelengths for determining Planck's constant h by measuring the cut-off voltage as a function of the frequency of the emitted light. Light-emitting diodes with series resistors mounted on a base plate with a stem.

- Wavelengths: 465 nm, 560 nm, 585 nm, 635 nm, 660 nm, 950 nm
 Series resistor: 100 Ω
 Max. voltage: 6 V
 Dimensions: 115x115 mm² approx.
 Weight: 120 g approx.

U8482460

Additionally required:

U33020-230 DC-Power Supply 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz)

or

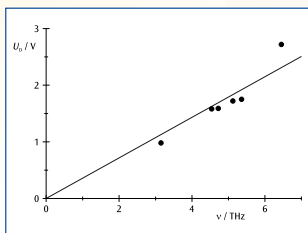
U33020-115 DC-Power Supply 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz)

1006810 Multimeter, Escala 10

U8611210 Stand base

Experiment leads

Cut-off voltage as a function of frequency



Simple, safe and fast
Accuracy < 5%

U10700-230
U10700-115



Planck's Constant Apparatus

Simple, safe and quick-to-operate, compact apparatus with integrated photocell as well as a voltmeter and nano-ammeter for determining Planck's constant and the work done in emitting an electron using the stopping potential method. Five light emitting diodes (LEDs) of known mean wavelengths act as light sources of differing frequencies. The intensity of the light emitted by them can be varied from 0 to 100%.

- Wavelengths: 472 nm, 505 nm, 525 nm, 588 nm, 611 nm
 Dimensions: 280x150x130 mm³
 Weight: 1.3 kg approx.

Contents:

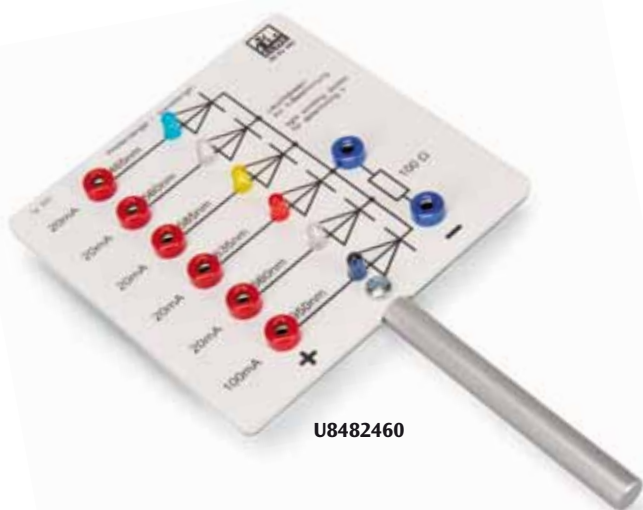
- 1 Basic apparatus with photocell, voltmeter, nano-ammeter and power supply for light sources
- 5 LEDs in casings with connector leads
- 1 Plug-in power supply 12 V AC

Planck's Constant Apparatus (230 V, 50/60 Hz)

U10700-230

Planck's Constant Apparatus (115 V, 50/60 Hz)

U10700-115



U8482460

Sodium Fluorescence Tube on Furnace Wall

Highly evacuated glass tube containing several times distilled sodium for demonstrating the resonance fluorescence of sodium vapour. Filled with argon. The entire tube emits yellow light at the wavelength of the sodium D line when it is brought to the heated state and illuminated with sodium spectral light. If it is instead illuminated with white incandescent filament light, the transmitted light exhibits a dark absorption line at the position of the sodium D line.

- Dimensions of tube: 170 mm x 42 mm diam.
 Dimensions of hotplate: 230x160 mm² approx.
 Weight: 550 g approx.

U8482260

Additionally required:

1012820 Heating Chamber (230 V, 50/60 Hz)

or

1006796 Heating Chamber (115 V, 50/60 Hz)

Additionally recommended:

U11817 Digital Thermometer, Single Channel

U11854 Immersible Temperature Sensor, NiCr-Ni, Type K, -65°C to 550°C

U8472660 Hand Held Spectroscope with Amici Prism

U8476840 Sodium Vapour Spectrum Lamp

U21905-230 Choke for Spectrum Lamps (230 V, 50/60 Hz)

or

U21905-115 Choke for Spectrum Lamps (115 V, 50/60 Hz)

Heating Chamber

Electric heating chamber with continuous temperature control and digital temperature display showing actual and set-point temperatures. In lacquered metal housing with two viewing windows, opening with spring-clip for thermometer and thermally insulated carrying handle. Temperature measurement and control is handled by an integrated microcontroller and a Pt100 thermocouple.

- Dimensions of front opening: 230x160 mm² approx.
 Heating power: 400 W
 Maximum temperature: 300°C (230 V, 50/60 Hz)
 250°C (115 V, 50/60 Hz)
 Temperature constancy: $\pm 1^\circ\text{C}$ approx.
 Dimensions: 335x180x165 mm³ approx.
 Weight: 5.6 kg approx.

Heating chamber (230 V, 50/60 Hz)

1012820

Heating chamber (115 V, 50/60 Hz)

1006796



U8482260

1012820
1006796

U8482415



Vacuum Photocell

Evacuated photocell for demonstrating the photoelectric effect and showing that the emission of electrons increases with increasing light intensity. Mounted ready for use on a base plate with electrical wiring and clamping bar.

Cathode:	Caesium on oxidized silver
Cathode area:	2.4 cm ²
Operating voltage:	50 V, max. 200 V
Working resistance:	1 MΩ
Dark current:	<0.05 μA
Sensitivity:	20 μA/lumen
Photoelectric current density:	max. 3.0 μA/cm ²

U8482415

U8482445



Gas Filled Photocell

Gas-filled photocell for demonstrating the photoelectric effect with simple measuring instruments for use by students that also shows how the emission of electrons increases with increasing light intensity. Mounted ready for use on a base plate with electrical wiring and clamping bar.

Cathode:	Caesium on oxidized silver
Cathode area:	2.4 cm ²
Operating voltage:	50 V, max. 90 V
Working resistance:	1 MΩ
Dark current:	<0.1 μA
Sensitivity:	125 μA/Lumen
Photoelectric current density:	max. 0.7 μA/cm ²

U8482445

External Photoelectric Effect (Hallwachs Effect)

Equipment:

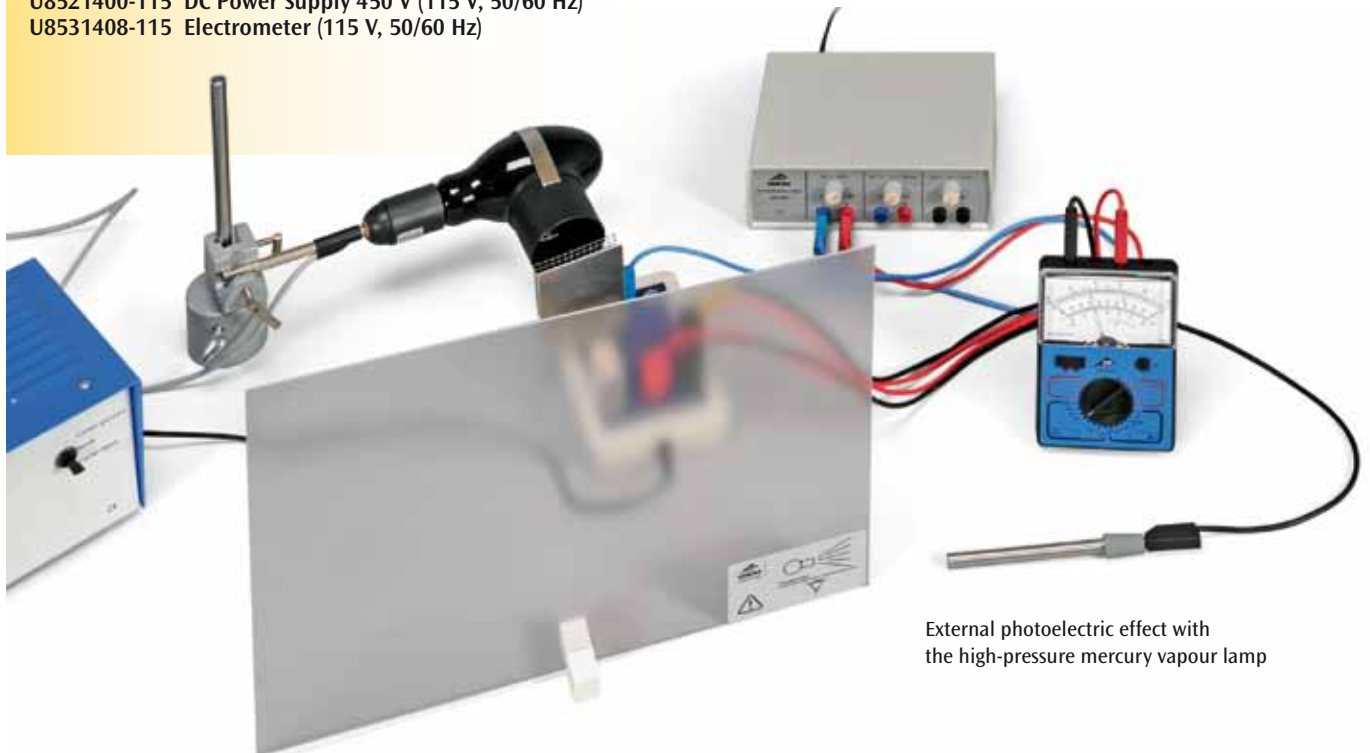
- U8473155 High-Pressure Mercury Vapour Lamp
- U8531420 Electrometer Accessories
- U13270 Tripod Stand, 150 mm
- U15001 Stainless Steel Rod, 250 mm
- U13255 Universal Clamp
- U17450 Analogue Multimeter AM50
- U21905-230 Control Unit for Spectrum Lamps (230 V, 50/60 Hz)
- U8521400-230 DC Power Supply 450 V (230 V, 50/60 Hz)
- U8531408-230 Electrometer (230 V, 50/60 Hz)
- or
- U21905-115 Control Unit for Spectrum Lamps (115 V, 50/60 Hz)
- U8521400-115 DC Power Supply 450 V (115 V, 50/60 Hz)
- U8531408-115 Electrometer (115 V, 50/60 Hz)

High-Pressure Mercury Vapour Lamp

High-pressure mercury vapour lamp in hardened glass bulb made of blackened borosilicate glass, with tube-shaped hole allowing emission of unfiltered ultra-violet radiation. Includes E27 lamp holder on stem and see-through screen to protect users from UV radiation.

Wavelength ranges:	UV-A, UV-B, UV-C
Power consumption:	125 W

U8473155



External photoelectric effect with the high-pressure mercury vapour lamp

...going one step further



Franck-Hertz experiment with neon

Franck-Hertz Experiment

The quantization of energy and the generation, recording and evaluation of spectra, along with the experimental verification thereof, is included in most of the curricula used around the world. The well known experiment first performed by James Franck and Gustav Hertz in 1913 is critically important in terms of demonstrating discrete energy states in atoms.

Power Supply Unit for Franck-Hertz Experiment

Power supply unit for operating the mercury filled Franck-Hertz tube (1006795 resp. 1006794, the neon filled Franck-Hertz tube (U8482230) or the critical potential tubes (U18560 and U18565). The equipment provides all the voltages needed to power the tubes and includes a sensitive built-in DC amplifier for measuring collector current. The voltages can simultaneously be read off a display. The accelerating voltage can be set-up manually on the apparatus or set to a saw-tooth wave form. Additional measuring inputs are also available for the anode current and accelerating voltage.

- Filament voltage U_f : 4 – 12 V, continuously adjustable
- Control voltage U_c : 0 – 12 V, continuously adjustable
- Accelerating voltage U_A : 0 – 80 V
- Modes of operation: manually adjusted / saw-tooth
- Countervoltage U_E : 0 – ± 12 V, continuously adjustable, switchable polarity

- Output U_E for collector current I_E : $I_E = U_A * 7 \text{ nA/V}$ (0 – 12 V)
- Output U_A for accelerating voltage U_x : $U_x = U_A / 10$
- Outputs: 4 mm safety sockets
- Input: BNC socket
- Dimensions: 160x132x210 mm³ approx.
- Weight: 3.4 kg approx.



1012819
1012818

Power Supply Unit for Franck-Hertz Experiment (230 V, 50/60 Hz)

1012819

Power Supply Unit for Franck-Hertz Experiment (115 V, 50/60 Hz)

1012818

Franck-Hertz experiment with mercury



BEST SELLER

Franck-Hertz Tube with Neon Filling

Highly evacuated electron tube containing neon, mounted on a base with socket connection for demonstrating that free electrons colliding with neon atoms emit energy in quantized packets and for determining the excitation energy of the 3P_0 or 3S_1 states at about 19 eV. When excited, these states emit visible light due to the energy drop from intermediate levels to a ground state at an excitation energy of about 16.7 eV. The light so emitted is in the red-yellow region of the spectrum. Parallel bands of light are formed between the control grid and the accelerator grid and can be observed through a window. The Franck-Hertz neon tube can be operated at room temperature. Tetrode with indirectly heated cathode, mesh control grid, mesh accelerating grid and collector (counter) electrode. Mounted on a base with colour coded connection sockets.

Filament voltage:	4 – 8 V
Control voltage:	9 V
Accelerating voltage:	max. 80 V
Counter voltage:	1.2 – 10 V
Tube:	130 mm x 26 mm diam. approx
Base with connector sockets:	190x115x115 mm ³ approx.
Weight:	450 g approx.

U8482230

Additionally required:

1012819 Power Supply Unit for Franck-Hertz Experiment
(230 V, 50/60 Hz)

or

1012818 Power Supply Unit for Franck-Hertz Experiment
(115 V, 50/60 Hz)

U11175 Analogue Oscilloscope 2x30 MHz



U8482230

Replacement Tubes for Franck-Hertz Experiment

Franck-Hertz Tube with Hg

U8482170

Franck-Hertz Tube with Ne

U8482240

U8482240



U8482170



Franck-Hertz Tube with Mercury Filling and Heating Chamber

Highly evacuated electron tube containing mercury in a heating chamber for demonstrating the discrete nature (quantization) of the energy released by free electrons in collisions with mercury atoms, and for determining the excitation energy of the mercury resonance line ($6^1S_0 - 6^3P_1$), which is 4.9 eV. The electron tube must be heated in the chamber to generate the necessary mercury vapour pressure to achieve a sufficiently high probability of collisions between electrons and mercury atoms. Electron tube with a plane parallel electrode system consisting of an indirectly heated oxide cathode with aperture, a grid and a collecting electrode. Front plate with printed tube symbol visible from a distance. Electric heating chamber with continuous temperature control and digital temperature display showing actual and set-point temperatures. In lacquered metal housing with two observation windows, opening with spring clip for thermometer, and thermally insulated carrying handle. Temperature measurement and control is handled by an integrated microcontroller and a Pt100 thermocouple.

Heater voltage:	4 – 12 V
Grid voltage:	0 – 70 V
Suppressor voltage:	1.5 V approx.
Tube dimensions:	130 mm x 26 mm diam. approx.
Heater output:	400 W
Temperature range:	160° C – 240° C
Temperature constancy:	±1° C approx.
Overall dimensions:	335x180x165 mm ³ approx.
Weight:	5.6 kg approx.

Franck-Hertz Tube with Mercury Filling and Heating Chamber (230 V, 50/60 Hz)

1006795

Franck-Hertz Tube with Mercury Filling and Heating Chamber (115 V, 50/60 Hz)

1006794

Additionally required:

1012819 Power Supply Unit for Franck-Hertz Experiment
(230 V, 50/60 Hz)

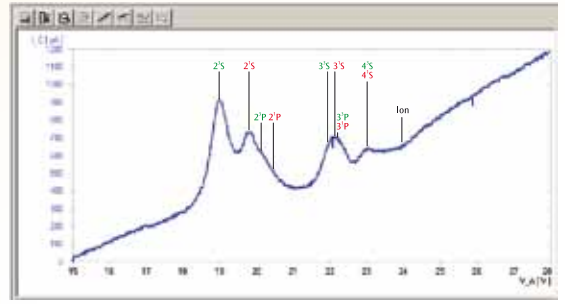
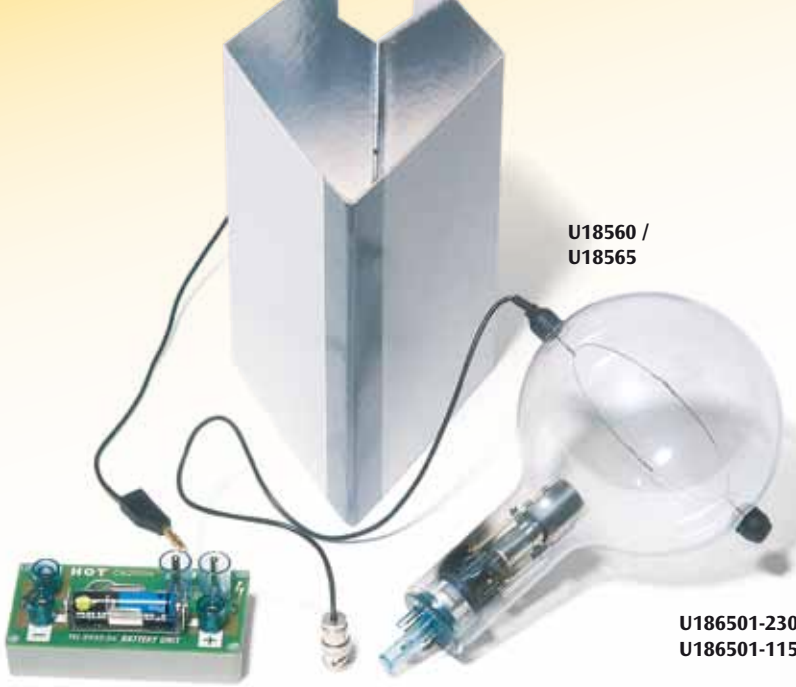
or

1012818 Power Supply Unit for Franck-Hertz Experiment
(115 V, 50/60 Hz)

U11175 Analogue Oscilloscope 2x30 MHz

1006795
1006794





Collector current I_R as a function of accelerating voltage U_A . Gas filling: He



Critical Potential Tube S

Hertz electron tube for quantitative investigations of inelastic collisions of electrons with inert gas atoms, determination of ionization energy and excitation energies of helium resp. neon, resolution of the energy states of various primary and orbital angular-momentum quantum numbers, as well as demonstrating meta stable states. Includes shielding as well as a discharge tube and battery unit (battery included) for the collector voltage.

- Cathode filament voltage: $U_F \leq 3 \text{ V}, I_F \leq 1,3 \text{ A}$
- Anode voltage: $U_A \leq 60 \text{ V}$
- Anode current: $I_A \leq 10 \text{ mA}$
- Collector voltage: $U_C = 1,5 \text{ V}$
- Collector current: $I_C \leq 200 \text{ pA}$

Critical Potential Tube S with He Filling

U18560

Critical Potential Tube S with Ne Filling

U18565

Additionally required:

- U185001 Tube Holder S**
- U186501-230 Control Unit for Critical Potential Tubes (230 V, 50/60 Hz)**
- U33020-230 DC-Power Supply 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz)**
- or
- 1012819 Power Supply Unit for Franck-Hertz Experiment (230 V, 50/60 Hz)**
- or
- U186501-115 Control Unit for Critical Potential Tubes (115 V, 50/60 Hz)**
- U33020-115 DC-Power Supply 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz)**
- or
- 1012818 Power Supply Unit for Franck-Hertz Experiment (115 V, 50/60 Hz)**

Control Unit for Critical Potential Tubes

Control unit for operating the critical potential tubes. Equipped with an output for sawtooth acceleration voltages; adjustable upper and lower limits of the acceleration voltage. Integrated pico-ammeter amplifier for anode current measurement. Allows recording of the acceleration voltage as a function of the anode current. A slow sawtooth voltage (approx. 6 seconds per cycle) is available with an interface or XY-recorder; a sawtooth voltage with a repetition rate of 20 Hz is available for oscilloscopic observations.

Input:	Anode current measurement via a BNC jack
Outputs:	
Tube	Sawtooth acceleration voltage of 0 – 60 V, 20 Hz
Fast	Voltage signal of 0 – 1 V, proportional to the acceleration voltage, for oscilloscopic observations
Slow	Voltage signal of 0 – 1 V, proportional to the acceleration voltage, for recording data with an XY-recorder or interface
Anode current	Voltage signal of 0 – 1 V, proportional to the anode current (1 V/nA)
Supply voltage:	12 V DC
Dimensions:	approx. 170x105x45 mm ³

Control Unit for Critical Potential Tubes (230 V, 50/60 Hz)

U186501-230

Control Unit for Critical Potential Tubes (115 V, 50/60 Hz)

U186501-115



Electron Diffraction Tube D

Highly evacuated electron tube for demonstrating the wave nature of electrons through the observation of interference caused by passage of electrons through a polycrystalline graphite lattice (Debye-Scherrer diffraction) and rendered visible on a fluorescent screen. Also intended for determining the wavelength as a function of the anode voltage from the radii of the diffraction rings and the lattice plane spacing of graphite, as well as confirming de Broglie's hypothesis.

Filament voltage: 6.3 V AC
 Max. anode voltage: 5000 V
 Anode current: approx. 0.1 mA at 4000 V
 Focussing voltage: 0 – 50 V
 Lattice constant of graphite: $d_{10} = 0,213 \text{ nm}$, $d_{11} = 0.123 \text{ nm}$

U19171

Additionally required:

U191001 Tube Holder D

U138101 Set of Leads for Electron Tube Experiments

U33010-230 High Voltage Power Supply, 5 kV (230 V, 50/60 Hz)

or

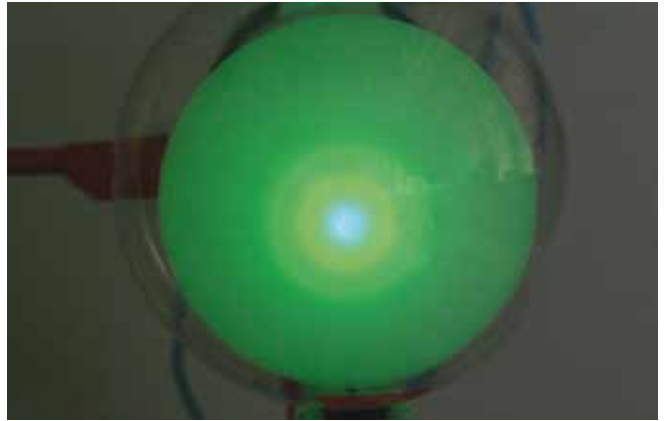
U33010-115 High Voltage Power Supply, 5 kV (115 V, 50/60 Hz)

Additionally recommended:

1009960 Three- Pole Protective Adapter



U19171



Electron Diffraction Tube S

Highly evacuated electron tube for demonstrating the wave nature of electrons through the observation of interference caused by passage of electrons through a polycrystalline graphite lattice (Debye-Scherrer diffraction) and rendered visible on a fluorescent screen. Also intended for determining the wavelength as a function of the anode voltage from the radii of the diffraction rings and the lattice plane spacing of graphite, as well as confirming de Broglie's hypothesis.

Filament voltage: 6.3 V AC
 Max. anode voltage: 5000 V
 Anode current: approx. 0.1 mA at 4000 V
 Lattice constant of graphite: $d_{10} = 0,213 \text{ nm}$, $d_{11} = 0,123 \text{ nm}$

U18571

Additionally required:

U185001 Tube Holder S

U138021 Set of 15 Safety Experiment Leads, 75 cm

U33010-230 High Voltage Power Supply, 5 kV (230 V, 50/60 Hz)

or

U33010-115 High Voltage Power Supply, 5 kV (115 V, 50/60 Hz)



U18571

Optical Equivalent to Debye-Scherrer Interference

Aluminium disc with ball bearing mounted optical lattice grating for illustrating the principle of Debye-Scherrer interference using visible light. The rotating lattice grating serves as a model for the polycrystalline graphite lattice in the electron diffraction tube. Includes an aperture and red and green colour filters.

Cross lattice: 20 grid points/mm, 3 mm diam.
 Flywheel: 100 mm diam.
 Pinhole aperture: 1 mm diam.
 Aperture frame: approx. 50x50 mm²
 Filter: approx. 80x100 mm²

U19172

Additionally recommended:

U191001 Tube Holder D

U21881 Optical Lamp

U13900-230 Transformer 12 V, 60 VA (230 V, 50/60 Hz)

or

U13900-115 Transformer 12 V, 60 VA (115 V, 50/60 Hz)

U17102 Convex Lens, f = 100 mm



U19172

U8474000 Object Holder, on Stem

U17130 Projection Screen

U13270 Tripod Base

U8611210 Barrel Foot (3x)



NMR Supplementary Set

Supplementary set for ESR/NMR basic set (U188031-230/U188031-115) for experiments on nuclear magnetic resonance using three different samples. Consists of an NMR probe-head with radio frequency coil, a permanent magnet giving a highly uniform field, a sample of glycerine, a sample of polystyrene, a sample of Teflon, an empty sample tube for comparison and two mounting discs.

Connection to the probe-head: Four-pin Lemo plug
 Magnetic flux density of permanent magnet: 300 mT approx.

U189021



ESR Supplementary Set

Supplementary set for ESR/NMR basic set (U188031-230/U188031-115) for experiments on electron spin resonance using DPPH. Consists of an ESR probe-head with radio frequency coil, a sample of DPPH (diphenyl picryl hydrazyl), an empty sample tube for comparison, two mounting rings and two mounting cylinders.

Connection to the probe-head: Four-pin Lemo plug

U188501



ESR/NMR Basic Set

This basic equipment set is intended for investigating the electron spin resonance (ESR) of an unpaired electron of a DPPH sample as well as the nuclear magnetic resonance (NMR) of glycerine, teflon and polystyrene. Resonances are observed via transitions induced through high frequencies resulting from changes in the external magnetic field. Resonance absorption curves can be represented with a simple dual-channel oscilloscope or with the 3B NETlog™ unit.

Contents:

- 1 Basic unit
- 1 Pair of coils
- 1 Control panel
- 1 Plug-in power supply, 12 V AC (230 V, 50/60 Hz)
- or
- 1 Plug-in power supply, 12 V AC (115 V, 50/60 Hz)

The basic unit is a mechanical base for test samples as well as ESR (from U188501) or NMR probes (from U189021), a coil pair and a permanent magnet (from U189021).

Dimensions: 165x105x135 mm³ approx.
Weight: 1.25 kg approx.

The coil pair is used to generate the variable magnetic field for electron spin resonance and – in conjunction with the permanent magnet (from U189021) – nuclear spin resonance.

Magnetic flux density: 0 – 3.7 mT
Connection: Barrel connector
Dimensions: 20 mm x 74 mm diam. approx. each
Weight: 0.2 kg approx. each

The control console provides the voltage for control and supply of power to probes and the coil pair. It also processes the signal for display on an oscilloscope and indicates the frequency of the high-frequency signal.

Probe connection: Four-pin Lemo socket
Coil pair connection: Saw-tooth current source, 0 – 250 mA, 50 ms, pair of barrel sockets
Field output: Proportional to coil current, 0 to 1 V, BNC socket
Signal output: Resonance signal, 0 to 1 V, BNC socket
Frequency range: 45 to 75 MHz approx. (ESR)
10 to 15 MHz approx. (NMR)
Dimensions: 170x105x45 mm³ approx.
Weight: 0.5 kg approx.

Experimental topics:

- Resonance absorption of a high-frequency oscillating circuit
- Dependence of resonance frequency on magnetic fields
- Line width
- Electron spin
- Magnetic moment of an electron
- Determination of the electron g factor
- Proton spin
- Magnetic moment of a proton and nucleus
- Determination of the nucleus g factor
- Nuclear-spin tomography

ESR/NMR Basic Set (230 V, 50/60 Hz)

U188031-230

ESR/NMR Basic Set (115 V, 50/60 Hz)

U188031-115

Additionally required:

U188501 ESR Supplementary Set

or

U189021 NMR Supplementary Set

U11175 Analogue Oscilloscope, 2x30 MHz

or

U11300-230 3B NETlog™ (230 V, 50/60 Hz)

or

U11300-115 3B NETlog™ (115, 50/60 Hz)



U188031-230/
U188031-115

Experiment topics:

- Extrinsic conductivity
- Intrinsic conductivity
- Mobility of electrons and holes
- Drift velocity of charge carriers
- Carrier concentration
- Band separation



1009934

Basic Hall Effect Apparatus

Basic apparatus for providing contact, power supply and support to a germanium crystal on a circuit board (U8487010, U8487020 and U8487030) in experiments on the Hall effect or on conductivity. Includes an integrated, adjustable constant current source to provide the current through the sample, a measuring amplifier with offset compensation for Hall voltages and heating to raise the crystal to as high as 170° C, also featuring temperature regulation and a switchable display showing Hall voltage, sample current, sample voltage or temperature. Hall voltage and sample voltage can be tapped directly from the front panel. In addition three equivalent voltage outputs for Hall voltage, sample current and sample temperature can be measured from the side. Includes an attachment for assembling the apparatus on the U-shaped core (U8497215) of a transformer assembly kit and 2 connecting leads with 8-pin miniDIN plugs.

Outputs for

equivalent voltages:

- 4-mm safety sockets
- 8-pin miniDIN sockets (for 3B NET^{log}TM)

Power supply:

12 V AC, 3 A via 4-mm sockets

Dimensions:

180x110x50 mm³ approx.

Weight:

0.5 kg approx.

1009934

Equipment:

U8487010	Undoped Germanium on Printed Circuit Board	yes	–	–
U8487020	P-Doped Germanium on Printed Circuit Board	–	yes	–
U8487030	N-Doped Germanium on Printed Circuit Board	–	–	yes
1009934	Basic Hall Effect Apparatus	yes	yes	yes
U33300-230 or U33300-115	Transformer with Rectifier 3, 6, 9, 12 V, 3 A	yes	yes	yes
U138021	Set of 15 Safety Experiment Leads	yes	yes	yes
U8497215	U-Shaped Core	yes	yes	yes
1009935	Pair of pole pieces for Hall effect with clamp	–	yes	yes
U8497430	Coil with 600 Turns (2x)	–	yes	yes
U33020-230 or U33020-115	DC Power Supply 0–20 V, 0–5 A	–	yes	yes
1009941	Magnetic Field Sensor ±2000 mT	–	yes	yes
U11300-230 or U11300-115	3B NET ^{log} TM	–	yes	yes



Undoped Germanium on Printed Circuit Board

High-quality interchangeable board with an undoped germanium crystal for investigating the conductivity of undoped germanium as a function of temperature. With contacts for transverse current, integrated resistive heating element with temperature sensor directly under the crystal, and multi pin plug for connecting the circuit board to the basic Hall effect apparatus (1009934).

Crystal dimensions: 20x10x1 mm³ approx.

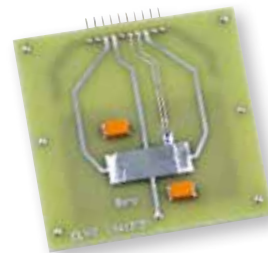
Overall dimensions: 70x70x10 mm³ approx.

Weight: 30 g approx.

U8487010

Additionally required:

1009934 Hall Effect Basic Apparatus



U8487010

P-Doped Germanium on Printed Circuit Board

High-quality interchangeable board with an p-doped germanium crystal for investigating the conductivity and Hall potential for p-doped germanium as a function of temperature. With contacts for transverse current and Hall potential, integrated resistive heating element with temperature sensor directly under the crystal and multi pin plug for connecting the circuit board to the basic Hall effect apparatus (1009934).

Crystal dimensions: 20x10x1 mm³ approx.

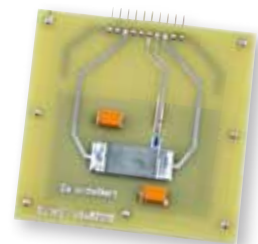
Overall dimensions: 70x70x10 mm³ approx.

Weight: 30 g approx.

U8487020

Additionally required:

1009934 Hall Effect Basic Apparatus



U8487020

N-Doped Germanium on Printed Circuit Board

High-quality interchangeable board with an n-doped germanium crystal for investigating the conductivity and Hall potential for n-doped germanium as a function of temperature. With contacts for transverse current and Hall potential, integrated resistive heating element with temperature sensor directly under the crystal, and multi pin plug for connecting the circuit board to the basic Hall effect apparatus (1009934).

Crystal dimensions: 20x10x1 mm³ approx.

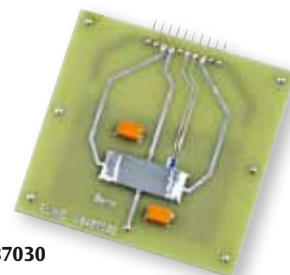
Overall dimensions: 70x70x10 mm³ approx.

Weight: 30 g approx.

U8487030

Additionally required:

1009934 Hall Effect Basic Apparatus



U8487030

Experiment Topics:

- Properties of X-rays:
 - Transmission
 - Linear propagation
 - Ionization
 - X-ray photography
- Fluorescent radiation
- Shielding of X-rays
- Absorption experiments
- Distance law
- Dosimetry and radiation protection
- Diffraction of X-rays:
 - Laue's recordings
 - Debye-Scherrer's recordings
 - Bragg's reflection
 - Duane-Hunt's displacement law (h-determination)
- Moseley's law

X-Ray Apparatus

The experiment chamber is contained in a closed, radiation-proof housing with a transparent synthetic-glass shield. If the synthetic-glass shield is opened, the high-voltage source for the X-ray tube is deactivated automatically. The high-vacuum X-ray tube with a directly heated tungsten cathode and copper anode is positioned in a borosilicate glass chamber with a thin-walled, concave ray emission window. A lead-glass hood with a collimator causes X-rays to emerge in parallel with the experiment plane and provides a shield against scattered radiation. The horizontal counter-tube goniometer consists of a central sample holder and a swiveling arm. In the form of a slide tray, this arm serves as a mount for the Geiger-Müller tube (U19201), ionization chamber (U19208) as well as experimental devices in slide format or on a 5 cm x 5 cm base plate (for example, from U19205, U19206, U19207). The swiveling arm can be rotated manually independently of the sample holder, or at a fixed mutual angle with a ratio of 2:1, for instance, for experiments involving Bragg's reflection. The device is equipped with angle and millimeter scales, position markings for experimental devices, as well as radiation-proof bushings for cables and hoses.

Anode voltage:	20/30 kV, switchable and electronically stabilized
Emission current:	0 to 80 μ A, continuously adjustable and electronically stabilized
Cathode heating:	4 V, 1 A
Focal spot:	5x1 mm ²
Anode material:	Cu
Lead-glass collimator:	radiation emission aperture with 5 mm diam. better than 10°
Ray divergence:	better than 10°
Characteristic radiation wavelength:	Cu-K _{α} : 154 pm Cu-K _{β} : 138 pm

Counter-tube goniometer:

Swiveling ranges:	0°, +10° to +130° and -10° to +130° relative to the ray axis
Angular coupling:	independent of the sample holder or with a ratio of 2:1
Measurement accuracy of Bragg's angle:	5 arc minutes
Timer:	0 to 55 minutes, continuously adjustable
Power consumption:	100 VA

Dimensions:

X-ray apparatus:	approx. 250 mm x 370 mm diam.
X-ray tube:	approx. 100 mm x 32 mm diam.
Weight:	approx. 9 kg

X-Ray Apparatus (230 V, 50/60 Hz)

U192001

X-Ray Apparatus (115 V, 50/60 Hz)

U192001-US

Spare Tube for X-Ray Apparatus

(not shown)

Spare tube with Cu anode for X-ray apparatus (U192001) and X-ray apparatus (U192001-US).

U19204



U192001 /
U192001-US

Motor Drive Debye-Scherrer

For structural investigations using the rotating-crystal method, suitable for the Debye-Scherrer camera (contained in U19205). Power transmission via bevel gears.

Power consumption: 3 VA

Motor Drive Debye-Scherrer (230 V, 50/60 Hz)

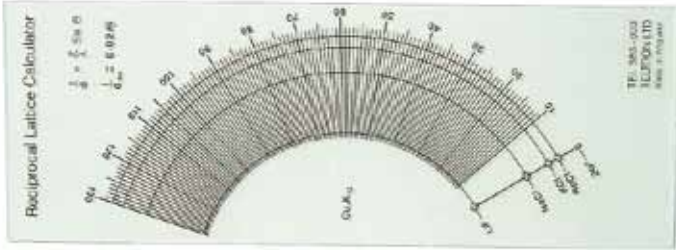
U19202-230

Motor Drive Debye-Scherrer (115 V, 50/60 Hz)

U19202-115



1000663
1000662



U19206

Crystallography Accessories

These accessories for the basic equipment set (U19205) are intended for additional crystallographic experiments as well as treatments of Moseley's law, the Debye-Scherrer method, Bragg's reflection and material tests.

Contents:

- 4 foils, Fe, V, Mn, Cr
- 2 single crystals, KCl, RbCl
- 5 powder samples, NaF, SiC, NH₄Cl, MgO, Al
- 2 wire samples, Al, Nb (3x each) for Debye-Scherrer experiments
- 10 polyethylene threads
- 1 disc for calculating Bragg's angle

U19206

Radiography Accessories

These accessories for the basic equipment set (U19205) are intended for investigating the following topics: scattering, absorption; dependence on acceleration voltage, emission current and penetration power, resolving power; shielding, half width; exposure time, non destructive materials testing.

Contents:

- 1 Maltese cross
- 1 phantom
- 1 pin diaphragm
- 1 aluminum layer, stepped
- 5 aluminum absorbers, 0.1/0.25/0.5/1.0/2.0 mm
- 1 lead absorber, 0.5 mm
- 1 plastic absorber
- 2 magnets
- 4 materials testing models (porosity, fissures, welding seam, painting)

U19207



U19207

Geiger-Müller Tube

Self-extinguishing halogen-trigger counter tube for registering alpha, beta, gamma and X-radiation. Enclosed in a plastic housing with a holder for mounting on the swiveling arm of the X-ray apparatus (U192001 resp. U192001-US); equipped with a firmly installed BNC patch cord. Includes a retention clip for other types of mounting.
 Dose-rate range: $10^{-3} - 10^2$ mGy/h
 Mass of the active surface: Mica: 2.0 – 3.0 mg/cm²
 Operating voltage: 500 V
 Dimensions: approx. 50x50x22 mm diam.
 Cable length: approx. 1 m

U19201

Basic Set Bragg

Basic equipment set for Bragg's reflection experiment with a LiF and a NaCl crystal.

Contents:

- 1 slit diaphragm collimator, 1 mm
- 2 slit diaphragms, 1 mm/3 mm
- 2 single crystals, LiF, NaCl
- 1 Geiger Müller tube (U19201)

U19212



U19212

U19201

Basic Equipment Set

Equipment set for qualitative and quantitative experiments involving, for instance, linear propagation, ionization, penetration capacity of X-radiation and X-ray photography; also for demonstrating the wave nature of X-radiation, investigating fluorescent X-radiation and determining mass-absorption coefficients. In a specially moulded storage box.

U19205

Contents:

- 1 fluorescent screen
- 1 Debye-Scherrer camera
- 2 film cassettes
- 1 lead mask
- 2 plate electrodes on a 4 mm contact pin
- 1 slit diaphragm collimator, 1 mm
- 1 pin diaphragm collimator, 1 mm diam.
- 1 ancillary magazine with a circular aperture
- 2 slit diaphragms, 1 mm/3 mm
- 1 pin diaphragm, 9.5 mm diam.
- 2 single crystals, LiF, NaCl
- 2 mini crystals, LiF
- 1 powder sample, LiF
- 10 copper wires
- 4 absorption foils, Ni, Cu, Co, Zn
- 1 scattering-foil revolver, coated with V, Cr, Mn, Fe, Co, Ni, Cu, Zn
- 1 set of assembly aids (acetate adhesive, clips)
- 1 storage box, specially moulded



U19205

Bragg Driver

The Bragg driver is a combination of hardware and software which allows the user to collect X-ray diffraction data in combination with the X-ray apparatus (U192001 resp. U192001-US). It provides the high voltage and counting circuitry for the Geiger Müller tube (U19201) and includes a software program that allows the user to control the driver and collect data. It includes the USB powered drive, a drive gear, an USB cable and a powder compressor. Scans can be obtained for all crystals available in the basic equipment set (U19205) and the crystallography accessories (U19209). An additional feature includes the ability to scan powders and foils. The software allows selection of scan angles, resolution, and time per step. Once the experiment is completed the software permits zoom-in on the data and the facility to add comments to the file. Data can be exported to a spreadsheet for further analysis.

Time interval for automatic data saving: 30 s
 Angular range: 12° – 120°
 Time per step: ≥ 0.1 s
 Angular step: ≥ 0.05°
 GM tube voltage: 0 – 1000 V

1012871

NEW

1012871



Recommended equipment:

Art. No.		Basic	Intermediate	Advanced
U192001 or U192001-US	X-ray Apparatus	yes	yes	yes
U19201	Geiger Müller Tube	yes	yes	yes
1012871	Bragg Driver	yes	yes	yes
U19205	Basic Equipment Set	yes	yes	yes
U19206	Crystallography Accessories		yes	yes
U19207	Radiography Accessories			yes
1000663/ 1000662	Motor Drive		yes	yes
U19209	Film-pack2	yes	yes	yes
U19210	Film-pack 4	yes	yes	yes

Basic:

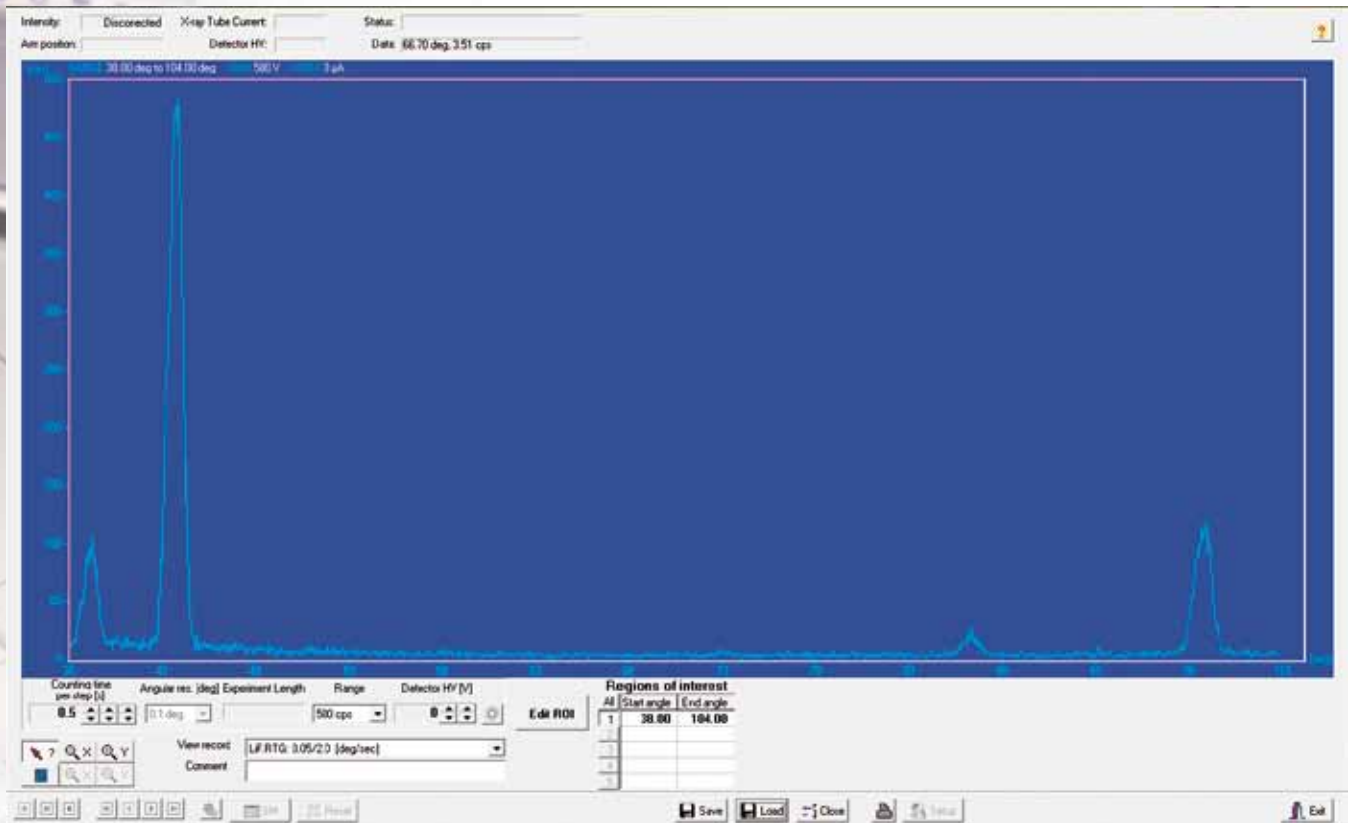
Basic experiments using photographic techniques and Geiger Müller tube like Laue experiments, Bragg diffraction experiments, experiments on inverse square law, emission, rectilinear propagation, penetration and absorption of X-rays.

Intermediate:

Basic experiments and experiments on Moseley, Debye-Scherrer diffraction, size of the unit cell in salt crystals in addition.

Advanced:

Intermediate experiments and experimental investigations into radiography, film and the properties of x-rays in addition.



X-ray Energy Detector

X-ray detector for recording energy spectra of X-rays or γ radiation in the energy range of approx. 2 keV to 60 keV. It mainly consists of a Si-PIN photodiode which is integrated in a metal housing together with a charge sensitive preamplifier, a main amplifier with pulse shaping and a digital signal processing circuit. The detector holder is particularly designed for installation on the swiveling arm of the X-ray apparatus (U192001 resp. U192001-US). The power supply is ensured via the USB port of a PC. Including CD with measuring and evaluation software for PC.

- Energy range: approx. 2 keV up to 60 keV
- Energy resolution (FWHM): 0.55 keV at $E_{FeK\alpha} = 6.40$ keV
- Entrance window: Plastics (absorption equivalent to Graphite with $d = 40 \mu\text{m}$)
- Detector: Si-PIN photo diode
- Active Area: 0.8 mm diam.
- Thickness: approx. 200 μm
- Dead time per pulse: approx. 200 μs
- Connection: USB
- Cable length: 1.75 m
- Dimensions: 80 mm x 22 mm diam.
- Mass: 150 g

U10600

- Additionally required:
- U192001 X-Ray Apparatus (230 V, 50/60 Hz)**
 - U192001-US X-Ray Apparatus (115 V, 50/60 Hz)**

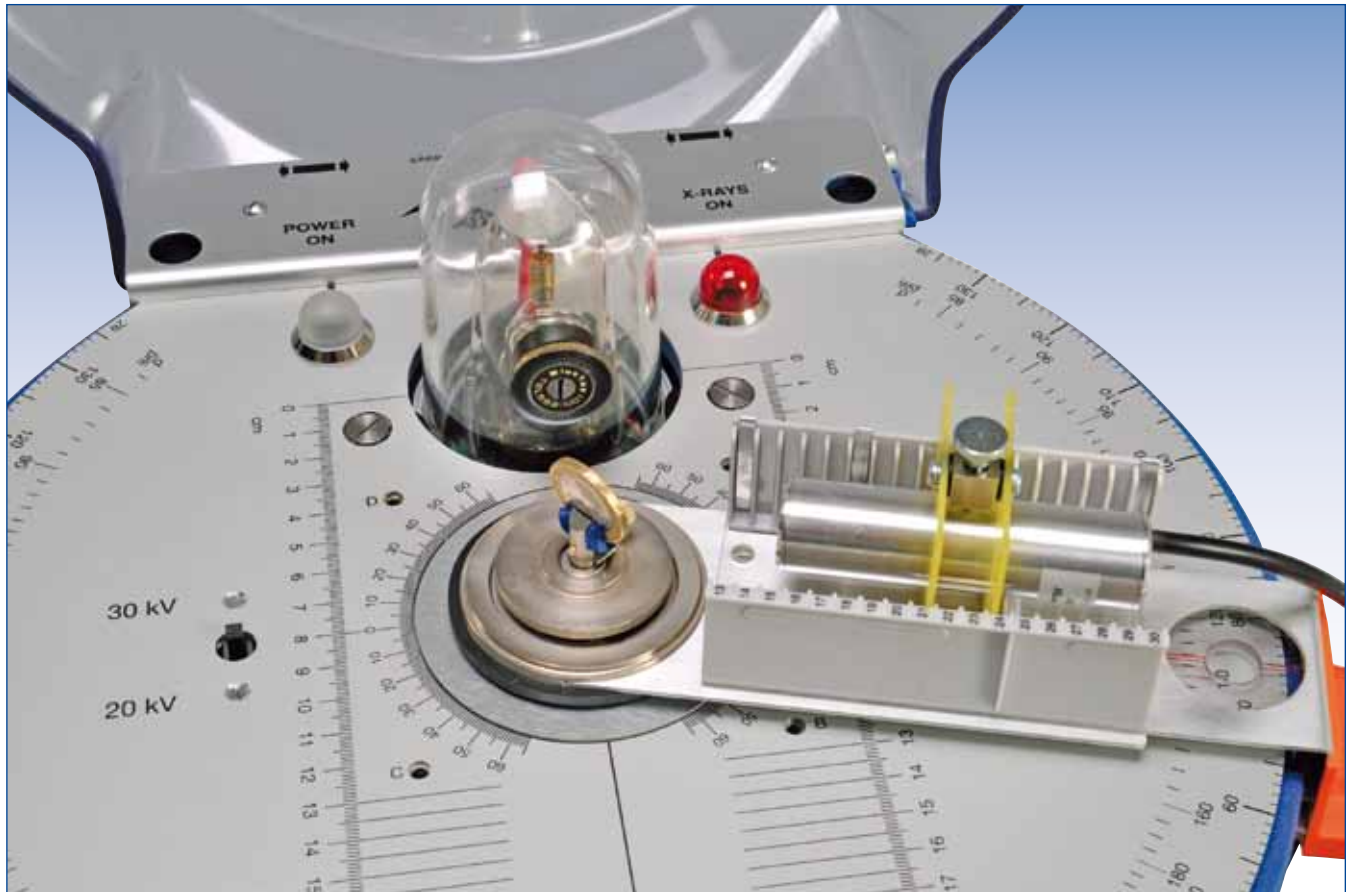
- Additionally recommended:
- 1012868 Set of Fluorescence Samples**

Experiment Topics:

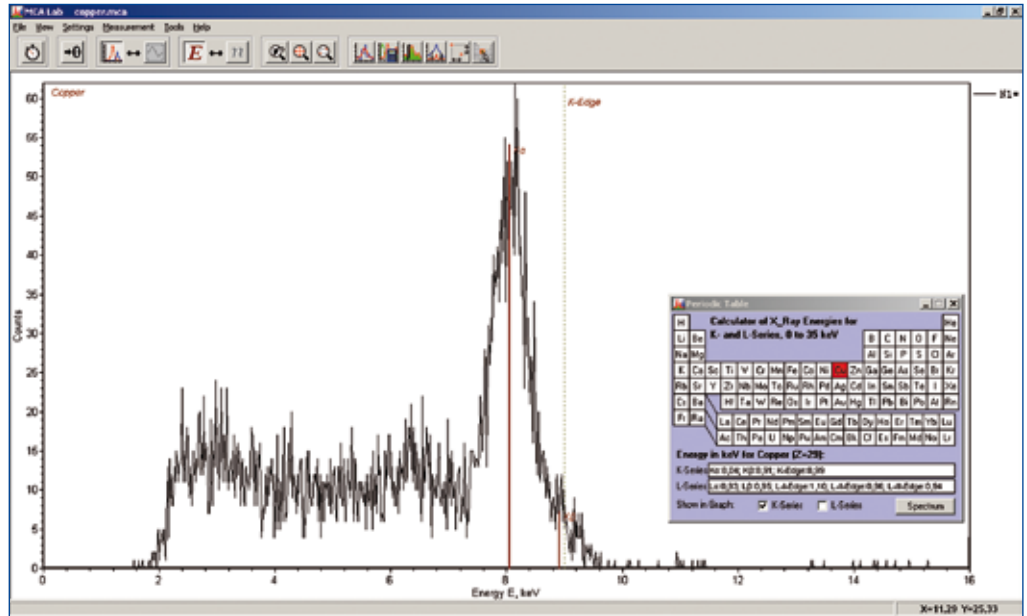
- X-ray energy spectroscopy
- Compton effect
- X-ray fluorescence spectroscopy
- Absorption experiments
- Bragg's reflection
- Duane-Hunt's displacement law
- Moseley's law



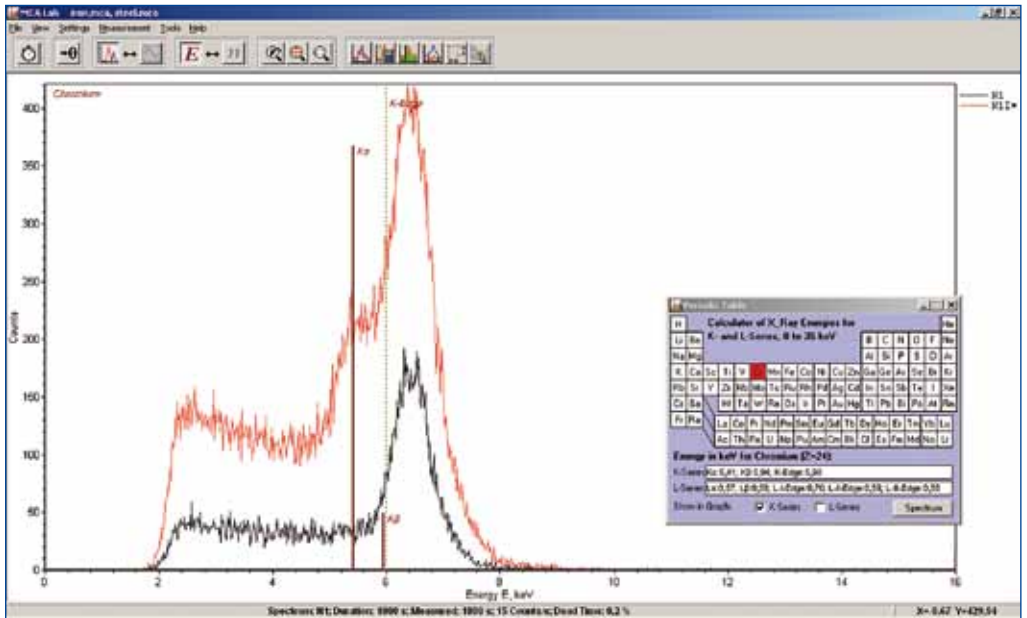
U10600



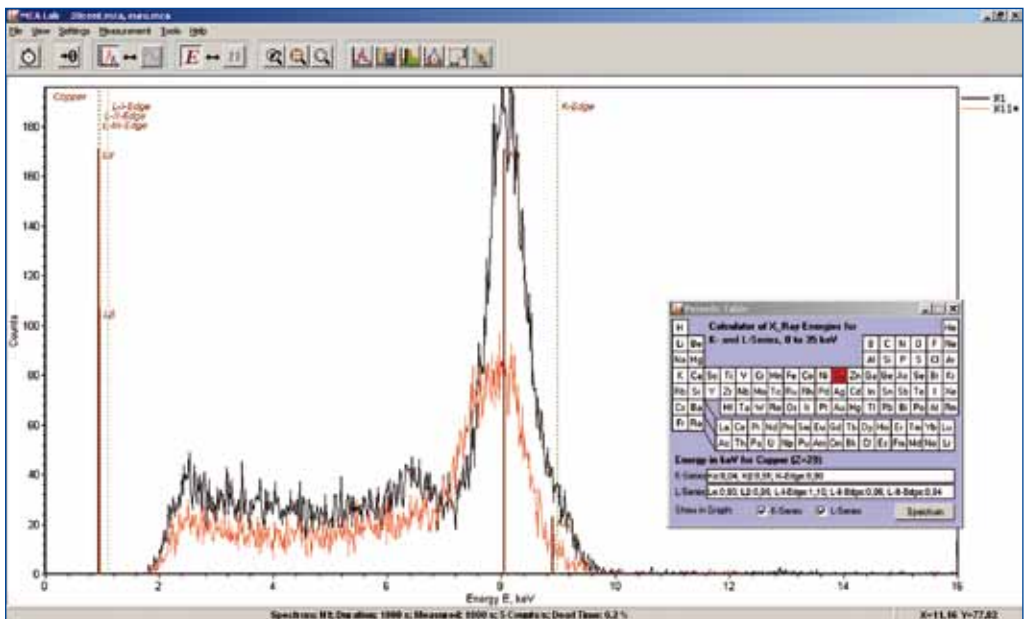
Energy spectrum of a copper anode



Comparing the x-ray fluorescence spectra of iron (black) and stainless steel (red)



Comparing the x-ray fluorescence spectra of two different coins





Pico-Ammeter Amplifier

Current amplifier for measuring electrical currents in the pico-ampere range. With zero-point adjustment; the measured currents can be fed via the voltage output to an XY-recorder, interface or other measuring device. Includes a jack.

Measuring ranges: 0 to ±200 nA
 0 to ±20 nA
 0 to ±2 nA
 0 to ±200 pA
 via a BNC jack

Additionally: 0 to ±200 µA via a jack
 Voltage output: 0 to 1V, proportional to the set measuring range via 4 mm jacks

Dimensions: 170x105x45 mm³

U18630

Additionally required:

U18700-230 Plug in Power Supply TEL (230 V, 50/60 Hz)
 or
U18700-115 Plug in Power Supply TEL (115 V, 50/60 Hz)

Plug in Power Supply TEL

Plug in Power supply with an electronically regulated output voltage. Connecting lead with a 6-pole, self locking special plug.

Lead length: approx. 1 m
 Output: 12 VDC, 400 mA

Plug-in Power Supply TEL (230 V, 50/60 Hz)

U18700-230

Plug-in Power Supply TEL (115 V, 50/60 Hz)

U18700-115

Film-pack 2

Highly sensitive film (38x35 mm²) for α-, β- and X-radiation. Single packaging in opaque plastic cases allows development and fixing in daylight (duration: approx. 6 minutes).

Contents:

- 20 film sheets (38x35 mm²) in light-tight plastic cases
- 1 bottle of X-ray developer
- 1 bottle of X-ray fixer
- 1 syringe with a cannula for introducing chemicals into the film cases
- 1 metal clip

U19209

Film-pack 4

Like U19209, but consisting of 12 film sheets, 150x12 mm², in light-tight plastic cases for a Debye-Scherrer camera.

U19210

Ionization Chamber

Intended for investigating the ionization of air and other gases brought about by X-radiation at different pressures (saturation characteristics, model of a Geiger-Müller tube, dosimetry). Possesses a cylinder-shaped cathode, rod-anode and hose shaft for evacuating and introducing gases.

Operating voltage: max. 2 kV
 Ionization current: 10⁻¹¹ – 10⁻¹⁰ A
 Rod-electrode: approx. 75 mm long
 Chamber: approx. 85 mm x 25 mm diam.
 Hose shaft: approx. 5 mm diam.

U19208

Additionally required:

U18630 Pico-Ammeter Amplifier

Set of Fluorescence Samples

Set of 7 samples for material analysis with the X-ray energy detector (U10600). The material composition can be determined from the energies of the appropriate X-ray fluorescence lines. Thus, for example the difference between stainless and low carbon steel, or between copper, brass and bronze can be seen clearly.

Materials:

Stainless Steel S321, Low Carbon Steel, Copper C101, Brass C260, Bronze C220, Zinc and Lead.

1012868



Geiger-Müller Counter Tube

Self-quenching halogen pulse ionisation chamber for detecting alpha, beta, gamma and x-ray radiation. In metal housing with mica window, removable mounting clamp with shaft. Long plateau length.

Filling:	Neon/argon mixture, halogen as quenching agent
Cathode dimensions:	approx. 39x14 mm ²
Window:	mica, 9 mm diam.
Mass per unit area:	1.5 – 2.0 mg/cm ²
Plateau length:	400 V – 600 V
Operating voltage:	400 – 600 V (recommended: 500 V)
Relative plateau slope:	0.04 %/V
Dead time:	90 µs
Limiting resistor:	10 MΩ, integrated in holder
Shaft:	approx. 100 mm x 10 mm diam.
Dimensions counter tube:	approx. 85 mm x 25 mm diam.
Weight:	approx. 160 g

U8533430

Additionally required:

U11255 HF Patch Cord, 1 m
U8533341-230 Digital Counter
(230 V, 50/60 MHz)

or

U8533341-115 Digital Counter
(115 V, 50/60 MHz)



U8533430

Digital Counter

Digital counter/timer for measuring duration of motion, transition times, periods, pendulum periods and frequencies, as well as for counting events or Geiger tube pulses. Includes a speaker that can be turned on and off, power supplies for direct connection to light barriers (U11365) or for powering a Geiger-Müller counter (U8533430). For event counting, a fixed counting period can be programmed in a range from 1 s to 99999 s. Counter events (start, stop) can either be triggered by a signal to the input sockets or manually via switches. Includes plug-in power supply.

Time measurement:	0.1 ms – 99999 s
Resolution:	0.1 ms / 1 ms / 0.1 s
Frequency measurement:	1 – 100 kHz, where voltage > 1.5 V _{pp}
Resolution:	1 mHz (1 – 100 Hz), 1 Hz (1 – 100 kHz)
Counting periods:	1/10/60/100 s or manually triggered
Input A:	miniDIN 8 socket, 4 mm safety sockets
Input B:	miniDIN 8 socket, 4 mm safety sockets
Input voltage A:	0.5 V – 15 V AC
Input voltage B:	1 V – 15 V AC
Active edge:	Rising/falling
Counter tube input:	BNC socket
Power supply:	550 V / 1 MΩ
Display:	5-digit LED display
Operating voltage:	9 – 12 V DC via plug-in power supply
Dimensions:	250x100x160 mm ³ approx.
Weight:	0.8 kg approx.

Digital Counter (230 V, 50/60 MHz)

U8533341-230

Digital Counter (115 V, 50/60 MHz)

U8533341-115



U8533341-230/
U8533341-115

U8533430

Geiger Counter

Versatile, easy to use and compact precision instrument for measuring α-, β- and γ-radiation. With filter selection switch at the front of the Geiger-Müller counter tube for filtering out types of radiation (γ/β, γ/α/β or γ only), large display and integrated USB interface. Including USB cable, Windows software, and operating instructions. The following functions and operating modes are available for measurement:

- Standard mode for displaying the current radiation level. Display of the equivalent dose as a numerical value and as bar chart and display of the time until a selected cumulative dose limit is reached (default 5 µSv/h). Also equipped with variable acoustic and optical warning threshold signal and display of average radiation from previous day.
- Pulse counting either permanent or with variable gate time. Gate time adjustable in seconds, minute or hours. Additional optional acoustic count indication.
- Count rate measurement. The pulses registered are measured successively and converted into a count rate (number of pulses per second).
- Integrated display of date and time for correct recording of measured radiation.
- The number of pulses registered is stored in the internal memory. This facilitates recording e.g. of weekly values for up to 10 years.
- Computer docking station. The software enables the measured data to be evaluated and processed on an MS-Windows PC.

Radiation types:	α from 4 MeV, β from 0.2 MeV, γ from 0.02 MeV
Measured variables:	equivalent dose in Sv/h, mSv/h, µSv/h pulses/s, pulses/variable time interval
Display:	LCD, 4 digit, numerical with display of measured variable, quasi analogue bar chart, operating mode indicators
Radiation detector:	End window Geiger-Müller counter tube, stainless steel housing with neon-halogen filling
Measuring length:	38.1 mm
Measuring diameter:	9.1 mm
Mica window:	1.5 – 2 mg/cm ²
Gamma sensitivity:	114 pulses/min for ⁶⁰ Co radiation = 1 µSv/h in background radiation energy band
Background rate:	10 pulses per minute approx.
Internal memory:	2 kilobytes
Battery life:	3 years approx.
Dimensions:	163x72x30 mm ³ approx.
Weight:	155 g approx.

U111511



U111511

Important Note:

In accordance with radiation protection regulations, anyone who works with radioactive materials or ionising radiation or plans to do so has the following obligations:

- Avoid unnecessary exposure to radiation or contamination of persons or of the environment.
- Ensure that any unavoidable exposure to radiation or contamination of persons or of the environment is below the limits specified by the regulations and is reduced to the minimum that is possible with present science and technology, taking into account all the circumstances of the case.

NEW

1012894



Dosimeter Radex RD 1706

Used for determining dose rates in $\mu\text{Sv/h}$ for β -, γ - and X-rays, this radiation meter can be operated by non-professionals while nonetheless offering the features of a professional dosimeter. Including two built-in Geiger-Müller counter tubes and a large, illuminated LCD display. The device measures the activity of β - and γ -particles and uses the results to calculate the dose rate. Depending on dose rate, the measurement and calculation times vary from 26 s to 1 s at high dose rates. Detection of each particle is indicated by an audio signal to facilitate searching for radioactive sources. The difference between the mean dose rate and background radiation level, as well as the background radiation level itself are displayed in the "background" mode. This facilitates, for example, inspections of enclosed spaces and building materials. Overshoot of an adjustable alarm threshold can be indicated either by an audio signal or a vibration signal. Measured values remain saved after the device has been turned off.

Counters:	Two GM counter tubes SBM20-1
Measurement variable:	Ambient equivalent dose rate $H^*(10)$
Measuring range:	0.05...999.0 $\mu\text{Sv/h}$
Alarm threshold:	Adjustable from 0.10 to 99.0 $\mu\text{Sv/h}$
Alarm:	Audio or vibration signal
Measurement and calculation times:	26 s 1 s (at $H^*(10) > 3.5 \mu\text{Sv/h}$)
Value display duration:	Continuous
Energy detection range	
X-radiation and γ -radiation:	0.03 to 3.0 MeV
β -radiation:	0.25 to 3.5 MeV
Batteries:	1.5 V, AAA (1 x or 2 x)
Operating time:	500 h, with 2 batteries (1350 mAh) under normal conditions
Dimensions:	105x60x26 mm ³
Weight (without batteries):	90 g

1012894



U8482490

Spintharoscope

Detection instrument for observing scintillations produced by radioactive decay. When a radiation cartridge (^{226}Ra , 4 kBq, 1006797) is screwed into the instrument so that its radiation outlet is directed downwards onto the exposed zinc sulphide screen, it is possible to look through the eyepiece of the instrument in total darkness and observe the random light flashes that are caused by radioactive decay.

U8482490

Additionally required:

1006797 Radiation Cartridge, ^{226}Ra , 4 kBq



U8483220

Cloud Chamber

Expansion cloud chamber for observing the paths of α -rays. Cover and side-wall are of plexiglas. With threaded hole for inserting the ^{226}Ra , 4 kBq radiation cartridge (1006797), hinged absorption foil for opening and closing the beam outlet and carrying handle at the side. By compressing the attached rubber ball and then allowing it to expand, a supersaturated methanol-water mixture is produced in the cloud chamber. Following that, the paths of the α -rays revealed by droplet formation are visible for 1 – 2 seconds in the light of an optical lamp.

U8483220

Additionally required:

1006797 Radiation Cartridge, ^{226}Ra , 4 kBq



1006797

Radiation Cartridge, ^{226}Ra , 4 kBq

Regulation-exempt radiation source with brass container for shielding. Radium sulphate rolled in gold foil and sealed at one end of a stainless steel cartridge.

Activity:	4 kBq
Weight:	400 g approx.

1006797

Nal(Tl) Scintillation Detector

An energy-sensitive detector for identifying γ -ray and X-ray fluorescent radiation with high probability. It can record energy spectra, which can be calibrated, and measure the relative intensity of the radiation. Incoming radiation causes a thallium-doped sodium iodide crystal to emit brief pulses of light, which are then converted into electrical pulses in proportion to the energy of the radiation by means of a photomultiplier affixed to the apparatus. The crystal is protected against light penetrating from outside by a thin aluminium cover. The photomultiplier is protected from interference by external magnetic fields by means of mu-metal shielding.

Relative energy resolution: 8% approx. at 662 keV
 Connector socket: 14-pin, with centring aid
 Dimensions of crystal : 51 mm x 51 mm diam. approx.
 Aluminium cover: 0.5 mm approx.
 Overall dimensions 185 mm x 58 mm diam. approx.

U46000

Additionally required:

U46010 Nal Operating and Evaluation Unit

Additionally recommended:

1006797 Radiation Cartridge, ^{226}Ra , 4 kBq

Warning Notice: "Radioactive"

Warning notice on white plastic. On stem.
 Dimensions: 210x300 mm² approx.
 Weight: 80 g approx.

U8483218

Steel Safe for Radioactive Materials

Steel safe for theft proof storage of radioactive materials in accordance with radiation protection requirements.

Dimensions: 140x300x360 mm³ approx.
 Weight: 3 kg approx.

U8483219

Nal Operating and Evaluation Unit

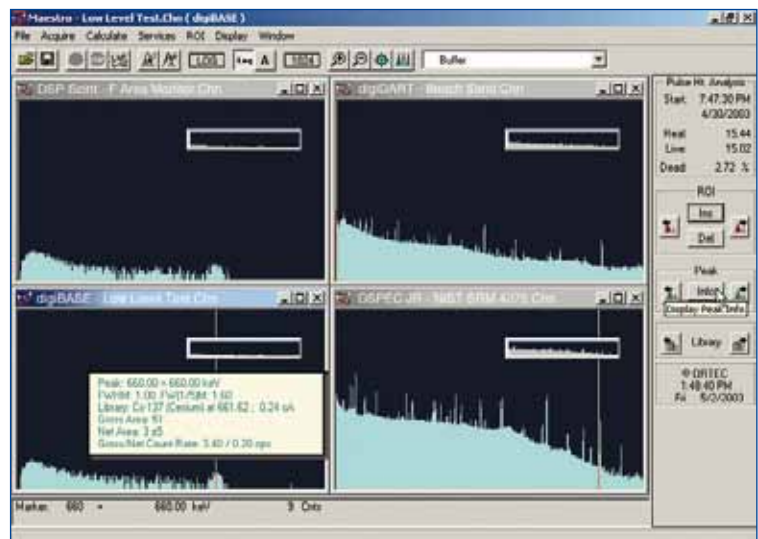
Complete apparatus for operation and evaluation, designed for measurement and comprehensive evaluation of energy spectra. Consists of a 14-pin connector stage with a high-voltage power supply for the photomultiplier of an Nal(Tl) scintillation detector. Possesses an integrated amplifier with pulse-shaping capability and digital signal processing for four-channel analysis. The power supply for the complete unit is provided via the USB port of a PC. Includes MAESTRO 32 measurement and evaluation software for a PC. The measurement and evaluation software has a versatile graphic user interface, supports identification of the measured radiation energies with the aid of integrated libraries and allows for the setting of all measurement parameters, including the high-voltage supply, from the PC.

Resolution: 1024 channels
 Amplification: 1, 3 or 9 (coarse) 0.4 – 1.2 (fine)
 Integral non-linearity: <0.05% over 99% of the range
 Differential non-linearity: <1% over 99% of the range
 Effect of lag: <5% for less than 50000 events per second
 High-voltage supply: 0 to 1200 V DC
 Amplifier drift: <0.15x10⁻³ per °C
 Offset drift: <0.05x10⁻³ per °C
 Pulse shaping: 0.75 – 2 μs

U46010



Screenshot of the measurement and evaluation software MAESTRO 32





Power Supply for Optical Lamps

Powerful electronic power supply, e.g. for the operation of lamps as used in optics. Short circuit proof, with connection leads and two cascadable 4 mm safety plugs.

Output: 12 V, max. 5 A

Transformer 12 V, 60 VA (230 V, 50/60 Hz)

Dimensions: approx. 100x45x70 mm³

U13900-230

Transformer 12 V, 60 VA (115 V, 50/60 Hz)

Dimensions: approx. 75x45x45 mm³

U13900-115

Transformer 12 V, 25 VA

Simple transformer for student exercises. Short circuit proof, with connection leads and two cascadable 4 mm safety plugs.

Output: 12 V AC, max. 2 A

Dimensions: approx. 110x95x65 mm³

Weight: approx. 0.64 kg

Transformer 12 V, 25 VA (230 V, 50/60 Hz)

U8475470-230

Transformer 12 V, 25 VA (115 V, 50/60 Hz)

U8475470-115



Plug In Power Supply 24 V, 700 mA

Plug in 24 V power supply for the operation of a Pohl torsion pendulum (U15040). With 2 m lead and two stackable 4 mm safety plugs.

Output: 24 V AC, max. 700 mA

Plug In Power Supply 24 V, 700 mA (230 V, 50/60 Hz)

U33200-230

Plug In Power Supply 24 V, 700 mA (115 V, 50/60 Hz)

U33200-115



NEW

Plug-In Power Supply, 12 V AC

Plug-in power supply with 5.5x2.5-mm co-axial power connector.

Art. No.	Voltage	Max. current	Mains voltage
1012900	12 V AC	2000 mA	230 V, 50/60 Hz
1012899	12 V AC	2000 mA	115 V, 50/60 Hz
1001014	12 V AC	750 mA	230 V, 50/60 Hz
1009545	12 V AC	500 mA	115 V, 50/60 Hz


 U8521112-230
 U8521112-115

Transformer with Rectifier 2/ 4/ 6/ 8/ 10/ 12/ 14 V, 5 A

Safety isolating transformer with safety cut out contained in metal housing. Output voltage switchable in 7 steps

AC output: 2/ 4/ 6/ 8/ 10/ 12/ 14 V, max. 5 A
 DC output: 2/ 4/ 6/ 8/ 10/ 12/ 14 V, max. 5 A
 Terminals: 4 mm safety sockets
 Dimensions: approx. 260x140x130 mm³
 Weight: approx. 3.1 kg

Transformer with Rectifier 2/ 4/ 6/ 8/ 10/ 12/ 14 V, 5 A (230 V, 50/60 Hz)

U8521112-230

Transformer with Rectifier 2/ 4/ 6/ 8/ 10/ 12/ 14 V, 5 A (115 V, 50/60 Hz)

U8521112-115


Voltage Regulating Transformer (230 V, 50/60 Hz)

High performance voltage regulating transformer with high load capacity and continuously adjustable AC output voltage. Two digital rms displays for current strength and output voltage. Thermally protected against overload with an overcurrent circuit breaker. Output electrically isolated from mains input.

Output: 0–260 V AC, max. 3 A
 Overload protection: Thermal
 Display: 3 digit LCD
 Connection: earthed socket outlet
 Power: 780 VA
 Voltage supply: 230 V ±10% 50/60 Hz
 Dimensions: approx. 250x235x178 mm³
 Weight: approx. 20 kg

U117401-230


 U8521114-230
 U8521114-115

Transformer with Rectifier 1/ 2/ 3/...12 V, 6 A

Low-voltage power supply with excess voltage circuit breaker in plastic case. Output voltage can be switched between 12 levels.

AC output: 1/ 2/ 3/ 4/ 5/ 6/ 7/ 8/ 9/ 10/ 11/ 12 V, max. 6 A
 DC output: 1/ 2/ 3/ 4/ 5/ 6/ 7/ 8/ 9/ 10/ 11/ 12 V, max. 6 A
 Terminals: 4 mm safety sockets
 Dimensions: approx. 190x210x160 mm³
 Weight: approx. 3 kg

Transformer with Rectifier 1/ 2/ 3/...12 V, 6 A (230 V, 50/60 Hz)
 U8521114-230

Transformer with Rectifier 1/ 2/ 3/...12 V, 6 A (115 V, 50/60 Hz)
 U8521114-115

 U33300-230
 U33300-115

Transformer with Rectifier 3/ 6/ 9/ 12 V, 3 A

Extra low voltage power supply with overload protection contained in plastic housing. Output voltage switchable in four stages.

AC output: 3/ 6/ 9/ 12 V, max. 3 A
 DC output: 3/ 6/ 9/ 12 V, max. 3 A
 Terminals: 4 mm safety sockets
 Dimensions: approx. 210x170x90 mm³
 Weight: approx. 2.6 kg

Transformer with Rectifier 3/ 6/ 9/ 12 V, 3 A (230 V, 50/60 Hz)
 U33300-230

Transformer with Rectifier 3/ 6/ 9/ 12 V, 3 A (115 V, 50/60 Hz)
 U33300-115



U117601-230
U117601-115

AC/DC Power Supply 0–12 V, 3 A

Extra low voltage power supply for training and demonstration experiments with continuously adjustable, stabilised and regulated DC output voltage and illuminated, analogue display panel. DC voltage output is short circuit proof and noise voltage proof. Four AC outputs galvanically isolated from the DC voltage outputs are overload protected via semiconductor fuses (multifuses).

- DC output: 0–12 V, max. 3 A
- Stability under full load: ≤ 20 mV
- Residual ripple under full load: ≤ 2 mV
- Analogue display: class 2.5
- AC outputs: 3, 6, 9, 12 V, max. 3 A
- Terminals: 4 mm safety sockets
- Dimensions: approx. 230x115x190 mm³
- Weight: approx. 3.5 kg

AC/DC Power Supply 0–12 V, 3 A (230 V, 50/60 Hz)

U117601-230

AC/DC Power Supply 0–12 V, 3 A (115 V, 50/60 Hz)

U117601-115



U8521105-230
U8521105-115

AC/DC Power Supply 0–12 V, 3 A, stab.

Extra low voltage power supply for student exercises with continuously adjustable, stabilised DC voltage or stabilised AC voltage. Selection between DC and AC output voltage is performed using a toggle switch.

- DC output: 0–12 V, max. 3 A, stabilised
- AC output: 0–12 V, max. 3 A, stabilised
- Dimensions: approx. 160x170x65 mm³
- Weight: approx. 2.9 kg

AC/DC Power Supply 0–12 V, 3 A, stab. (230 V, 50/60 Hz)

U8521105-230

AC/DC Power Supply 0–12 V, 3 A, stab. (115 V, 50/60 Hz)

U8521105-115



U117301-230

AC/DC Power Supply 0–30 V, 5 A (230 V, 50/60 Hz)

Continuously adjustable AC/DC power supply unit with digital displays for voltage and current readings, particularly suitable for experiments for students and trainees. The outputs are galvanically isolated. A pushbutton can be used to turn the capacitor filtration of the output direct voltage on and off (smoothing). In the event of an overload, the device is turned off by a thermal overload protection switch.

- DC output: 0–30 V, max. 5 A
- AC output: 0–30 V, max. 5 A
- Max. output power: 150 VA
- Display: 2x 3 digit LED
- Digit height: 15 mm
- Connections: 4 mm jacks
- Dimensions: approx. 280x205x140 mm³
- Weight: approx. 8.3 kg

U117301-230



U8521131-230
U8521131-115

AC/DC Power Supply 0–20 V, 0–5 A

Power supply with adjustable and stabilised DC voltage and analogue voltage and current display for DC voltage. The DC voltage component features an automatically alternating voltage and current control and is protected against continuous short circuits. The AC voltage can be selected in eight steps, the output is protected by an overcurrent circuit breaker. The AC and DC voltage outputs are DC isolated. A temperature regulated fan protects the unit from overheating.

- DC output: 0–20 V, 0–5 A
- AC output: 2, 4, 6, 8, 10, 12, 15, 20 V, max. 5 A
- Ripple U: <10 mV
- Dimensions: approx. 235x175x245 mm³
- Weight: approx. 8 kg

AC/DC Power Supply 0–20 V, 5 A (230 V, 50/60 Hz)

U8521131-230

AC/DC Power Supply 0–20 V, 5 A (115 V, 50/60 Hz)

U8521131-115



U33030-230
U33030-115

AC/DC Power Supply 1/ 2/ 3/...15 V, 10 A

AC and DC power supply adjustable to various levels and housed in metal case. Particularly suitable for experiments by pupils and for lab practicals. Features stabilised DC voltages. Outputs are galvanically isolated and short-circuit-proof.

- DC output: 1/ 2/ 3/ 4/ 5/ 6/ 7/ 8/ 9/ 10/ 11/ 12/ 13/ 14/ 15 V, max. 10 A
- AC output: 1/ 2/ 3/ 4/ 5/ 6/ 7/ 8/ 9/ 10/ 11/ 12/ 13/ 14/ 15 V, max. 10 A
- Max. output power: 150 VA
- Connections: 4 mm jacks
- Dimensions: approx. 170x160x250 mm³
- Weight: approx. 6.3 kg

AC/DC Power Supply 1/ 2/ 3/...15 V, 10 A (230 V, 50/60 Hz)

U33030-230

AC/DC Power Supply 1/ 2/ 3/...15 V, 10 A (115 V, 50/60 Hz)

U33030-115



U8521121-230
U8521121-115

DC Power Supply 1.5–15 V, 1.5 A

Handy DC power supply contained in a sturdy metal housing. The output voltage is continuously adjustable and is displayed via an analogue measuring instrument. The output is short circuit proof and floating.

- Output voltage: 1.5–15 V, max. 1.5 A
- Residual ripple: 10 mV
- Terminals: 4 mm safety sockets
- Dimensions: approx. 100x80x150 mm³
- Weight: approx. 2 kg

DC Power Supply 1.5–15 V, 1.5 A (230 V, 50/60 Hz)

U8521121-230

DC Power Supply 1.5–15 V, 1.5 A (115 V, 50/60 Hz)

U8521121-115



U8521400-230
U8521400-115

DC Power Supply 450 V

Power supply with three outputs for the electric supply in experiments with the Electrometer (U8531408-230 resp. U8531408-115).

- Output 1:
 - Voltage: 0–450 V DC
 - Max. current: 10 µA
- Output 2:
 - Voltage: 1.2–12 V DC
 - Max. current: 100 mA
- Output 3:
 - Voltage: 0–12 V AC
 - Max. current: 10 mA
- Dimensions: approx. 250x100x160 mm³
- Weight: approx. 0.8 kg

DC Power Supply 450 V (230 V, 50/60 Hz)

U8521400-230

DC Power Supply 450 V (115 V, 50/60 Hz)

U8521400-115



U33035-230
U33035-115

AC/DC Power Supply, 0–30 V, 0–6 A

Combined power supply with separate AC and DC outputs plus separate displays of output voltage and current. The DC output can be used as a voltage source or current source and can be set to any value within its range. The AC output features current limiting and is electronically protected against overload.

- DC voltage: 0...30 V
- DC current: 0...6 A
- AC voltage: 0...30 V
- AC current: max. 6 A
- Dimensions: 380x140x300 mm³ approx.
- Weight: 12 kg approx.

AC/DC Power Supply 0–30 V, 0–6 A (230 V, 50/60 Hz)

U33035-230

AC/DC Power Supply 0–30 V, 0–6 A (115 V, 50/60 Hz)

U33035-115



U11710-230
U11710-115

DC Power Supply

Universal power supply with a digital display for voltage and current. The output voltage and current are continuously adjustable. The device can be used as a constant voltage supply with current limiting or a constant current supply with voltage limiting. Two or more devices can be operated in parallel or series.

- Display: 2x 3 digit LED
- Accuracy: 1% + 2 digits for *U*, 1% + 4 digits for *I*
- Terminals: 4 mm safety sockets
- Dimensions: approx. 210x132x255 mm³

	U11705-230 U11705-115	U11710-230 U11710-115
Output voltage	0–16 V	0–32 V
Output current	0–10 A	0–2.5 A
Output power	160 W	80 W
Stability under full load	≤10 mV	≤10 mV
Residual ripple	≤4 mV	≤4 mV
Weight	ca. 5.9 kg	ca. 5.3 kg

**DC Power Supply 0–16 V,
0 – 10 A (230 V, 50/60 Hz)**

U11705-230

**DC Power Supply 0–32 V,
0 – 2.5 A (230 V, 50/60 Hz)**

U11710-230

**DC Power Supply 0–16 V,
0 – 10 A (115 V, 50/60 Hz)**

U11705-115

**DC Power Supply 0–32 V,
0 – 2.5 A (115 V, 50/60 Hz)**

U11710-115



U117361

DC Power Supply 0–16 V, 0–20 A

DC high current power supply with digital display of voltage and current. The voltage and current are continuously adjustable by means of coarse and fine controllers. The device can be used as a constant voltage source with current limiting, or a constant current source with voltage limiting. The selected operating mode is indicated by an LED on the front panel. High reliability even under extremely adverse conditions is ensured by automatic transformer switchover, MOSFET power amplifiers and temperature controlled fan speed with monitoring function. This equipment is also provided with a preset function for protecting against excess current and voltage. The design of the device omits any air vents at the top or bottom and does not require an external heat sink. The output is protected against sustained short circuits. Two or more such units can be operated in series or in parallel.

- DC output: 0–16 V, 0–20 A
- Fine adjustment range *U*: 800 mV
- Stability at 0–100% load: <12 mV
- Residual ripple: <1 mV
- Fine-adjustment range *I*: 2 A
- Connections: 4 mm jacks
- Mains connection: 115 V/230 V, 50/60 Hz
- Dimensions: approx. 240x120x300 mm³
- Weight: approx. 10 kg

U117361



U33020-230
U33020-115

DC Power Supply 0–20 V, 0–5 A

Universal power supply with digital current and voltage display. Output voltage and output current are continuously adjustable. The device can be used as a constant voltage source with current limiting or as a constant current source with voltage limiting.

- DC output: 0–20 V, 0–5 A
- Output power: 100 W
- Stability under full load: ≤0.01% + 5 mV, ≤0.2% + 5 mA
- Residual ripple: ≤1 mV, 3 mA
- Display: 2x 3 digit LED
- Terminals: 4 mm safety sockets
- Dimensions: approx. 130x150x300 mm³
- Weight: approx. 4.7 kg

DC Power Supply 0–20 V, 0–5 A (230 V, 50/60 Hz)

U33020-230

DC Power Supply 0–20 V, 0–5 A (115 V, 50/60 Hz)

U33020-115

NEW



1012857
1012858

DC Power Supply 1–32 V / 0–20 A

High-quality switched-mode power supply in space-saving housing with intelligent control of fan speed to ensure safe and quiet operation. Simple, precise and fast adjustment of voltage and current levels with dual-function rotary knobs for coarse and fine adjustment. Adjustable current limiting in open circuit. Three user-definable stored configurations for voltage and current limiting make it easy to recall frequently used settings. Full remote control of voltage and current plus output which can be turned on and off.

- Display: 3-digit, 15 mm, green LED
- Output voltage: 1–32 V DC
- Output current: 0–20 A (output with pole terminals on rear)
0–5 A (output with 4-mm safety sockets on front)
- Max. power output: 640 W
- Residual ripple: 5 mV rms
- Efficiency: > 87.0 %
- Dimensions: 200x90x255 mm
- Weight: 2.6 kg

DC Power Supply, 1–32 V / 0–20 A (230 V, 50/60 Hz)

1012857

DC Power Supply, 1–32 V / 0–20 A (115 V, 50/60 Hz)

1012858



U33000-230
U33000-115



U33010-230
U33010-115



U8521371-230
U8521371-115

DC Power Supply 0–500 V

Low voltage power supply with four outputs primarily intended to supply power for electron tubes and Helmholtz coils simultaneously, with four independently adjustable DC voltages and analogue dials for each of them. The DC voltages are stabilised and regulated, floating and galvanically isolated from one another, short circuit proof and secure from external voltages.

500 V output:	Voltage:	0–500 V DC, max. 50 mA
	Stability at full load:	≤ 0,01 % ±100 mV
	Residual ripple:	≤ 20 mV
50 V output:	Voltage:	0–50 V DC, max. 50 mA
	Stability at full load:	≤ 0.1 % ±30 mV
	Residual ripple:	≤ 5 mV
8 V output:	Voltage:	0–8 V DC, max. 3 A
	Residual ripple:	≤ 0.1 % ±30 mV
	Overload protection:	Thermal cut-out
12 V output:	Voltage:	0–12 V DC, max. 4 A
	Residual ripple:	≤ 0.1 % ±30 mV
	Overload protection:	Thermal cut-out
Displays:	Analogue, class 2	
Connections:	4 mm safety sockets	
Power consumption:	50 VA	
Dimensions:	85x325x190 mm ³ approx.	
Weight:	4 kg approx.	

DC Power Supply 0–500 V (230 V, 50/60 Hz)

U33000-230

DC Power Supply 0–500 V (115 V, 50/60 Hz)

U33000-115

High Voltage Power Supply 5 kV

Universally applicable, floating, high-voltage source for operation of electron tubes. With built in, high voltage resistant transformer to supply the heater voltage for electron tubes. Continuously adjustable high voltage, safe to touch, with passive current limitation and analogue voltage display.

High voltage output:	0–5000 V DC, max. 2 mA
Heater voltage output:	6.3 V AC, max. 3 A, high voltage resistant up to 6 kV
Overload protection:	Primary: fuse Secondary: current-limiting resistors
Connections:	4 mm safety sockets
High-voltage display:	Analogue
Dimensions:	235x130x155 mm ³ approx.
Weight:	3.5 kg approx.

High Voltage Power Supply 5 kV (230 V, 50/60 Hz)

U33010-230

High Voltage Power Supply 5 kV (115 V, 50/60 Hz)

U33010-115

DC Power Supply 0–300 V

Low voltage power supply to supply voltages for operating narrow electron beam tubes (U8481430) or training oscilloscope (U8481350). The DC voltages 0–50 V and 0–+300 V have a common zero volt ground so that DC voltages of up to 350 V can be supplied. In addition, a ramp generator is available for generating an adjustable, temporally linear rising or falling voltage. For this reason, experiments on the law of induction and the charging and discharging of capacitors can also be carried out.

Outputs:	0–300 V DC, max. 200 mA/ 0–50 V DC, max. 10 mA/ 4–12 V DC, max. 400 mA
Ramp generator:	2.5–50 V/s, linear rising or falling
Operating voltage:	230/115 V AC, 50 (60) Hz
Connections:	4 mm safety sockets
Dimensions:	240x230x170 mm ³ approx.
Weight:	3.7 kg approx.

DC Power Supply 0–300 V (230 V, 50/60 Hz)

U8521371-230

DC Power Supply 0–300 V (115 V, 50/60 Hz)

U8521371-115

High Voltage Power Supply 6 kV

Universally applicable, floating, high voltage source for electrostatic experiments or operation of spectrum tubes, gas discharge tubes and electron tubes. With built in, high voltage resistant transformer to supply the heater voltage for electron tubes. Continuously adjustable high voltage, safe to touch, with passive current limitation and digital voltage display.

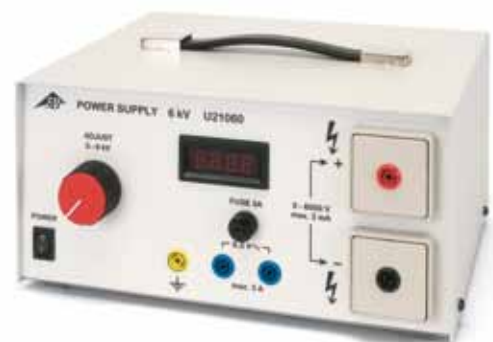
High voltage output:	0–6000 V DC, max. 2 mA
Heater voltage output:	6.3 V AC, max. 3 A, high-voltage resistant up to 6 kV
Overload protection:	Miniature fuse 3 A, slow-blow
Connections:	4 mm safety sockets
Power consumption:	50 VA
High-voltage display:	3 digit LED
Dimensions:	140x285x220 mm ³ approx.
Weight:	6 kg approx.

High Voltage Power Supply 6 kV (230 V, 50/60 Hz)

U210601-230

High Voltage Power Supply 6 kV (115 V, 50/60 Hz)

U210601-115



U210601-230
U210601-115

NEW



U8533600-230
1009956

Function Generators

FG 100 Function Generator

Externally controllable function generator with power amplifier for use in practical and school experiments studying simple harmonic oscillation, alternating current and induction. Featuring illuminated, digital display for frequency, signal form, offset and other parameters. The output is short-circuit protected as well as being protected against induced voltages and spark discharges, e.g. for when experiment leads are unintentionally pulled out while coils are connected. In internal sweep mode, one trigger pulse is output per cycle and the voltage output is proportional to the frequency. With retractable feet. Includes power supply.

Signals:

Frequency range: 0.001 Hz to 100 kHz
Signal forms: Sine, square, triangular
Offset: 0 to ± 5 V, adjustable in 0.1 V steps

Output:

Output amplitude: 0 to 10 V, continuously adjustable
Power output: 10 W, permanent
Output current: 1 A, permanent, 2 A max.

Sweep:

Sweep modes: External, continuous internal, individual internal
Frequency range: 1 Hz to 100 kHz
Stop/start frequency ratio: Max. 1000:1, e.g. 2 Hz to 2 kHz max.
Time range: 0.04 s to 200 s
External sweep: Start via trigger pulse or application of 0 to 5 V control voltage

Max. modulation frequency: 200 Hz

Internal sweep: Start and stop via Start/Stop button
One trigger output per cycle plus proportional voltage

General data:

Power supply: Plug-in power supply, 12 V AC, 2 A
Dimensions: 170x105x40 mm
Additional features: Fold-out feet

FG 100 Function Generator (230 V, 50/60 Hz)

U8533600-230

FG 100 Function Generator (115 V, 50/60 Hz)

1009956

Function Generator 0.02 Hz–2 MHz

Multifunctional function generator with four different functions in a single device: function generator, sweep generator, pulse generator and 50 MHz frequency meter.

Frequency range: 0.02 Hz–2 MHz in 7 ranges
Accuracy: $\pm 5\%$
Waveform: Sine, square, triangle, pulse, saw-tooth, ramp

Signal outputs:

Output voltage: 0– ± 5 V_{pp}
Output impedance: 50 Ω $\pm 5\%$
Attenuator: 0–20 dB continuously adjustable and 20 dB fixed

Sinusoidal: Ripple factor $< 1\%$ (0.2 Hz–100 kHz)
Square-wave: Rise time < 120 ns
Triangular: Linearity error $< 1\%$ (0.2 Hz–100 kHz)

Rise time TTL: < 25 ns
Rise time CMOS: < 140 ns (max.)
Pulse duty factor: 1:1–10:1

Sweep generator:

Sweep generator: internal or external, linear
Sweep frequencies: 0.02 Hz–2 MHz (7 ranges)
Sweep time: 20 ms–2 s

Frequency meter:

Frequency range: 200 mHz–50 MHz
Accuracy: 5% of reading ± 1 Digit
Max. input voltage: 250 V_{pp}

Input impedance: 890 Ω
Display: 6-digit LED
Dimensions: approx. 280x240x90 mm³
Weight: approx. 2 kg

Function Generator 0.02 Hz–2 MHz (230 V, 50/60 Hz)

U11230-230

Function Generator 0.02 Hz–2 MHz (115 V, 50/60 Hz)

U11230-115



U11230-230
U11230-115



Instrumentation



U22065



U8533550

Two-Channel Function Generator, 20 MHz

Incorporating DDS (Direct Digital Synthesis) technology, this real, two-channel function generator generates stable, highly precise signals with low distortion. Waveforms can be selected in standard form with variable parameters including frequency, amplitude, offset and phase, or edited freely. Numerous modulation types are implemented. A frequency meter is integrated.

- Channels: 2 independent channels with adjustable phase
- Frequency range: 1 μHz...20 MHz (sine)
- Standard signals: Constant, sine, rectangular, ramp, pulse, exponential rise / fall, sync, white noise
- Editable signals: 48 pre-configured forms (100 MSA/s, 14-bit vertical accuracy)
- Modulation: Amplitude (AM), frequency (FM), phase (PM), frequency shift keying (FSK), sweep, burst and alphanumeric
- Display: LCD, 256 pixels x 64 pixels, 4 grey stages, graphic and alphanumeric
- Frequency meter: 100 MHz to 200 MHz
- Outputs: Signals, synchronization signal, external modulation signal
- Inputs: External modulation signal, external 10-MHz signal, external trigger signal
- Interface configurations: USB device, USB host
- Supply voltage: 100–240 V, 50/60 Hz
- Dimensions: approx. 230x110x290 mm³
- Weight: approx. 2.7 kg

U22065

Power Function Generator

Function generator with external sweep capability including power amplifier designed to conduct experiments on simple harmonic oscillation, alternating current and induction. Can be used as a function generator, a stabilised current source or a power amplifier. Equipped with a digital frequency display showing value and unit and an electronic circuit to protect against capacitive and inductive overload.

- Frequency display: 3½ digit LED display with 13 mm digit height
- Unit display: mHz, Hz, kHz
- Function generator:
 - Waveform: Sinusoidal, triangular, square-wave
 - Frequency range: 10 mHz–100 kHz, 7 decades
 - Output voltage: 0–20 V, 10 mA, short-circuit proof
 - DC Offset: 0–±10 V
 - Internal resistance: 10 mΩ
 - Modulation: FM and AM via external generator
 - Sweep range: sweep through 7 decades
- Power unit:
 - Frequency range: 0–50 kHz
 - Input impedance: 1 MΩ || 60 pF
 - AF-gain: 10
 - Max. output power: 30 W
 - Dimensions: approx. 125x170x225 mm³
 - Weight: approx. 6.5 kg

Power Function Generator (230 V, 50/60 Hz)

U8533510-230

Power Function Generator (115 V, 50/60 Hz)

U8533510-115

Sine Wave Generator

Sine wave generator with power output up to 16 W in a frequency range from 1 Hz to 100 kHz. The apparatus contains a preamplifier, which can be used in isolation (e.g. as a microphone amplifier) or with a power output stage connected downstream as a broadband amplifier (0 up to 100 kHz).

- Sine wave generator with power output:
 - Frequency range: 1 Hz–100 kHz, in 5 decadic stages, scale with linear division
 - Frequency deviation: <5 %
 - Output voltage: 0–6 V, adjustable
 - Max. output current: 10 A, short circuit proof
 - Max. output power: 16 W constant, 30 W temporary
 - Input impedance: 100 kΩ
- Preamplifier:
 - Gain factor: 1–300, continuously adjustable
 - Input: AC coupled, with switchable microphone voltage
 - Max. output voltage: 10 V_{PP}
 - Max. output current: 15 mA, short circuit proof
 - Output impedance: 1 kΩ
- Power amplifier:
 - Voltage gain: 8.5
 - Operating voltage: 12 V AC
- Dimensions: approx. 160x160x50 mm³
- Weight: approx. 1.1 kg

U8533550

Additionally required:

U8475470-230 Transformer 12 V, 25 VA (230 V, 50/60 Hz)

or

U8475470-115 Transformer 12 V, 25 VA (115 V, 50/60 Hz)



U8533510-230
U8533510-115



U11234-230

Analogue Oscilloscope, 1x10 MHz (230 V, 50/60 Hz)

Analogue single channel oscilloscope with all the functions and possible display modes of conventional dual beam analogue oscilloscopes. With a bandwidth of 10 MHz, this is a high performance device which is easy to operate, even for inexperienced users.

U11234-230

Additionally recommended:

U11800 Oscilloscope Probe 100 MHz



U33070-230

Analogue Oscilloscope, 2x20 MHz (230 V, 50/60 Hz)

Robust, easy-to-operate dual channel oscilloscope with a bandwidth of 20 MHz. Includes 2 adapters and 2 BNC/4-mm safety plug connector cables.

U33070-230

Additionally recommended:

U11800 Oscilloscope Probe 100 MHz



U11175

Analogue Oscilloscope, 2x30 MHz

Microprocessor controlled analogue oscilloscope for the display of rapid periodic signals. With SMART AUTOSET for both channels, which reproduces the last configuration used when the device is switched back on.

U11175

Additionally recommended:

U11800 Oscilloscope Probe 100 MHz



U11177

Analogue Oscilloscope 2x150 MHz

Analogue dual channel oscilloscope with high bandwidth for accurate tracing of very fast periodic events. Including two scope probes.

U11177



U11176

Analogue/Digital Storage Oscilloscope 2x40 MHz

Analogue/digital storage oscilloscope for the display and storage of rapid periodic and aperiodic signals. With moveable cursors and 17 measurement functions. Fully equipped for direct PC and printer connection (RS232 interface).

- Cursor measurements: ΔV , Δt , $1/\Delta t$, phase
- Memory: 2048x8 Bit pro channel
- Scan rate: Single Shot: 50 MS/s
- Glitch capture: 20 ns
- Operating mode: Roll Refresh, Single, XY-mode, Envelope, Average, Dot Join

U11176

Additionally recommended:

U11800 Oscilloscope Probe 100 MHz

	U11234-230	U33070-230	U11175	U11177	U11176
Vertical deflection:					
Operation modes:	CH1, XY	CH1, CH2, -CH2, DUAL (ALT/CHOP) ADD, XY	CH1, CH2, -CH2, ALT, CHOP, ADD, XY	CH1, CH2, -CH2, ALT, CHOP, ADD, XY	CH1, CH2, -CH2, ALT, CHOP, ADD, XY
Bandwidth :	10 MHz	20 MHz	30 MHz	150 MHz	40 MHz
Rise time:	≤ 35 ns	≤ 17.5 ns	< 11.7 ns	≤ 2.3 ns	≤ 8.75 ns
Deflection coefficient:	5 mV/div.–5 V/div., 10 steps	5 mV/div.–20 V/div., 12 steps	5 mV/div.–20 V/div., 12 steps	2 mV/div.–5 V/div., 11 steps	5 mV/div.–20 V/div., 12 steps
Accuracy:	±3%	±3%	±3%	±3%	±3%
Input impedance:	1 MΩ ±3% // 25 pF ±5 pF	1 MΩ // 25 pF	1 MΩ // 25 pF	1 MΩ ±1% // 15 pF	1 MΩ // 25 pF
Horizontal deflection :					
Time coefficient :	100 ns/div.–100 ms/div., 19 steps	200 ns/div.–500 ms/div., 20 steps	50 ns/div.–200 ms/div., 21 steps	50 ns/div.–100 ms/div., 20 steps	10 ns/div.–200 s/div. (digital), 50 ns/div.–200 ms/div. (analogue)
Accuracy :	±3%	±5%	±3%	±3%	±2% (digital), ±3% (analogue)
Enhancement:	---	up to 10 ns/div.	up to 10 ns/div.	up to 5 ns/div.	up to 5 ns/div. (analogue)
Accuracy :	---	±10%	±5%	±5%	±5%
Triggering:					
Operation mode:	Auto, Normal, TV	Auto, Normal, TV-V, TV-H	Auto, Normal, TV	Auto, Normal, TV	Flanke +/-, TV
Trigger source :	Y INPUT, LINE, EXT	CH1, CH2, ALT, LINE, EXT	CH1, CH2, ALT, LINE, EXT	CH1, CH2, ALT, LINE, EXT	CH1, CH2, ALT, LINE, EXT
Trigger coupling :	DC	AC	DC, AC, LFR, HFR, TVV, TVH	DC, AC, LFR, HFR, TV ALL, TV CPT	DC, AC, LFR, HFR, TV
Data:					
Screen size:	48x60 mm ²	80x100 mm ²	80x100 mm ²	80x100 mm ²	80x100 mm ²
Supply voltage :	230 V, 50/60 Hz	230 V, 50/60 Hz	94–264 V, 48–440 Hz	94–264 V, 48–440 Hz	94–264 V, 48–440 Hz
Dimensions:	approx. 278x215x85 mm ³	approx. 435x330x160 mm ³	approx. 435x330x163 mm ³	approx. 435x330x163 mm ³	approx. 435x330x163 mm ³
Weight:	approx. 3 kg	approx. 5.5 kg	approx. 5.5 kg	approx. 5.5 kg	approx. 5.5 kg

Oscilloscope Probe, 100 MHz

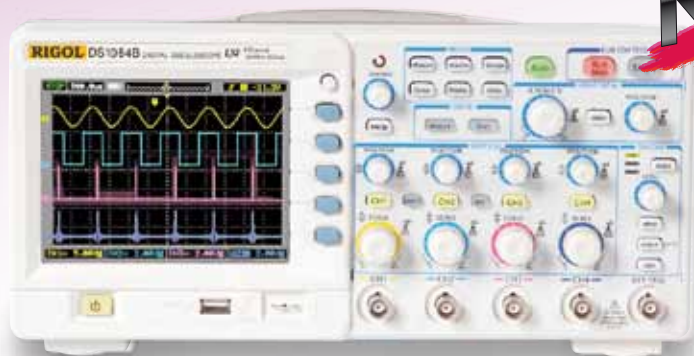
Probe to extend the voltage measurement range of any standard commercial oscilloscope. A changeover switch allows selection of bandwidth. The device includes a channel identification terminal, spring-loaded terminal connection, ground lead, insulating cover tip, measuring tip, special tip for IC measurements, trimmer key and BNC adapter.

Bandwidth: DC to 100 MHz (1:10), DC to 6 MHz (1:1)
 Input resistance: 10 MΩ (1:10), 1MΩ (1:1)
 Input capacitance: 16 pF (1:10), 90 pF (1:1)
 Max. measuring voltage: 600 VDC, 600 VAC
 Connection: BNC plug
 Cable length: approx. 1.20 m

U11800



U22060



Digital Oscilloscope 4x60 MHz

Capable of simultaneously displaying four independent channels in colour, this digital oscilloscope offers the following functions: Storage and recall of measured signals, automatic measurement of up to 22 parameters, mathematical operations including fast Fourier transformation, delayed sampling, digital filtering. Including four probes, software and USB cable.

Inputs:

Coupling: DC, AC, GND
Impedance: 1 M Ω
1.2 M Ω (<254 mV AC)

Capacitance: 18 pF \pm 3 pF
Probe attenuation factors: 0.001x–1000x
Maximum input voltage: 100 V_{rms}, 1000 V_{pp} (in CAT II)
Mathematical operations: FFT, +, -, *

Vertical deflection:

Deflection coefficient: 2 mV/div.–10 V/div., 12 stages
Offset range: 2 mV/div.–10 V/div.
Accuracy: \pm 4% (2 mV/div.–5 mV/div.)
 \pm 3% (10 mV/div.–10 V/div.)

A/D converter:

Bandwidth 60 MHz
Rise time: <5.8 ns

Horizontal deflection:

Time coefficient: 5 ns/div.–50 s/div., 31 stages

Trigger:

Trigger sensitivity: 0.1 div.–1.0 div., adjustable
Trigger threshold: \pm 6 div. (internal),
 \pm 1.2 V (EXT),
 \pm 6 V (EXT/5)
Trigger hold-off: 100 ns–1.5 s
Operating mode: Edge, pulse width, video, pattern and alternate trigger

Cursor measurements:

Manual: Voltage difference, time difference, reciprocal time difference

Track: Voltage values for Y-axis
Time values for X-axis

Automatic:

Automatic measurement:

Measurement variables: V_{pp}, V_{amp}, V_{max}, V_{min}, V_{top}, V_{base}, V_{avg}, V_{rms}, Overshoot, Preshoot, Freq, Period, Rise Time, Fall Time, +Width, -Width, +Duty, -Duty, Delay A→B+, Delay A→B+, Phase A→B+, Phase A→B+

General data:

Display: TFT-LCD, 5.7 inches, 320 pixels x 240 pixels, 64 k colours

Memory:

Interface configurations: USB device, dual USB host

Supply voltage:

Dimensions: approx. 325x160x135 mm³

Weight:

approx. 3 kg

U22060

NEW

1012879



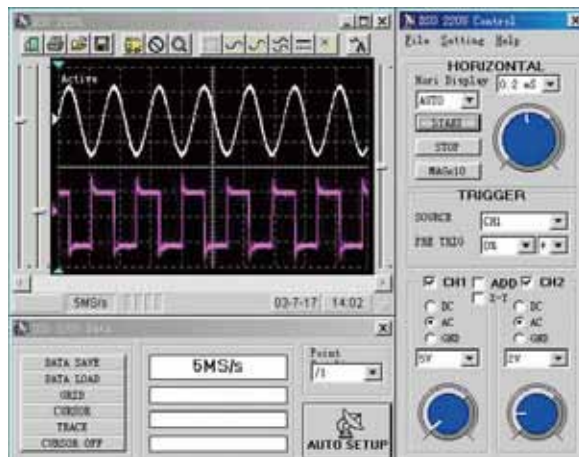
USB Oscilloscope 2x40 MHz

Meant for connection to a PC with USB ports, this two-channel USB oscilloscope comes with a USB cable as well as Windows software. On being connected to a PC, the digital storage oscilloscope not only offers a wide spectrum of features but also the added advantage of being able to save measured data and process them further, for example, for purposes ranging as far as FFT analysis. The monitor's surface is modelled after that of a conventional oscilloscope. Operation is facilitated by an auto-set function for automatic adaptation to measuring signals and numerous trigger functions.

Technical data:

Channels: Two
Operating modes: CH1, CH2, X/Y
Sampling rate: 100 MSa/s (real time)
Input coupling: DC, AC, GND
Input impedance: 1 M Ω || 50 pF
Input voltage: 0–35 V
Deflection coefficient: 10 mV/div.–5 V/div.
Accuracy: \pm 3%
A/D converter: 8-bit resolution
Bandwidth: 40 MHz
Time coefficient: 4 ns/div.–1 h/div.
Roll mode: 1 s/div.–1 h/div.
Trigger: Auto/Normal/Single/Ext.
Calibrator: 1 kHz/ 2 Vpp
Memory depth: 32 kpts/channel (64 kpts with 1 channel)
Interface: USB 2.0
Voltage supply: Via two USB ports
Dimensions: 190x40x100 mm³
Weight: 340 g
Windows: 98SE/ ME/ 2000/ XP/ Vista™
Analysis options: LabVIEW® compatible, data transfer to spreadsheet programs

1012879





Rear of instrument

U21020-230
U21020-115

Power and Energy Meter with PC Interface

Power and Energy Meter for measuring electrical active, apparent and reactive power as well as electrical work in the case of voltages and currents with any continuous curve shape. The voltage, current, frequency, phase angle, power factor and time are measured simultaneously and can be displayed digitally via a pushbutton. It is also possible to simultaneously measure and display two temperatures as well as the difference between them. This device is particularly suitable for experiments involving heat pumps and Stirling engines. The power and energy meter can be used alone or together with a PC. It has an internal data logger with a real-time clock. All 13 parameters and the time—a total of 3100 measured values—can be stored. The storage of measured values can be commenced manually, or at a specified point in time, or if a power or temperature limit is exceeded or fallen short of. The stored data can be transferred subsequently to a PC via a RS232 interface. Includes Windows Software and interface cable. The software permits programming of the data logger, graphic displays of measured values and export of all measured data to a spreadsheet program.

Terminals: 4 mm safety sockets (front panel),
Euro socket (rear panel)

Voltage (front panel):

Measuring ranges: 0–30 V_{RMS}, 0–42 V DC
Resolution: 0.01 / 0.1 V_{RMS}, 0.01 / 0.1 V DC
Accuracy: ±1% of measured value / ±1 digit
Input impedance: 75 kΩ
Frequency range: 0–1000 Hz

Current (front panel):

Measuring range: 0–10 A
Resolution: 0.01 A
Accuracy: ±1% of measured value / ±1 digit
Frequency range: 0–1000 Hz
Input impedance: 50 mΩ
Frequency range: 0–1000 Hz

Voltage (rear panel):

Measuring range: 10–240 V_{RMS}
Resolution: 0.01 / 0.1 V_{RMS}
Accuracy: ±1% of measured value / ±1 digit
Input impedance: 950 kΩ

Current (rear panel):

Measuring range: 0–10 A_{RMS}
Resolution: 0.01 A_{RMS}
Accuracy: ±1% of measured value / ±1 digit
Frequency range: 45 Hz–65 Hz
Input impedance: 50 mΩ

Power:

Active power: 0–2400 W
Reactive power: 0–2400 VA (only sinusoidal)
Apparent power: 0–2400 VA (only sinusoidal)
Resolution: 0.01 / 0.1 / 1 W
Accuracy: ±2% of measured value / ±1 digit
Frequency: DC / 16–999 Hz
Measuring range: DC / 16–999 Hz
Resolution: 0.1 Hz
Accuracy: ±1% of measured value / ±1 digit

Phase angle:

φ: 0°–±90°
Resolution: 0.1°
cos φ: 0,999–0,000
Resolution: 0,001
Accuracy: ±1% of measured value / ±1 digit

Power factor (ratio of active power to apparent power):

cos φ: 0,999–0,000
Resolution: 0,001
Accuracy: ±1% of measured value / ±1 digit

Work:

Measuring ranges: 0.0–9999x1000 Ws / 0.0–9999 Wh
Resolution: 0.1 Ws / 0.0001 Wh
Accuracy: ±2% of measured value / ±1 digit

Time:

Measuring range: 0–9999x1000 s
Resolution: 1 s
Accuracy: ±0.1%

Temperature 1 and 2

Measuring range: -100°C–450°C
Resolution: 0.1°C
Accuracy: ±1% of measured value / ±1 digit

Connections: Thermocouple jack Type K

Display:

4 digit LED, 7 segments

Digit height:

20 mm

Computer connection:

Serial interface (RS232) for PC (DB9)

Power consumption:

50 VA

Dimensions:

approx. 215x310x210 mm³

Weight:

approx. 5.7 kg

Power and Energy Meter with PC Interface (230 V, 50/60 Hz)

U21020-230

Power and Energy Meter with PC Interface (115 V, 50/60 Hz)

U21020-115

Additionally recommended:

U21036 NiCr-Ni Temperature Sensor

NiCr-Ni Temperature Sensor

Clad thermocouple for temperature measurement in conjunction with the energy meter (U21020-230 resp. U21020-115); equipped with a 2-pole, standard flat connector.

Measurement range: -40°C–500°C

U21036



Measuring Instruments for Student Use

Sturdy pointer instruments for measuring current or voltage. In shock proof desktop housings. Built especially for student and practical lab experiments. With moving coil instruments, mirror scale and 4 mm safety sockets.

Accuracy: class 2.0
 Dimensions: approx. 90x106x103 mm³



Art. No.	Designation	Meas. ranges	Scale division	Internal resistance
U11810	Ammeter, DC	50 mA, 500 mA, 5.0 A	1 mA, 10 mA, 0.1 A	10 Ω
U11811	Voltmeter, DC	3.0 V, 15 V, 300 V	0.1 V, 1 V, 10 V	1 kΩ/V
U11812	Ammeter, AC	1.00 A, 5.0 A	0.02 A, 0.1 A	Rectifier
U11813	Voltmeter, AC	15.0 V, 150 V	0.5 V, 5 V	Rectifier
U11814	Galvanometer, DC	± 35 μA	1 μA	1000 Ω

Analogue Multimeter AM50

Hand held multimeter for measuring voltage and current for a wide range of applications in student and practical experiments. A heavy duty device with excellent overload protection, zero point of scale centre or left and automatic battery cut off after approx. 45 minutes.

Measuring ranges:

- Direct voltage: 100 mV–300 V, 8 levels
- Alternating voltage: 3 V–300 V, 5 levels
- Direct current: 0.1 mA–3 A, 6 levels
- Alternating current: 0.1 mA–3 A, 6 levels
- Internal resistance: 10 MΩ
- Scale zero-point: Centre/left
- Accuracy: class 2 (DC) / class 3 (AC)
- Supply voltage: 1x 9 V battery
- Dimensions: approx. 98x138x35 mm³
- Weight: approx. 0.3 kg

U17450.....

Analogue Multimeter AM51

Low price hand held multimeter for measuring current, voltage and resistance. For universal use in student experiments and practicals.

Measuring ranges:

- Direct voltage: 100 mV–600 V, 7 steps
- Alternating voltage: 10 V–600 V, 5 steps
- Direct current: 50 μA–1 A, 5 steps
- Alternating current: 3 mA–3 A, 4 steps
- Resistance: Ωx1/ 10/ 100
- Internal resistance: 20 kΩ/V (DC) / 6.67 kΩ/V (AC)
- Scale zero-point: left
- Accuracy: class 2.5
- Supply voltage: 1x 1.5 V battery
- Dimensions: approx. 98x138x35 mm³
- Weight: approx. 0.25 kg

U17451.....



U17450



U17451

BEST SELLER

No replacement of fuses required.
Operable with an inexpensive
1.5-V battery



1006811



1006810

Multimeter ESCOLA

Moving coil multimeter contained in shockproof plastic housing for any requirements in student experiments. Two easy-to-read, linear mirror scales and clearly identifiable measurement ranges guarantee error-free readings of the measurement values. Electronic overload protection is achieved without equipment safety fuses, thus eliminating the tedious task of changing of fuses and ordering replacement parts. The protective circuitry operates without auxiliary power and is also guaranteed to function with a flat or missing battery. Alternating quantities are linearised by the use of a measurement amplifier with a cut-off frequency of 20 kHz. The amplifier operates with a single, low cost 1.5 V battery cell (R6; Mignon cell). Nevertheless, under normal use the measuring instrument should remain operational for years between battery replacements since the maximum discharge current during operation is 1.5 mA. The status of the equipment is indicated by a red bar.

Scale length: 80 mm
Supply voltage: 1x 1.5 V Mignon cell/IEC R6
Dimensions: approx. 100x150x50 mm³
Weight: approx. 300 g

Multimeter ESCOLA10

Student measuring instrument for the measurement of voltage, current, resistance, impedance, conductance and admittance. Equipped with electronic protection against overload and a potentiometer to electronically calibrate the zero point as well as the end value setting for measuring resistance and conductance. Includes battery test function. The separate terminal sockets for current and voltage permit connection of the instrument that allows for current as well as voltage to be measured without having to reconnect the measuring leads, so that resistance and conductance, capacitance and admittance can all be measured very simply.

Measurement ranges:
Direct and alternating voltage: 0.1–600 V, 9 ranges each
Direct and alternating current: 0.1 mA–10 A, 11 ranges each
Frequency range: 20 Hz–20 kHz
Internal resistance: 1 MΩ
Accuracy: class 2 (DC), class 3 (AC)
Scale zero point: Centre/left
Long term maximum voltage: 600 V
Long term maximum current: 35 A
Safety classification: CAT II 600 V (IEC-1010-1)

1006810

Multimeter ESCOLA2

Student measuring instrument for the measurement of voltages and currents. Equipped with electronic protection against overloading and electronic zero calibration for all DC current and voltage ranges.

Measurement ranges:
Direct and alternating voltage: 0.3–30 V, 5 ranges each
Direct and alternating current: 1–3000 mA, 5 ranges each
Accuracy: Class 2 (DC), class 3 (AC)
Scale length: 80 mm
Scale zero point: Centre/left

1006811

Zero Point Galvanometer CA 403

Reasonably priced, sturdy and easy to use analogue measuring instrument with moving coil instrument and rectifier, particularly well suited for student and practical experiments, may be used as a DC microammeter and DC millivoltmeter. This device has only one control knob, includes safety sockets and quick break fuses, is electrically protected and double insulated.

Measurement ranges: 100 mV DC, 30 μA DC, 3 mA DC
Internal resistance: 3333 Ω, 460 Ω, 500 Ω
Accuracy: ±1.5%
Zero point: centre
Mirrored scale: yes
Connection: 4 mm security sockets
Fuse: 0.315 A HBC 380 V 50 kA
Dimensions: approx. 165x105x50 mm³
Weight: approx. 450 g

U11170



U11170

Digital Mini Multimeter

Very reasonably priced mini multimeter in pocket format for measuring voltage, DC current, resistance and temperature and also including diode and continuity tests. Overload protection for mA ranges, 10 amp range is unprotected. Includes measuring leads, type K thermocouple and battery.

DC voltage:	200 mV–250 V, 5 ranges, $\pm 0.8\% \pm 2$ digits
AC voltage:	200/ 250 V, 2 ranges, $\pm 1.2\% \pm 10$ digits
DC current:	200 μ A–10 A, 5 ranges, $\pm 1.0\% \pm 2$ digits
Resistance:	200 Ω –2000 k Ω , 5 ranges, $\pm 0.8\% \pm 2$ digits
Temperature:	0–1000°C, $\pm 2.0\% \pm 3$ digits
Display:	3½ digit LCD, 12 mm, max: 1999
Operating voltage:	9 V battery
Safety classification:	CAT II 600 V (IEC-1010-1)
Dimensions:	approx. 70x140x30 mm ³
Weight:	approx. 210 g

U118071



U118071



U11806



U118091



U118082

Digital Multimeter P3340

Digital multimeter for universal use in measuring voltage, current, resistance, frequency, capacitance, temperature and also including diode and continuity tests. Includes a measurement value hold function, analogue bar graphs, automatic polarity reversing, overload and overvoltage protection as well as an acoustic overload indicator, automatic switch off. Device comes in a shock-proof holster with fold-out stand. Including testing leads, type K temperature sensor and batteries.

DC voltage:	400 mV–1000 V, 5 ranges, $\pm 0.5\% \pm 2$ digits
AC voltage:	4–700 V, 4 ranges, $\pm 1.2\% \pm 3$ digits
DC current:	400 μ A–10 A, 6 ranges, $\pm 1\% \pm 3$ digits
AC current:	400 μ A–10 A, 6 ranges, $\pm 1.5\% \pm 5$ digits
Resistance:	400 Ω –40 M Ω , 6 ranges, $\pm 1\% \pm 2$ digits
Capacity:	40 nF–100 μ F, 5 ranges, $\pm 3\% \pm 5$ digits
Temperature:	-20–760°C, $\pm 3\% \pm 3$ digits
Display:	3½ digit LCD, 39 mm, max: 3999
Operating voltage:	9 V battery
Safety classification:	CAT II 1000 V (IEC-1010-1)
Dimensions:	approx. 92x195x38 mm ³
Weight:	approx. 200 g

U118091

Digital Multimeter P1035

Compact 3½ digit multimeter for measuring voltage, current, resistance and temperature and also including diode and continuity tests. Complete with pouch, leads and battery.

DC voltage:	200 mV–600 V, 5 ranges, $\pm 0.5\% \pm 2$ digits
AC voltage:	200/ 600 V, 2 ranges, $\pm 1.2\% \pm 10$ digits
DC current:	2000 μ A–10 A, 4 ranges, $\pm 1\% \pm 2$ digits
Resistance:	200 Ω –2000 k Ω , 5 ranges, $\pm 0.8\% \pm 2$ digits
Display:	3½ digit LCD, 27 mm, max: 1999
Operating voltage:	9 V battery
Safety classification:	CAT III 600 V (IEC-1010-1)
Dimensions:	approx. 70x150x48 mm ³
Weight:	approx. 260 g

U11806

Digital Multimeter P3320

Digital multimeter for universal use in measuring voltage, current, resistance, frequency, capacitance and temperature. With real time rms measurement feature and backlighting. 3½ digit LCD display with function symbols and analogue bar graphics. Automatic and manual range selection. With non-contact voltage detector. Includes measuring leads, type K thermocouple, shock resistant pouch and battery.

DC voltage:	600 mV–1000 V, 5 ranges, $\pm 1.2\% \pm 2$ digits
AC voltage:	6 V–1000 V, 4 ranges, $\pm 1.5\% \pm 10$ digits
DC current:	6 A–10 A, 2 ranges, $\pm 2.5\% \pm 5$ digits
AC current:	6 A–10 A, 2 ranges, $\pm 3\% \pm 5$ digits
Resistance:	600 Ω –60 M Ω , 6 ranges, $\pm 1\% \pm 2$ digits
Capacity:	40 nF–4000 μ F, 6 ranges, $\pm 5\% \pm 5$ digits
Frequency:	10 Hz–10 MHz, 7 ranges, $\pm 1.2\% \pm 3$ digits
Temperature:	-20–760°C, $\pm 3\%$
Display:	3½ digit LCD, 19 mm, max: 3999
Operating voltage:	9 V battery
Safety classification:	CAT III 600 V / CAT II 1000 V (IEC-1010-1)
Dimensions:	approx. 70x150x48 mm ³
Weight:	approx. 260 g

U118082



1012865



U8531050

DMM 1000 Iso-Multimeter

Digital multimeter with integrated insulation resistance measuring capability for voltages from 50 V to 1000 V and additional measuring functions for testing AC and DC voltage and current, resistance, capacitance, frequency and temperature plus diode testing. Automatic blocking of sockets (ABS), which are not used for specific functions. Automatic shut-off, excess voltage and overload warning, true RMS (TRMS) measurement capability for distorted input signals. Back-lit liquid crystal display with digital read-out and analogue bar chart scale. Supplied with English instructions and impact-resistant protective case with stand legs.

Safety category: CAT II 1000V
CAT III 600 V

1012865

Digital Multimeter E

Compact 3½-digit multimeter for measuring voltage, current and resistance as well as for diode and hFE gain testing. Overload protection in $\mu\text{A}/\text{mA}$ range but no protection for 20-A range. Folding digital display. Includes measuring leads and battery.

DC voltage: 200 mV–1000 V, 5 ranges, $\pm 0.5\% \pm 1$ digit
 AC voltage: 200 mV–750 V, 5 ranges, $\pm 0.8\% \pm 3$ digits
 DC current: 20 μA –20 A, 7 ranges, $\pm 0.8\% \pm 1$ digit
 AC current: 20 μA –20 A, 7 ranges, $\pm 1.0\% \pm 3$ digits
 Resistance: 200 Ω –20 M Ω , 6 ranges, $\pm 0.8\% \pm 1$ digit
 Display: 3½ display LCD, 24 mm, max. 1999
 Operating voltage: 9 V battery 6F22
 Safety classification: CAT II 600 V (IEC-1010-1)
 Dimensions: approx. 85x185x35 mm³
 Weight: approx. 230 g

U8531050

Digital Storage Multimeter

This innovative digital multimeter uses an opto-coupled USB cable to connect directly to a computer to allow you to record up to three measurements per second. A wide range of functionalities such as autoranging, relative measurements, and Min/Max/Hold also make this a highly versatile stand-alone tool. Measuring modes include DCV, ACV, DCA, ACA, resistance, diode, continuity, frequency, capacitance and temperature. The unit is supplied with a carrying case, USB cable, Software for Windows 2000/XP/Vista/7, type-K thermocouple, test leads, test clips, battery and operation manual.

DC voltage: 600 mV–1000 V, 5 ranges
 AC voltage: 600 mV–700 V, 5 ranges
 DC current: 600 μA –10 A, 6 ranges
 AC current: 600 μA –10 A, 6 ranges
 Resistance: 600 Ω –60 M Ω , 6 ranges
 Frequency: 100 Hz–1 MHz, 5 ranges
 Capacity: 60 nF–300 μF , 5 ranges
 Temperature: -55 °C–1000 °C, 2 ranges
 Display: 3½ digit LCD, 18 mm
 Operating voltage: 9 V battery (included)
 Safety classification: CAT II (IEC-1010-1)
 Dimensions: 90x190x40 mm³ approx.
 Weight: 500 g approx.

U118241



U118241



NEW

1012817



NEW

TRMS

1012816

Digital Wattmeter

Digital single-phase wattmeter with LCD display for accurate measurement (2000 points) of the true effective power.

Display: 3.5 digits, 13 mm

Measuring functions: V AC, V DC, A AC, A DC, W AC

Current measurements:

DC: 10 A \pm (1% + 1 digit) + 10 mA

AC: 10 A \pm (1% + 1 digit) \pm 10 mA

Voltage drop: 200 mV

Voltage measurements:

DC: 200 and 1000 V (\pm 0.5% + 1 digit) \pm 0.1 V and \pm 1 V

AC: 200 and 750 V (\pm 0.5% + 1 digit) \pm 0.1 V and \pm 1 V

Impedance: 1 M Ω

Power measurements:

AC: 0 to 6000 W in 2 ranges (2000 and 6000 W)

Accuracy: \pm 1% + 1 digit.

Resolution: 1 W and 10 W, based on the range

Protection: 1000 V in AC, 1100 V in DC

Polarity: bipolar through automatic switching

Power supply: 9V battery (not included)

Power consumption: \pm 6 mA

Dimensions: 185x90x60 mm³

Mass: 500 g (with the battery)

U29931

DMM Digital Multimeter

Digital multimeter for conducting measurements in situations where a high degree of safety needs to be assured. Automatic blocking of sockets (ABS), which are not used for specific functions. Back-lit liquid crystal display with digital read-out and analogue bar chart scale. Economy mode with automatic shut-off after 10 minutes without the measured reading changing. Excess voltage and overload warning, automatic or manual range selection, data storage and maximum and minimum functions. Supplied with measurement leads, 9-V block battery, spare fuse, English instructions, test report and impact-resistant protective case with stand legs and carrying strap.

Measured variables and ranges:

DC voltage: 30.00 mV (10 μ V)...1000 V (1 V), 6 ranges \pm 0.25% \pm 1 digit

AC voltage: 3.000 V (1 mV)...1000 V (1 V), 4 ranges \pm 0.75% \pm 1 digit

Direct current: 300.0 μ A (100 nA)...10.00 A (10 mA), 6 ranges \pm 1.00% \pm 2 digits

Alternating current: 3.000 mA (1 μ A)...10.00 A (10 mA), 4 ranges \pm 1.50% \pm 2 digits

Resistance: 30.00 Ω (10 m Ω)...30.00 M Ω (10 k Ω), 7 ranges

Capacitance: 30.00 nF (10 pF)...30.00 μ F (10 nF), 4 ranges

Frequency: 300.0 Hz (0.1 Hz)...100.0 kHz (100 Hz), 4 ranges

Other variables:

Duty cycle: 2.0 %...98.0 %

Temperature*: -200.0 $^{\circ}$ C...+850.0 $^{\circ}$ C (Pt 100)

-100.0 $^{\circ}$ C...+850.0 $^{\circ}$ C (Pt 1000)

Continuity test: Yes

Diode test: 2 V

Other data:

Safety category: CAT III 1000 V (IEC 61010-1:2001)

CAT IV 600 V (IEC 61010-1:2001)

Dimensions: 200x80x30 mm³

Weight: 700 g approx.

* Sensors available on request

DMM50 Digital Multimeter

Digital multimeter without true RMS (TRMS) measurement capability.

1012817

DMM60 Digital Multimeter

Digital multimeter with true RMS (TRMS) measurement capability for distorted input signals.

1012816

NEW

U29931



Sound Level Meter P5055

Universally deployable digital meter used to determine the sound level of any number of acoustic sources across a wide sound range. Device is housed in a robust plastic casing with integrated calibration signal and large LCD display for easy reading of measured values. Includes range selection switch and maximum hold function. There are two evaluation levels (A and C) available for the frequency. The measurement in the A-range is oriented on the human ear and is particularly well suited for measurements out in the open, while the C-range is designed for measurements of motor noise. The device's response time can be adjusted between fast and slow. The slow mode brings about attenuation of the measurement i.e. the measured value displayed corresponds to the average sound level. Fast mode is used to measure brief noise sequences and to determine the maximum noise level. Furthermore, the device also offers the option of connecting an external measuring instrument (e.g. for compiling and printing out measurement sequences) via an analogue output (phone jack). On the underside of the sound level meter there is a drill hole for attaching to a stand. Supplied in a foam lined portable bag.

Measurement range: 35 – 130 dB
 Resolution: 0.1 dB
 Accuracy: ± 3.5 dB at 94 dB (1kHz)
 Display: 3½-digit LCD display
 Digit height: 17 mm
 Microphone: Electret capacitor microphone
 Power supply: 9 V block-type battery
 Dimensions: 251x64x40 mm³ approx.
 Weight: 250 g approx.

U11801

Digital Energy Meter

Digital meter for measuring consumption of electrical energy by appliances connected to the mains and for determining bills given a rate for kilowatts per hour. It is also possible to demonstrate stand-by operation for larger appliances. If the connected appliance consumes more than 3600 W a warning signal is emitted. Supplied with an internal battery for memory back-up.

Values displayed: Energy, costs incurred, power, voltage, current, time, day of the week
 Input voltage: 230 V, 50/60 Hz
 Maximum permitted load: 3680 W/16 A
 Minimum load for display: 1 W/0.005 A
 Energy: 0.00 – 9999.99 kWh
 Current: 0 – 16 A
 Active power: 1 – 3680 W
 Accuracy: ±1%
 Safety classification: Cat II 300 V (IEC-1010-1)
 Operating voltage: internal battery for memory back-up
 Dimensions: 128x64x78 mm³
 Weight: 170 g

U118261-230

Digital Luxmeter

Extremely reasonably priced, easy to use pocket luxmeter for testing and measurement of light conditions. C.I.E. standard spectrum.

Including light sensor, pouch and battery
 Measuring ranges: 200 – 50000 lux, 4 ranges, ±5%
 Operating voltage: Battery
 Dimensions: approx. 65x115x25 mm³
 Weight: approx. 160 g

U11803

Noise Level Meter P8005

Digital noise level meter with circuit for suppressing background noise for measuring all types of sound levels in the environment, including noise levels in schools, offices, factories, traffic noise, household noise or for noise-reduction projects. Allows for manual or automatic selection of levels and measurements of minimum and maximum levels. Thanks to its built in USB port, the supplied 9 V mains adapter and stand, it is also suitable for permanent or long term measurement. Includes case, USB cable, Windows software, stand, 9 V mains adapter, 9 V battery and instruction manual.

Digital display: 4 digit LCD
 Height of digits: 20 mm
 Multi-functions display: 58x44 mm²
 Digital display of measurement, measuring time, bar graphs plus overs and unders

Background lighting: blue
 Applicable standards: IEC-61672-1 type 2, ANSI S1.4 type 2

Frequency range: 31.5 Hz – 8 kHz
 Dynamic range: 50 dB
 Level ranges: 30 – 80 dB (low)
 50 – 100 dB (medium)
 80 – 130 dB (high)
 30 – 130 dB (automatic)

Resolution: 0.1 dB
 Precision: ±1.4 dB
 Response times: 125 ms (fast), 1s (slow)

Microphone: ½-inch, with electret capacitor
 Display update: Twice a second
 Analogue output: AC/DC
 Operating voltage: 9 V battery or 9 V mains adapter
 Dimensions: 90x280x50 mm³ approx.
 Weight: 350 g approx.

U11804





U8533341-230
U8533341-115

Digital Counter

Digital counter/timer for measuring duration of motion, transition times, periods, pendulum periods and frequencies, as well as for counting events or Geiger tube pulses. Includes a speaker that can be turned on and off, power supplies for direct connection to light barriers (U11365) or for powering a Geiger-Müller counter (U8533430). For event counting, a fixed counting period can be programmed in a range from 1 s to 99999 s. Counter events (start, stop) can either be triggered by a signal to the input sockets or manually via switches. Includes plug in power supply.

- Time measurement: 0.1 ms – 99999 s
- Resolution: 0.1 ms / 1 ms / 0.1 s
- Frequency measurement: 1 – 100 kHz, where voltage > 1.5 V_{pp}
- Resolution: 1 mHz (1 – 100 Hz), 1 Hz (1 – 100 kHz)
- Counting periods: 1/10/60 s or manually triggered
- Input A: miniDIN 8 socket, 4 mm safety sockets
- Input B: miniDIN 8 socket, 4 mm safety sockets
- Input voltage A: 0.5 V – 15 V AC
- Input voltage B: 1 V – 15 V AC
- Active edge: Rising/falling
- Counter tube input: BNC socket
- Power supply: 550 V / 1 MΩ
- Display: 5 digit LED display
- Operating voltage: 9 – 12 V DC via plug in power supply
- Dimensions: 250x100x160 mm³ approx.
- Weight: 0.8 kg approx.

Digital Counter (230 V, 50/60 Hz)

U8533341-230

Digital Counter (115 V, 50/60 Hz)

U8533341-115



U8533341-230
U8533341-115

U8533430

U8611210



U8533341-230
U8533341-115

U11365

U8611210

U8533341-230
U8533341-115



U8400830

U210051-230
U210051-115



Digital Counter with Interface

Microprocessor controlled digital counter for measuring duration of motion, transition times, periods, pendulum periods and frequencies, as well as for counting events or Geiger tube pulses. Keyboard operated. With adjustable trigger edge, speaker that can be turned on and off, power supply for direct connection to light barriers (U11365) and adjustable low voltage output for supplying a Geiger-Müller tube (U8533430). With RS 232 interface and supplied cable plus software for graphic depiction of measured data and export to spreadsheet programs.

Frequency (Input A):

Measuring range: 0.01 Hz – 100 kHz
Resolution: 10 mHz – 10 Hz
Type of measurement: Repeated measurement/
single measurement

Period of oscillation (Input A):

Measuring range: 1 ms – 100 s
Resolution: 0.01 – 10 ms
Type of measurement: Repeated measurement/
single measurement

Pulse counting (Input A)/rate

measurement (counter tube input):

Measuring range: 0 – 9999 pulses
Resolution: 1 pulse
Type of measurement: Continuous measurement
Single measurement for counting
periods of 1 s, 6 s, 10 s, 60 s, repeated
measurement for a period of 10 s

Time for motion between A and B:

Measuring range: 0.01 ms – 100 s
Resolution: 0.01 ms
Start: START/STOP button, pulse at A
Stop: START/STOP button, pulse at B

Transition times via A and B:

Measuring range: 0.01 ms – 100 s
Resolution: 0.01 ms
Type of measurement: Simultaneous measurement
at both inputs

Transition time and period of motion:

Measuring range: 0.01 ms – 100 s
Resolution: 0.01 ms
Type of measurement: Time for motion from A to B, time for
transition at A, time for transition at B

Input A: BNC socket, miniDIN 8 socket,
two 4 mm safety sockets

Input B: BNC socket, miniDIN 8 socket,
two 4 mm safety sockets

Tube input:

BNC socket (on reverse)

Power supply:

300 – 625 V DC, continuously adjustable

Measurement display:

7 segment LED, 4 digit

Height of digits:

20 mm

Function display:

LCD with illumination, 2x 16 digit

Computer connection:

RS 232

Power consumption:

20 VA approx.

Dimensions:

95x245x185 mm³ approx.

Weight:

5 kg approx.

Digital Counter with Interface (230 V, 50/60 Hz)

U210051-230

Digital Counter with Interface (115 V, 50/60 Hz)

U210051-115

Millisecond Counter

Inexpensive, compact counter for measuring milliseconds, e.g. in conjunction with the free-fall apparatus (U8400830). Each count is started and stopped by a signal at the input sockets. The device is automatically reset to zero each time it is restarted. Includes plug-in power supply.

Time measurement: 1 ms – 9999 s

Supply voltage: 5 V DC

Connectors: 4-mm safety sockets

Dimensions: 105x75x35 mm approx.

Weight: 400 g approx.

Millisecond Counter (230 V, 50/60 Hz)

1012832

Millisecond Counter (115 V, 50/60 Hz)

1012833

NEW

1012832
1012833



Experiment Motor with Gearbox

Experiment motor for universal use in experiments on rotational motion, e.g. for experiments using the rings demonstrating flattening of the earth (U8403120) or Watt’s governor (U8403115). Can also be used as a generator in conjunction with the included hand crank. Robust clockwise and counter-clockwise rotating IDC motor with epicyclic gearbox and quick-action chuck in a tough anodized aluminum casing with removable and adjustable stainless steel stand rod. Can also be mounted on the clamp for the projectile launcher (U10361). Speed of rotation is adjusted by altering the supply voltage. Adjustable torque. Includes 3 belt pulleys of different diameters on a mounting axle.

- Speed without load: approx. 480 rpm at 12 V
- Speed sensitivity: approx. 40 rpm per V
- Span of chuck: 0.8 to 10 mm
- Stand rod: 12 mm diam.
- Pulleys: 10 mm diam., 20 mm diam., 40 mm diam.
- Axle: 10 mm diam.
- Drive belt: 130 mm diam. x 4 mm
- Nominal voltage: 12 V DC, 5A
- Connection: via 4-mm safety sockets
- Dimensions: 210x95x60 mm³
- Mass: 1.2 kg

Contents:

- Experiment motor
- Stand rod with knurled screws
- Hand crank
- Pulleys
- Drive belt

U10375



U10375

Digital Stroboscope

Portable microprocessor-controlled device with quartz-controlled time base for observation of periodic movements, as well as for frequency and rotation speed measurement. Xenon flash tube built into a robust plastic casing with handle and photo thread for mounting on a stand, continuous frequency adjustment in two ranges through coarse and fine setting using control knobs, 4-digit digital display permits readings of the desired flash sequence per minute.

- Meas. ranges: 100 min⁻¹ – 1000 min⁻¹ (approx. 1.5 Hz –18 Hz)
1000 min⁻¹ – 10000 min⁻¹ (approx. 18 Hz –165 Hz)
- Accuracy: ± (0.05% + 1 digit)
- Display: 4-digit LED
- Resolution: 0.1 min⁻¹ (< 1000 min⁻¹)
1 min⁻¹ (1000 min⁻¹ –9999 min⁻¹)
10 min⁻¹ (10000 min⁻¹)
- Flash duration: 60 µs –100 µs
- Flash energy: 4 Ws
- Flash angle: 80°
- Dimensions: 210x210x120 mm³ approx.
- Weight: 1 kg approx.

Digital Stroboscope (230 V, 50/60 Hz)

U40160-230

Digital Stroboscope (115 V, 50/60 Hz)

U40160-115



U40160-230
U40160-115

Spare Bulb, Stroboscope (not shown)

Spare bulb for the Digital Stroboscope (U40160-230).

U40161


U8532161
Measuring Amplifier 5

Measuring amplifier for measuring small voltages and current in conjunction with an ordinary voltmeter in the course of student experiments.

Measuring range with reference to 1 V output voltage:

Voltage (AC/DC): 1 mV – 1 V
 Current (AC/DC): 100 nA – 100 μ A
 Frequency range: 0 – 20 kHz ($v = 1$)
 0 – 500 Hz ($v = 1000$)

Input impedance: 10 k Ω
 Input U: BNC socket
 Input I: BNC socket
 Max input voltage: 10 V
 Output: 4 mm safety sockets
 Max output voltage: 10 V
 Limiting frequency: 100 Hz
 Gain factor: 106
 Accuracy: 2 %
 Operating voltage: 12 V AC
 Dimensions: approx. 175x85x65 mm³
 Weight: approx. 250g

U8532161

Additionally required:

U8475470-230 Transformer 12 V, 25 VA (230 V, 50/60 Hz)
 or
U8475470-115 Transformer 12 V, 25 VA (115 V, 50/60 Hz)
U17450 Analogue Multimeter AM50

Microvoltmeter

Measuring instrument and amplifier for measuring very small DC and AC voltages, e.g. thermo-voltages, inductive voltages and photo-electric voltages. With LED display. The measuring input includes a filter that can be switched in for smoothing the signal or for setting an upper frequency limit. The signal is input via a BNC socket or 4 mm safety sockets. An additional DIN socket is provided for the connection of Hall sensors, the axial/tangential magnetic field sensor (U8533997).

Inputs: 4 mm safety sockets, BNC socket, DIN socket
 Outputs: 4 mm safety sockets
 Measuring ranges: 199.9 μ V – 199.9 mV AC/DC, 4 ranges each
 Gain factors: 10 – 10000, 4 decades
 AC frequency range: 10 Hz – 1 kHz
 Input resistance: 100 k Ω (DC), 900 k Ω (AC)
 Upper frequency limit: 1 Hz – 1 kHz, 4 decades
 Precision: 5 %
 Sampling rate: 3 measurements/s
 Output signal: 0 – \pm 2 V, max. 1 mA
 Dimensions: approx. 235x250x180 mm³
 Weight: approx. 3.3 kg

Microvoltmeter (230 V, 50/60 Hz)
U8530501-230
Microvoltmeter (115 V, 50/60 Hz)
U8530501-115

Additionally recommended:

U8533997 Magnetic Field Sensor, Axial/Tangential


U8531401-230
U8531401-115
Measuring Amplifier

Measuring amplifier for recording very small voltage, current and charge. For display purposes, any DC meter capable of measuring in the range up to 10 V can be used with no additional configuration. Including offset correction and polarity switch. Additional outputs are provided so that the -15 V and +15 V operating voltage can be tapped for use in external circuitry, e.g. bridge circuits.

Input: BNC sockets
 Measuring range with reference to 1 V output voltage:
 Voltage: 0.1 mV – 100 V, 7 ranges
 Current: 10 pA – 10 μ A, 7 ranges
 Charge: 10 pAs – 100 nAs, 5 ranges
 Input resistance: 10 Ω (voltage), compensated 0 Ω (charge, current)

Overvoltage protection: up to 300 V
 Precision: typically 3 %
 Signal output: 0 – 10 V, configurable zero point, polarity switch
 Fixed voltage output: \pm 15 V, max. 50 mA
 Dimensions: approx. 235x230x180 mm³
 Weight: approx. 2.8 kg

Measuring Amplifier (230 V, 50/60 Hz)
U8531401-230
Measuring Amplifier (115 V, 50/60 Hz)
U8531401-115

Additionally required:

U17450 Analogue Multimeter AM50


U8530501-230
U8530501-115



U42000,
U42001



U42060,
U42061

Mechanical Balance 610

- Solid, all-metal construction
- Notched positions for sliding weights on three sliding beams
- Captive sliding weights
- Magnetic damping
- Zero point adjustment
- Extensible scale range

	U42000	U42001
Scale range	0 – 610 g	0 – 610 g
Scale range with additional weights	2610.0 g	2610.0 g
Readability	0.1 g	0.1 g
Tare range	—	225 g
Sliding weight		
front	0.1 g bis 10 g	0.1 g bis 10 g
centre	100 g bis 500 g	100 g bis 500 g
rear	10 g bis 100 g	10 g bis 100 g
Plate diameter	150 mm	150 mm

Electronic Scales

Universal scales in robust plastic casing, with easy-clean foil keyboard. Menu functions, easy selection using two buttons. High-resolution, easy-to-read LCD display, overload and underload display, battery or mains operation optional. Automatic shutdown after five minutes in battery operation. Batteries included.

	U42060	U42061
Scale range	0 – 200.0 g	0 – 5000 g
Accuracy	0.1 g	1 g
Weight units	g, lb:oz	g, lb:oz
Counter-balancing range	subtractive, entire weight range	subtractive, entire weight range
Power supply	3 AA alkaline batteries	3 AA alkaline batteries
Dimensions	approx. 193x135x39 mm ³	approx. 193x135x39 mm ³
Weight	ca. 470 g	ca. 470 g



Mechanical Balance 311

- Solid, all-metal construction
- Notched positions for sliding weights on four sliding beams
- Captive sliding weights
- Magnetic damping
- Zero point adjustment

Scale range: 0 – 311.00 g
 Readability: 0.01 g
 Sliding weight ranges: 0.01 – 1 g (1st beam), 1 – 10 g (2nd beam), 10 – 100 g (3rd beam), 100 – 200 g (4th beam)
 Pan diameter: 100 mm

U42010

U42010

Specific Benefits:

- **Flexible Power:**
Use either the included AC adapter, or 4 "AA" batteries to power your Scout Pro.
- **Easy to Clean:**
Sealed front panel and moulded spill ring.
- **Easy to View:**
High contrast LCD quickly displays weight and applications data, as well as indicators for stability, over/underload conditions, and low battery power.



U42056



U42048-230, U42048-115
U42049-230, U42049-115



U42050-230, U42050-115

Round or Square Stainless Steel Platform

Removable for easy cleaning.

Lockswitch

The Scout Pro can be locked into a specific configuration using the integral locking switch.



Weigh Below Hook

The integral weigh-below-hook on the bottom of the Scout Pro allows density determination or calculation of the specific gravity of samples.



Integral Shipping Lock

Quickly accessible under the weighing pan, the shipping lock allows you to lock and go.

Electronic Scales Scout Pro

Precision scales with removable stainless steel platform. Multi-function with percentage weighing, totalisation, display hold, and parts counting. Includes calibrating weight.

	U42048-230/ U42048-115	U42049-230/ U42049-115	U42050-230/ U42050-115
Weight range	0 – 200.00 g	0 – 400.00 g	0 – 600.0 g
Accuracy	0.01 g	0.01 g	0.1 g
Display	LCD, 6 digits, 15 mm		
Weight ranges	g, N, oz, %	g, N, oz, %	g, kg, N, oz, lb, %
Calibration	Automatic using external weight		
Scale pan	120 mm diam.	120 mm diam.	165x140 mm
Dimensions	ca. 192x54x210 mm ³		
Weight	ca. 700 g	ca. 700 g	ca. 800 g

Other weight ranges available on request.

Electronic Scale Pro 200 g (230 V, 50/60 Hz)

U42048-230

Electronic Scale Pro 400 g (230 V, 50/60 Hz)

U42049-230

Electronic Scale Pro 600 g (230 V, 50/60 Hz)

U42050-230

Electronic Scale Pro 200 g (115 V, 50/60 Hz)

U42048-115

Electronic Scale Pro 400 g (115 V, 50/60 Hz)

U42049-115

Electronic Scale Pro 600 g (115 V, 50/60 Hz)

U42050-115

Accessories:

USB Interface

For connecting Scout Pro to a printer or PC.

U42056

NEW



1012881

ABS Analytical Scales (230 V, 50/60 Hz)

Precision analytical scales with automatic adjustment mechanism and high resolution. Tough metal casing with glass windscreen, large graphic display and RS232 port. The scales offer practically every function needed in laboratories:

- Counting items
- Percentage weights
- Switching between different units
- Capacity display for weight range
- GLP/ISO protocols
- Programmable 4-digit ID number
- CAL adjustment program for setting accuracy

Max. measuring range:	220 g
Precision:	0.1 mg
Reproducibility:	0.1 mg
Linearity:	±0.2 mg
Time to settle:	3 – 5 s approx.
Item counting	
Minimum weight:	1 mg
References:	10, 20, 50, 100
Weight display:	LCD, 13 mm
Weighing platform:	80 mm diam.
Power supply:	12 V DC power supply, mains voltage 230 V, 50/60 Hz
Dimensions:	225x315x330 mm ³
Weight:	7 kg

1012881



U30150-230
U30150-115

Overhead Projector

Reliable overhead projector in modern moulded plastic housing with collapsible reflector column. High quality optical system with correction to avoid coloured edges and highly efficient low noise cooling.

Lamp:	36 V, 400 W
Light flux:	2200 lumens
Aperture:	285x285 mm ² approx.
Dimensions of housing:	450x440x320 mm ³ approx.
Weight:	9 kg approx.

Overhead Projector (230 V, 50/60 Hz)

U30150-230

Overhead Projector (115 V, 50/60 Hz)

U30150-115



Replacement Bulb for Overhead Projector

(not shown)
Replacement bulb for overhead projector, 36 V, 400 W.

U30151

W30600-230
W30600-115

BEST SELLER



NEW

U30722



Monocular Course Microscope Model 100

The monocular course microscope Model 100 is distinguished by its robust construction and ease of operation. It is equipped with three achromatic objectives as used in common practice and has a simple object stage with two clips for holding slides. It can be supplemented by means of a variety of spare parts and accessories.

Monocular Course Microscope Model 100 (230 V, 50/60 Hz)

W30600-230

Monocular Course Microscope Model 100 (115 V, 50/60 Hz)

W30600-115

Monocular Polarisation Microscope

High-quality mechanics and optics along with ease of operation are the stand-out features of the monocular polarisation microscope. Its compact and ergonomic design makes it easier to work with it. The main application for polarisation microscopes is in mineralogy, where they are used for investigating optically anisotropic objects, e.g. crystals or minerals (intrinsic birefringence) or isotropic materials being acted upon by mechanical forces (stress-induced birefringence).

U30722

	W30600-230, W30600-115	U30722
Stand	All-metal stand, arm firmly connected with base, pinion knobs attached on both sides of the stand for coarse and fine focusing	Robust, all metal stand with arm permanently connected to the base. Focussing by means of separate knobs for coarse and fine adjustment located on either side of the stand and operated by rack and pinion drive with ball bearings and retaining lever, adjustable stopper for protecting the object slides and objective.
Tube	Monocular inclined 45°, head rotation 360°	Monocular inclined 30°, head rotation 360°
Polarisation equipment	–	Polariser with scale and analyser, which can be inserted into the tube
Eyepieces	Wide field eyepiece WF 10x 18 mm with pointer and eyepiece lock	Wide field eyepiece WF 10x 18 mm
Objectives	Revolving nosepiece with 3 achromatic objectives 4x / 0.10, 10x / 0.25, 40x / 0.65	Inverted objective revolver with 3 achromatic objectives 4x / 0.10, 10x / 0.25, 40x / 0.65
Enlargement	40x, 100x, 400x	40x – 400x
Object stage	110x120 mm ² with 2 specimen clips	Circular object stage 120 mm in diameter, which can be rotated 360°, scale with Vernier and 2 specimen clips
Illumination	115 V resp. 230 V, 20 W tungsten lamp integrated in base, with blue filter in lamp shaft and a converging lens, power supply 115 V resp. 230 V 50/60 Hz	Adjustable 6 V, 20 W halogen lamp incorporated into the base, universal 85 to 265 V, 50/60 Hz power supply
Condenser	Bright-field condenser N.A. 0.65, iris diaphragm, filter holder and blue filter	Abbe condenser N.A. 1,25 with iris diaphragm, focussed via rack and pinion drive
Dimensions	approx. 175x135x370 mm ³	approx. 240x190x385 mm ³
Weight	approx. 2.9 kg	approx. 5.5 kg
Supplied	Complete with dust cover	Complete with dust cover

HD Video Flex®

Robust, ultra high resolution desktop digital colour camera for direct connection to a PC or notebook via a USB interface. Thanks to the ball and socket bearing, video head that can pivot and swivel via its flexible gooseneck, the camera can be easily and accurately connected, e.g. to microscopes and telescopes, or directed towards visual material, running processes or items of scientific or technical interest so that they can be viewed on a monitor. The heavy, triangular base ensures the necessary stability. Audio recordings are possible via a microphone equipped computer. An external power supply is not necessary as the camera is powered via the USB connection. Includes microscope adapter, Discovery Scope Kit, Applied Vision™ software and carrying case. Compatible with interactive whiteboards. The Applied Vision™ software for picture recording, reproduction and processing is characterized by its user friendliness and features e.g.

- Full screen, real time video
- Still frame recording
- Recording of films in AVI format
- Time-lapse recording
- Internet streaming
- Can be used in local network
- Zoom function
- Image processing
- Brightness, contrast control and positive/negative image display
- Drawing tools
- Organizer/memo function
- Printout of real time images
- Memory function (jpeg, bmp, tiff)
- Choice of background
- Creation of image collages
- Comparison of two adjacent images
- Measurement of the distance between 2 points or the area of a circle
- Exporting data to an Excel spreadsheet or MS Word
- Compatible with Windows, Mac and Linux
- Free software updates
- Unlimited local licences

1012828

	1012828	U42103	1012834	1012643	1012835
Photosensitivity	8 lux	20 lux	20 lux	3 lux	2 integrated white LEDs
Image digitization	digital CMOS	digital CMOS	¼" CMOS	¼" CCD	digital CMOS
Output signal	digital / USB 2.0	digital / USB 2.0	digital / USB 2.0	S-Video / USB 2.0	digital / USB 2.0
Resolution	HD 1080P	1280x960 SXGA	1280x1024	640x480	2048x1536
Live video	up to 30 images per second	up to 30 images per second	up to 30 images per second	up to 30 images per second	up to 30 images per second
TV system	–	–	–	PAL	–
Microphone	–	–	–	–	yes
Lens	8 mm HD	6 mm glass	glass f = 2.8 and 1.729 mm	8 mm glass, D-mount	F2.8 coated
Focal distance	6 mm to infinity	8 mm to infinity		6 mm to infinity	100 mm to infinity
Focus	manual	manual	auto	manual	auto
Microscope adapter	34,5 mm built-in and 28 mm	34,5 mm built-in and 28 mm	34,5 mm built-in and 28 mm	26 mm, 28 mm, 34 mm	–
Power supply	via USB	via USB	via USB	via USB	via USB
Cable	USB connecting cable, approx. 170 cm	USB connecting cable, approx. 150 cm	USB connecting cable, approx. 170 cm	USB connecting cable, approx. 180 cm	USB connecting cable, approx. 180 cm
Dimensions	approx. 180x180x720 mm ³	approx. 180x180x640 mm ³	approx. 180x180x640 mm ³	approx. 180x190x560 mm ³	approx. 200x200x630 mm ³
Weight	approx. 4.55 kg	approx. 1.7 kg	approx. 1.65 kg	approx. 1.8 kg	approx. 2.04 kg

iCam Digital

This innovative, inexpensive desk-top colour video camera is the perfect instrument for the presentation of various objects, images and text, for making video portfolios and sending video e-mails. The camera has video (PAL), S-video and USB outputs, so that it is easy to connect it to televisions as well as Mac or Windows computers, video recorders and LCD projectors. The iCam Digital camera is particularly suitable for microscope images. The focussing ring exactly matches the supplied microscope adapter. Includes Applied Vision™ software. NTSC version available on request.

1012643

FlexCam® 2

This modern document camera with high definition (HD) resolution can do the job of multiple presentation devices, e.g. overhead projectors, opaque projectors or slide projectors. Documents, pictures, objects etc. can be laid directly onto the flat base under the camera. The two bright white LEDs integrated into the head of the camera provide excellent illumination of the field of view. A built-in microphone allows sound recordings to be made. Includes Applied Vision™ software.

1012835

Vision Viewer™

Lighter version of the HD Video Flex® (1012828) with similar optical properties and for the same applications. The difference is that the video head is directly attached to the gooseneck arm (with no universal joint). Compatible with interactive whiteboards. Includes a microscope adapter, observation set (Discovery Scope Kit) and Applied Vision™ software.

U42103

Auto Focus Vision Viewer™

High-resolution, easy-to-use, desk-top colour video camera with a host of uses. Particularly suitable for presenting printed text, images and other objects or even dynamic processes. Includes auto-focus camera lens and wide field of vision (43x36 cm), flexible goose-neck support and integrated USB cable. Compatible with interactive whiteboards. Includes microscope adapter and Applied Vision™ software.

1012834



1012835



1012643



U42103



1012817



U11875-230
U11875-115



U29945-230



U11876

Magnetic Stirrer with Heater

Magnetic stirrer with stainless steel hotplate and secure safety circuit. Variable heating temperature and smooth starting stirrer motor. Housing resistant to chemicals.

- Quantity stirred, max. (H₂O): 10 l
- Speed: 100 – 2000 rpm
- Heater power: 400 W
- Heating temperature range: Room temperature to 320° C
- Work plate: 125 mm diam.
- Dimensions: 168x105x220 mm³ approx.
- Weight: 2.4 kg approx.

Magnetic Stirrer with Heater (230 V, 50/60 Hz)

U11875-230

Magnetic Stirrer with Heater (115 V, 50/60 Hz)

U11875-115

12L Magnetic Stirrer (230 V, 50/60 Hz)

Electronically regulated magnetic stirrer in stainless steel casing with an aluminium hot plate. Accommodates stand rods (12 mm diam.) and has a 12 V DC output to supply power to accessories.

- Maximum speed: 350 rpm
- Hot plate: 135 mm diam.
- Maximum temperature: 450°C
- Power consumption: 400 W
- Dimensions: 165x220x105 mm³
- Weight: 2 kg

1011739

Additionally recommended:

- U29026 Adapter for Round-Bottomed Flasks, 100 ml**
- U29027 Adapter for Round-Bottomed Flasks, 150 ml**
- U29028 Adapter for Round-Bottomed Flasks, 250 ml**
- U29029 Water Bath**
- U29030 Frame for Water Bath**

Adapters for Round-Bottomed Flasks

Adapters for heating round-bottomed flasks on the 12L magnetic stirrer (1011739)

Adapter for Round-Bottomed Flasks, 100 ml

U29026

Adapter for Round-Bottomed Flasks, 150 ml

U29027

Adapter for Round-Bottomed Flasks, 250 ml

U29028

SPEEDSAFE Magnetic Stirrer (230 V, 50/60 Hz)

Inexpensive, compact magnetic stirrer which can be adjusted to any speed within its range. Its casing and base plate are made of ABS plastic, making it resistant to chemical spray. Includes stirring rods.

- Speed: 100...1000 rpm
- Maximum stirrable volume: 1 l
- Mains voltage: 230 V, 50/60 Hz
- Dimensions: 120x120x45 mm³
- Weight: 700 g approx.

U29945-230

Magnetic Stirrer

Ultra flat magnetic stirrer with non wearing drive featuring no moving parts. With feature for changing direction of stirring automatically every 30 seconds for improved homogenization. Work plate and housing resistant to chemicals, non slip and secure base. Including plug in power supply.

- Quantity stirred, max. (H₂O): 0.8 l
- Speed: 15 – 1500 rpm
- Work plate: 100 mm diam.
- Power supply: power supply unit 100 V – 240 V
- Dimensions: 114x12x161 mm³ approx.
- Weight: 0.3 kg approx.

U11876

NEW



U29029

U29030

1011739

U29026

U29027

U29028

Water Bath

Vessel holding 4 l of water for use with the 12L magnetic stirrer (1011739).

U29029

Frame for Water Bath

Frame for supporting multiple smaller vessels inside the water bath (U29029).

U29030

Whiteboards

Metal board with enamelled surface for demonstration experiments using magnetic components, e.g., for mechanics or optics. Scratch- and acid resistant steel board that can be written on using water soluble pens. Can be wall mounted or set up on a stand.

Art. No.	Designation	Dimensions
U10030	Whiteboard	600x900 mm ²
U10031	Whiteboard	900x1200 mm ²



U10045



U10030/U10381

Whiteboards / Drawing Equipment

Set of Drawing Instruments for Whiteboard

Consisting of a flat profile ruler with decimetre scale divisions, a triangular set square for geometry, circle instrument with centimetre scale, and a pointing baton. With storage case.

- Flat profile ruler: Marked at decimetre intervals, polystyrene, 1000 mm
- Set square triangle: Plexiglas, 600 mm
- Circle instrument: centimetre scale, 520 mm
- Pointing baton: Fibreglass, 1050 mm

U10045

Whiteboard Holders

Aluminium frame for mounting whiteboards (U10030 or U10031). With two adjusting screws for mounting the board either horizontally or vertically. The horizontal frame consists of profile rails suitable for mounting standard experiment panels of DIN A4 size. T-stands ensure stability on the workbench.

Holder for Whiteboard, Small

For holding 2 experiment panels of DIN A4 size.
Dimensions: 625x600 mm² approx.

U10381

Holder for Whiteboard, Large

For holding 8 experiment panels of DIN A4 size.
Dimensions: 925x900 mm² approx.

U10382



U10382

U10381

Instrumentation

Laboratory Jacks

Height adjustable table with continuously variable extension mechanism for raising experiment equipment. May be fixed in place via wing nuts.

U15020



U15021
U15022



Art. No.	Designation	Maximum load	Tabletop	Height of table	Weight
U15022	Laboratory Jack I	30 kg	320x220 mm ²	65–250 mm	2.6 kg
U15020	Laboratory Jack II	40 kg	200x200 mm ²	70–260 mm	2.3 kg
U15021	Laboratory Jack III	50 kg	160x130 mm ²	60–250 mm	1.2 kg



U8611130

Stand with H-Shaped Base

Provides a firm base for large and extensive structures, with six clamping positions for stand rods up to 12 mm diameter.

Max. stand area: 300x280 mm²
Weight: 1.7 kg approx.

U8611130



U8611160

Stand Base, A-Shaped

Levelable duplex tripod base, extremely stable, for holding two rods of 4 up to 15 mm diameter. Made of grey cast iron.

Art. No.	Leg length	Weight
U8611160	200 mm	1.5 kg
U8611150	280 mm	3.7 kg



U13270

Tripod Stand

Levelable duplex tripod base, extremely stable, for holding two rods of up to 16 mm diameter. Distance between rods 135 mm.

Art. No.	Leg length	Weight
U13270	150 mm	1450 g
U13271	185 mm	1850 g



U13265

Barrel Foot, 1 kg

Heavy base for holding rods of up to 13 mm diameter. Made of powder-coated cast iron.

U13265



U8611210



U8611200

Barrel Foot

Heavy base to accommodate stand rods up to 12 mm in diameter and rectangular plates of up to 10 mm or 12 mm thickness. Made of painted cast iron.

Art. No.	Weight	Height	Diameter
U8611200	0.9 kg	56 mm	64 mm
U8611210	0.5 kg	47 mm	54 mm

Multiclamp

Universal clamp for attachment of rods up to 13 mm diameter and for holding plates, rulers, etc. of up to 13 mm thickness in a multitude of alignments. Nickel-plated steel screws.

U13255



BEST SELLER

U13255

Bosshead

Bosshead for connecting rods of up to 16 mm diameter. Powder-coated zinc die-casting, 110 g. Nickel-plated steel screws.

U13250



U13250

Cross-Bosshead

Cross-bosshead for connecting rods of up to 20 mm diameter. Powder-coated zinc die-casting, 130 g. Nickel-plated steel screws.

U13256



U13256

Clamp with Hook

Clamp with hook for attaching rods of up to 16 mm diameter. Powder-coated zinc die-casting, 93 g. Nickel-plated steel screws.

U13252



U13252

Clamp with Jaw Clamp

Stand clamp with jaw clamp for attaching rods up to 16 mm diameter. Powder-coated zinc die-casting, 190 g. Clamp with cork lining.

Clamping width: 20–40 mm

U13253



U13253

Universal Jaw Clamp

Clamp with cork lining. Unpainted zinc die-casting, 180 g.

Clamping width: 0–80 mm

U13261



U13261

Table Clamp

Table clamp for vertically attaching rods of up to 13 mm to tabletops.

Powder-coated aluminum alloy, 350 g

Clamping width: 0–60 mm

U13260



U13260

Adjustable Double Clamp

Double clamp with two grippers which can be rotated by 360° with respect to one another. Made of non-corroding aluminium alloy.

Clamp opening widths: 3...16 mm and 3...20 mm

U29381



U29381

Drilled Rod

Plastic rod with six lateral bore holes and one axial bore hole for the attachment of components with 4 mm plugs.

Length: 250 mm

Diameter: 12 mm

Bore hole spacing: 19 mm and 50 mm

Bore hole diameter: 4 mm

U11055



U11055



U15005

U15002

NEW

1012848
1012847

SW Stand Equipment Set

Stand equipment for easy, understandable and stable assemblies, e.g. for investigating mechanical oscillations and waves using the sensors from the SW sensors set (1012850 resp. 1012851). Including SW base plate as non-tilting base with three special threads to accommodate stand rods with internal and external threads, which can be extended by screwing stand rods with external thread onto the end. Two double clamps for use with the SW tie bar or 10-mm diameter stand rods. The SW tie bar serves as multi-function holder for fitting between stand rods on the base plate in order to build set-ups featuring the dynamic force sensors from the SW sensors set.

Base plate: 345x240x16 mm³ approx.
Stand rods: 400 mm x 10 mm diam. approx.

Contents:

- 1 SW Base plate
- 2 Stand rods with internal and external thread
- 2 Stand rods with external thread
- 2 SW Double clamps
- 1 SW Tie bar

1012849

Additionally recommended:
1012848 Steel Rod 280 mm
1012847 Steel Rod 400 mm

Stainless Steel Rods

Art. No.	Length	Diameter
U15000	100 mm	12 mm
U15001	250 mm	12 mm
U15002	470 mm	12 mm
U15003	750 mm	12 mm
U15004	1000 mm	12 mm
U15005	1500 mm	12 mm
1012848	280 mm	10 mm
1012847	400 mm	10 mm

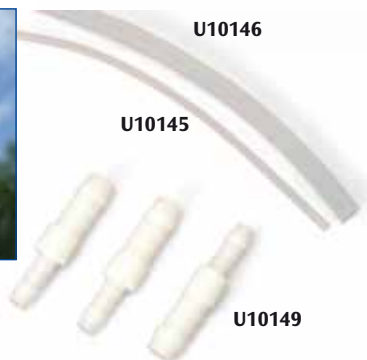


1012849

NEW



U29495/
U29532



U10146

U10145

U10149

Tubing

Silicone, transparent, 1 m long.

Art. No.	Internal diameter	Wall thickness
U10145	2 mm	1 mm
U10146	6 mm	2 mm

PVC Tubing

Tubing made of crystal clear PVC. Length 20 m.

Art. No.	Internal diameter	Wall thickness
U29495	4 mm	1 mm
U29532	6 mm	1,5 mm

Tubing Clamps, Set of 3

Connection adapters, 12 mm to 8 mm diameter, for attachment of hoses.

U10149



1012831

1012830

NEW

Vacuum Hoses

Vacuum hoses made of natural rubber according to DIN 12865. Colour red.

Art. No.	Length	Internal diameter	Wall strength	Temperature range
1012831	1 m	4 mm	4 mm	-30° up to + 85°
1012830	1 m	6 mm	4 mm	-30° up to + 85°
U10140	1 m	8 mm	5 mm	-30° up to + 85°
U10141	1 m	10 mm	5 mm	-30° up to + 85°



U10140

U10141

For a reliable connection

Set of 15 Experiment Leads, 75 cm

Set of 15 copper leads with highly-flexible PVC insulation, 75 cm long, with stackable 4 mm laminated plugs at both ends. Five leads in each of the colours red, black and blue.

Voltage: Safety extra low voltage
Plugs and sockets: Nickel-plated

Art. No.	Conductor cross-section	Max. continuous current
U13800	1 mm ²	19 A
U13801	2.5 mm ²	32 A

Set of Experiment Leads for Electron Tube Experiments

Set of 18 copper leads with highly flexible PVC insulation for all connections to series D electron tubes.

Wire cross-section: 1 mm²
Max. continuous current: 19 A
Plug and jack: 4 mm (nickel-plated)

U138101

Quantity	Length	Colour	Connection
3	75 cm	red	Safety jack/plug
4	75 cm	blue	Plug/plug
2	75 cm	black	Plug/plug
2	50 cm	blue	Plug/plug
5	25 cm	black	Plug/plug
2	25 cm	red	Plug/plug

Experiment Lead, Plug and Socket

Experiment lead with 4 mm laminated plug and 4 mm socket. 75 cm long, colour red.

Wire cross-section: 1 mm²
Max. continuous current: 19 A

U13760

Experiment Lead, Safety Plug and Socket

Experiment lead with stackable 4 mm safety-grade laminated plug and 4 mm socket. 75 cm long, colour red.

Wire cross-section: 1 mm²
Max. continuous current: 19 A

U13761

Crocodile Clip 4 mm, Not Insulated

Not insulated test clip with 4 mm sockets for accepting 4 mm-test leads or any other 4 mm-Multilam plug. Connection also possible with screw clamp or soldering.

U13805

Pair of Experiment Leads, 75 cm

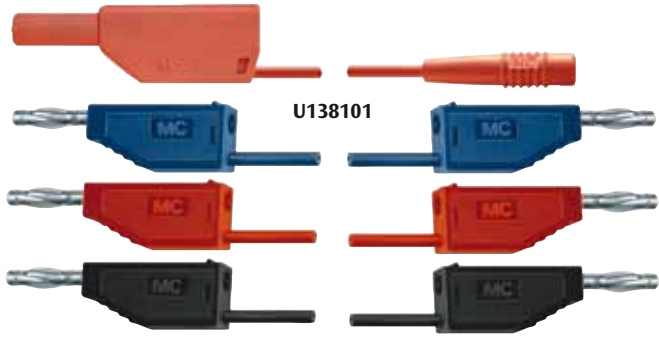
Set of two copper leads with highly flexible PVC insulation, 75 cm long, black, with cascable 4 mm laminated plugs at both ends.

Conductor cross-section: 1 mm²
Voltage: Safety extra low voltage
Max. continuous current: 19 A

U13813



U13800/
U13801



U138101



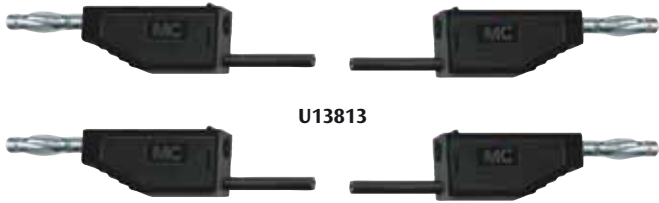
U13760



U13761



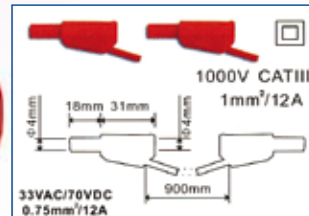
U13805



U13813

For your safety

NEW



Experiment Leads and Cables



Safety Crocodile Clip 4 mm, Black

Fully insulated safety crocodile clip with 4 mm safety socket for accepting 4 mm safety test leads or any other 4 mm Multilam plug.

U13806

Safety Crocodile Clip 4 mm, Red

Fully insulated safety crocodile clip with 4 mm safety socket for accepting 4 mm safety test leads or any other 4 mm Multilam plug.

U13808

Set of 5 Safety Experiment Leads

Art. No.	Length	Colour
U29987	0.25 m	black
U29988	0.50 m	black
U29989	1.00 m	black
U29990	0.25 m	red
U29991	0.50 m	red
U29992	1.00 m	red

Set of 15 Safety Experiment Leads, 75 cm

Set of 15 copper leads with highly flexible PVC insulation, 75 cm long, with stackable 4 mm safety laminated plugs at both ends. Four leads in each of the colours red, black and blue, and one lead in each of the colours green, brown and yellow-green.

Wire cross-section: 2,5 mm²

Voltage: Low voltage

Max. continuous current: 32 A

U138021

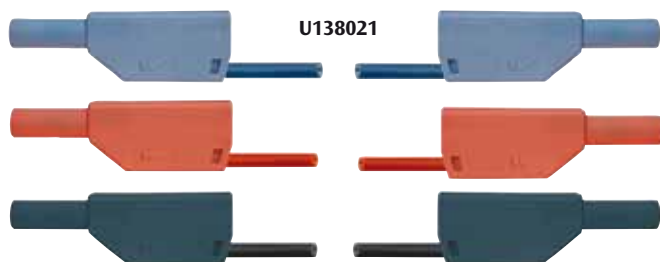
Pair of Safety Experiment Leads, 75 cm

(not shown)
Set of two copper leads with highly flexible PVC insulation, 75 cm long, black, with stackable 4 mm safety laminated plugs at both ends.

Conductor cross-section: 2.5 mm²
Voltage: Safety extra low voltage

Max. continuous current: 32 A

U13812



Set of Three Safety Experiment Leads for Free-Fall Apparatus

(not shown)
Set of three copper leads with highly flexible PVC insulation for connecting to free-fall apparatus (U8400830), with stackable 4 mm safety laminated plugs at both ends. Two leads 75 cm long, one red and one black. One green lead, 150 cm long.

Wire cross-section: 2,5 mm²

Voltage: Low voltage

Max. continuous current: 32 A

U13811

Pair of High-Voltage Cables, 150 cm

Set of two copper leads sheathed in highly flexible PVC, 150 cm long with 4-mm safety plugs at either end housed in rigid insulating sleeves. One red cable and one black.

Cable cross section: 0.5 mm²

Voltage: Up to 5 kV (using high-voltage power supply U33010-230 resp. U33010-115)

U13814



U13814

Set of Fuses

Set of fuses, including 105 fast-acting fuses of a high switching capacity and 135 slow-acting fuses of a low switching capacity. Stored in a box.

Dimensions: 5 mm diam. x 20 mm

Rated voltage: 250 V

Type SP:

Material: Glass tube

Time response: Fast

Switching capacity: 1000 A @ 250 V

Assortment: 1 A (15 units); 3.15 A; 6.3 A; 10 A (30 units in each case)

Type FST:

Material: Ceramic tube

Time response: Slow

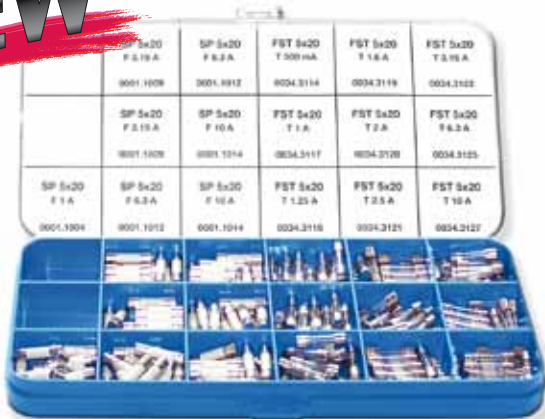
Switching capacity: 35 A @ 250 V

Assortment: 0.5 A; 1 A; 1.25 A; 1.6 A; 2 A; 2.5 A; 3.15 A; 6.3 A; 10 A (15 units each)

1012873

NEW

1012873



Lab Material

BNC Patch-Cord Connector
Coupling at either end with a BNC jack for connecting high-frequency patch cords.
U11258

Adapter, BNC Plug/ 4 mm Jacks
Crossover from a BNC plug to 4 mm jacks with 19 mm spacing.
U11259



HF-Patch Cord
Shielded patch cords for low loss, low capacitance transmission of high frequency signals. Equipped at either end with a BNC plug.
Impedance: 50 Ω
Length: 1 m
U11255

HF Patch Cord, BNC/4 mm Plug
Shielded patch cord for low loss, low capacitance transmission of high frequency signals. Lead with a BNC plug at one end and two 4 mm plugs at the other end.
Impedance: 50 Ω
Length: 1 m
U11257

Adapter, BNC Jack/ 4-mm-Plugs
Crossover from a BNC jack to 4 mm plugs with 19 mm spacing.
U11260

T-Piece, BNC
T-piece for connecting two high-frequency patch cords to one BNC jack.
U11261

Universal Plug
Earth-contact socket with various adapters permitting worldwide use. The adapter suitable for the national standard is fitted as the mains contact.
Maximum rated load: 250 V AC, 10–16 A
W10860

Adapter, BNC Plug/ 4 mm Safety Jacks
Crossover from a BNC plug to 4 mm safety jacks with 19 mm spacing.
U29564

Cuvette, Rectangular, 80x30x80 mm³
Plane-parallel cuvette of plexiglas with highly-polished optical surfaces for investigating the paths of light beams in liquids.
Dimensions: 80x30x80 mm³
U8475830

Set of 3 Funnel Holders
Set of 3 stainless steel rings with attaching nut for 12 mm rod diameter. Inner diameters of rings 55 mm, 75 mm and 95 mm.
U29566

Plastic Trough (not shown)
Transparent plastic trough.
Dimensions: 170x130x85 mm³
T52006

Funnel
Funnel, 50 mm diameter, plastic.
U8634700

U11260

U11259

U11257

U11261

U11258

U11255

W10860

NEW

U29564

U8475830

U29566

U8634700

Experiment Leads and Cables / Glassware

Lab Material



...going one step further

NEW

U29422

U21885

U14201

U14200

U14205

U29453

U8411310

U14211

U14210

U29452

NEW

U8634606

U14315

U14316

U14317

Glassware

Lab Material

Set of 10 Glass Stirrers

Set of 10 Stirrers, made of sodical-calcic glass. 4 to 5 mm diam., length 250 mm

U29422

Plane MirrorGlass mirror, ground edges. Dimensions: approx. 170x130 mm²

U21885

Watch Glass Dishes

Made of thin-walled soda-glass, ground rim. Diameter 80 mm or 125 mm.

Art. No.	Designation
U14200	Set of 10 Watch Glass Dishes, 80 mm
U14201	Set of 10 Watch Glass Dishes, 125 mm

Graduated Cylinder, 250 ml

Graduated cylinder made of borosilicate glass. Tall form with spout and hexagonal base.

Scale: 250 ml

Divisions: 2.5 ml

U29453

Vessel with Overflow

Vessel with overflow, 275 ml, made of Plexiglas.

U8411310

Graduated Cylinder, 100 ml

Graduated cylinder made of Duran glass. Tall form with spout with hexagonal base.

Scale: 100 ml

Divisions: 1 ml

U14205

Free-Standing Cylinder

Non-graduated cylinder made of Duran glass. With round base and coarse ground rim.

Height: 300 mm

Diameter: 40 mm

U14206

Beakers, 600 ml

Set of 10 beakers made of Borosilicate glass. With scale, 100 ml divisions and spout.

Art. No.	Designation
U14210	Set of 10 Beakers, Low Form
U14211	Set of 10 Beakers, Tall Form

Round-Bottomed Flask, 250 ml

(not shown)

Round-bottomed flask made of borosilicate glass, 250 ml.

1011768

Round-Bottomed Flask, 500 ml

(not shown)

Round-bottomed flask made of borosilicate glass, 500 ml.

1011769

Set of 8 Test Tubes

Set of 8 Test Tubes, 16 mm diam.

U8634606

Gas Test Tube, 250 ml

To collect gases; made of ordinary glass; with thick round bottom.

U29452

Gas Syringe

For storing and measuring quantities of gases and liquids. Consists of a glass cylinder with a scale having divisions of 0.5 ml or 1 ml. The ground finish of the glass cylinder ensures extreme tightness and smooth operation.

Art. No.	Volume	Division	Valve
U14315	100 ml	1 ml	1-way
U14316	50 ml	0.5 ml	-
U14317	25 ml	0.5 ml	-

Resonance Bowl

Dating from the Song Dynasty (960–1279 A.D.), this bronze basin has two prominent handles and four fish in relief on the bottom, as well as lines emanating from the mouths or tails of the fish. When the handles are rubbed briskly with the palms of the hands, a harmonious sound is heard and standing waves are excited in the four quadrants along the circumference, causing water columns to come alive, spouting more than 30 cm into the air, as if squirting from the fish.

Diameter: approx. 380 mm
 Height: approx. 150 mm

U30001

BEST SELLER

U30001



Pythagorean Cup

Pythagoras is known to most students today as the author of the Pythagorean Theorem ($a^2 + b^2 = c^2$). There was far more to Pythagoras' philosophy than this: he was a deep thinker on religion, the nature of the soul, and the harmony of the cosmos. With the "Pythagorean Cup" he illustrated to his students the virtues of moderation: when filled halfway, it retains its contents, but if it's too full, all of the liquid drains out through a hole in the bottom. Our Pythagorean cup is manufactured of clear blown glass. The secret of the construction is a siphon, which is built in the centre of the cup. Ideal to explain to your students the principle of a siphon with an historical background.

Height: approx. 250 mm
 Diameter: approx. 80 mm

U14350

U14350



Magic Mirror

The Western Han "Light-Transmitting" Mirror known as the magic mirror has a history of more than two thousand years. It is a miracle created by the ingenious Chinese craftsmen in Western Han Dynasty (206 B.C.–24 A.D.) through combining the optical and mechanical principles with superb metallurgical technology. Those wonderful mirrors are able to reflect the decorative pattern cast on their backs onto a white screen when sunlight is shining on their polished fronts. The fabrication technology of this magic mirror was lost in Song Dynasty (960 – 1279 A.D.) and had remained a mystery until 1975. With a perfect combination of science and technology, culture and art, the celebrated Magic Mirror is a perfect classroom tool as well as a cherished gift.

Diameter: approx. 70 mm
 Thickness: approx. 10 mm

U300001

U300001

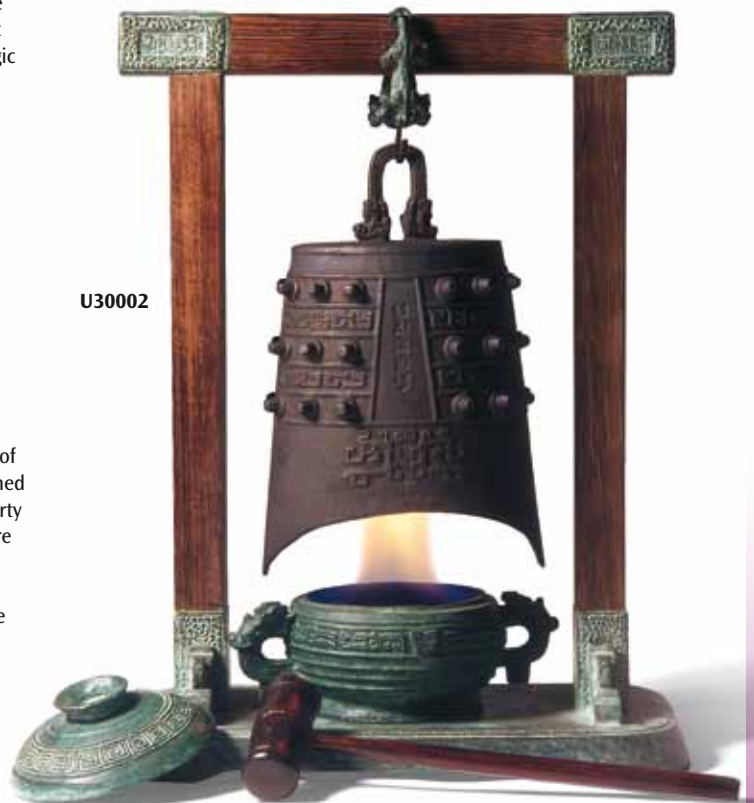
Yi Bell

The "faith bell" is shaped after the two-tone bell unearthed in the tomb of Marquis Yi in 1978. This reproduction has been cast using a newly designed copper alloy containing magnesium and exhibits a unique physical property resulting from a combination of bell design and the effect of temperature on vibrational damping. At room temperature the bell exhibits excessive damping and gives a dull sound when struck, as though it were made of wood. After being heated with an alcohol burner for several minutes, the bell is restruck and rings beautifully.

Dimensions: approx. 295x210x120 mm³

U30002

U30002



Description	Art. No.	Page
"Addition of Colours" School Apparatus	1012821	156
"Renewable Energy" Kit	U40624	31
"Solar Hydrogen" Kit	U40623	109
3B NETlab™	U11310	34
3B NETlog™ (115 V, 50/60 Hz)	U11300-115	35
3B NETlog™ (230 V, 50/60 Hz)	U11300-230	35
3B NETlog™ with Ethernet Port (115 V, 50/60 Hz)	U11300ip-115	35
3B NETlog™ with Ethernet Port (230 V, 50/60 Hz)	U11300ip-230	35
3B POWERlog (115 V, 50/60 Hz)	U11305-115	42
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3B Student Kit	–	14–18
60°-Prism, Crown Glass, 40 mm x 40 mm	U283060	153
60°-Prism, Flint Glass, 40 mm x 40 mm	U283070	153
6-Piece Model of a Human Eye	F15	175
– A –		
ABS Analytical Scales (230 V, 50/60 Hz)	1012881	270
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Steam Engine B
U13850

Page 131

Monocular Polarisation Microscope
U30722

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U30722



W13650-230

LAB2 Electrical Burner (230 V, 50 Hz)
W13650-230

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NEW

Glass Inset for Newton's Ring Experiments
U22018

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U22018



U30090

Roman Arch Kit
U30090

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Orbit™ Tellurium
U19600

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U19600

New Products



U14053

Fresnel Biprism
U14053

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Protective Adapter, 3-Pole
1009960

Protective Adapter, 2-Pole
1009961



1009961



1009960

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NEW



"Oersted's Needle" Device
U29310

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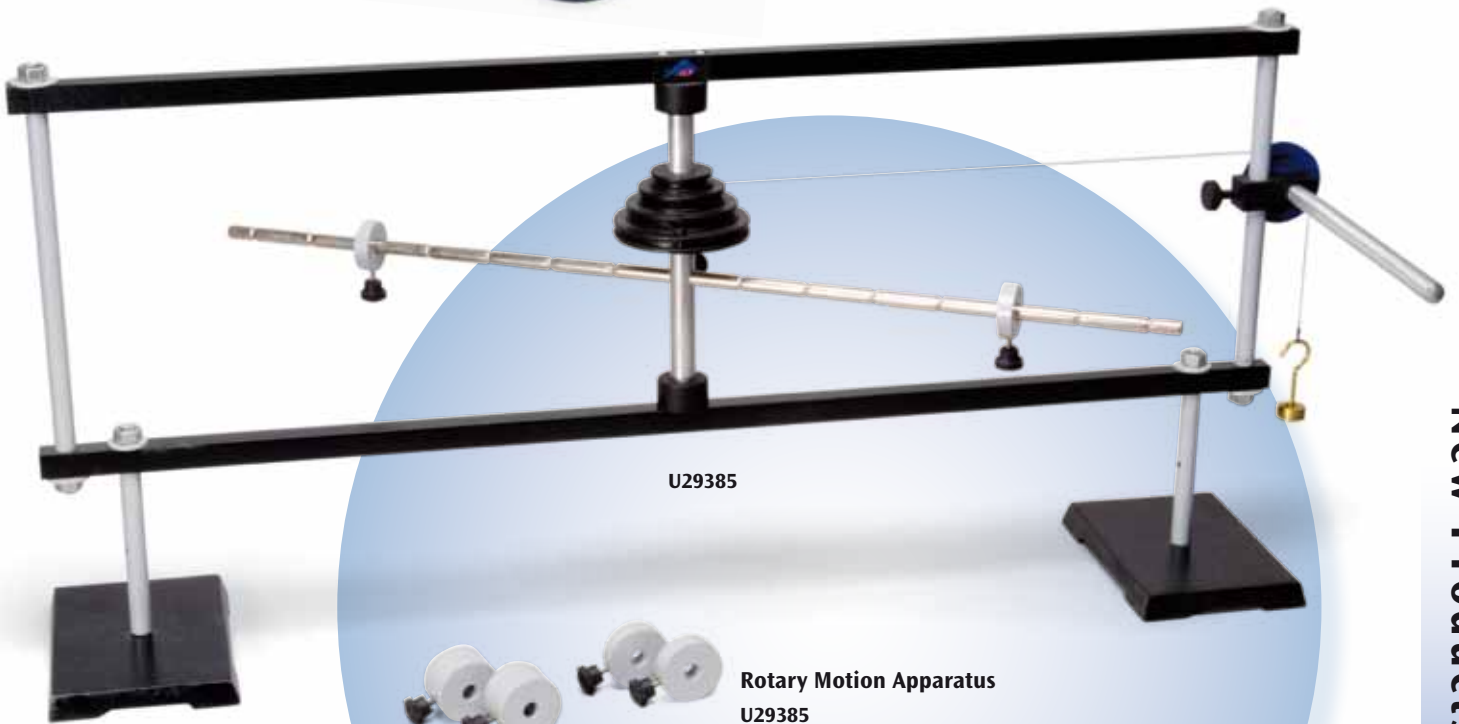


1009955
1009954

Connector Box (230 V, 50/60 Hz)
1009955

Connector Box (115 V, 50/60 Hz)
1009954

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U29385



Rotary Motion Apparatus
U29385

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...going one step further

NEW

Induction Torch

U29615

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U29615



Bicycle Dynamo, Transparent

U29538

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U29538



Newton's Colour Disc,
with DC Motor

U29555

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U29555



U29587



Newton's Colour Disc,
with Crank

U29587

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Interactive Atomic Model According to Bohr for your Physics, Chemistry and Biology Classes

This didactically excellent training model greatly simplifies the teaching and understanding of Bohr's model of the atom. The practical hands-on model illustrating the underlying theory allows students to comprehend the topic more directly. Science classes automatically become more 'real', easier to grasp and fun to do!

Learning content:

- Atoms, isotopes, ions, noble gas configurations, structure of the elements, covalent bonds, ionic bonds
- Elements, atomic mass, atomic number and the periodic table

Each class kit (W19900/W19901) contains eight student training models (W19902) as well as two demonstration atoms for the teacher. With this completely magnetic demonstration atom you will be able to clearly and quite easily explain Bohr's atomic model to your students on the blackboard. Using the training atom your students will be able to construct their own atoms, isotopes, and even ions. In this manner natural science teaching becomes concrete, simple and lots of fun! Each student training model includes a flat round plastic container holding 30 protons, neutrons and electrons. The lid and the turned-over lower part of the container each represent an atom with orbits.

All the benefits at a glance:

- Inter-disciplinary learning game
- Suitable for individual, partner and group work
- Playful learning of natural science subjects
- Easy understanding of processes and structures at the atomic level
- Simple and lots of fun to use
- Appealing 3D design
- Convenient storage



2 completely magnetic demonstration models for the teacher

Class Kit for Whiteboard

Each class kit for 1 teacher and 8 student groups comes with 2 completely magnetic demonstration models for the teacher (1 white background sheet to be hung up, 2 black atomic nuclei, each with 8 black orbits, 20 protons, electrons and neutrons), 8 student training models each with 2 atoms, 30 protons, 30 neutrons and 30 electrons, instructions.

D/E/S/F/I/P

W19900

Class Kit for Blackboard

Each class kit for 1 teacher and 8 student groups comes with 2 completely magnetic demonstration models for the teacher (1 black background sheet to be hung up, 2 white atomic nuclei, each with 8 white orbits, 20 protons, electrons and neutrons), 8 student training models each with 2 atoms, 30 protons, 30 neutrons and 30 electrons, instructions

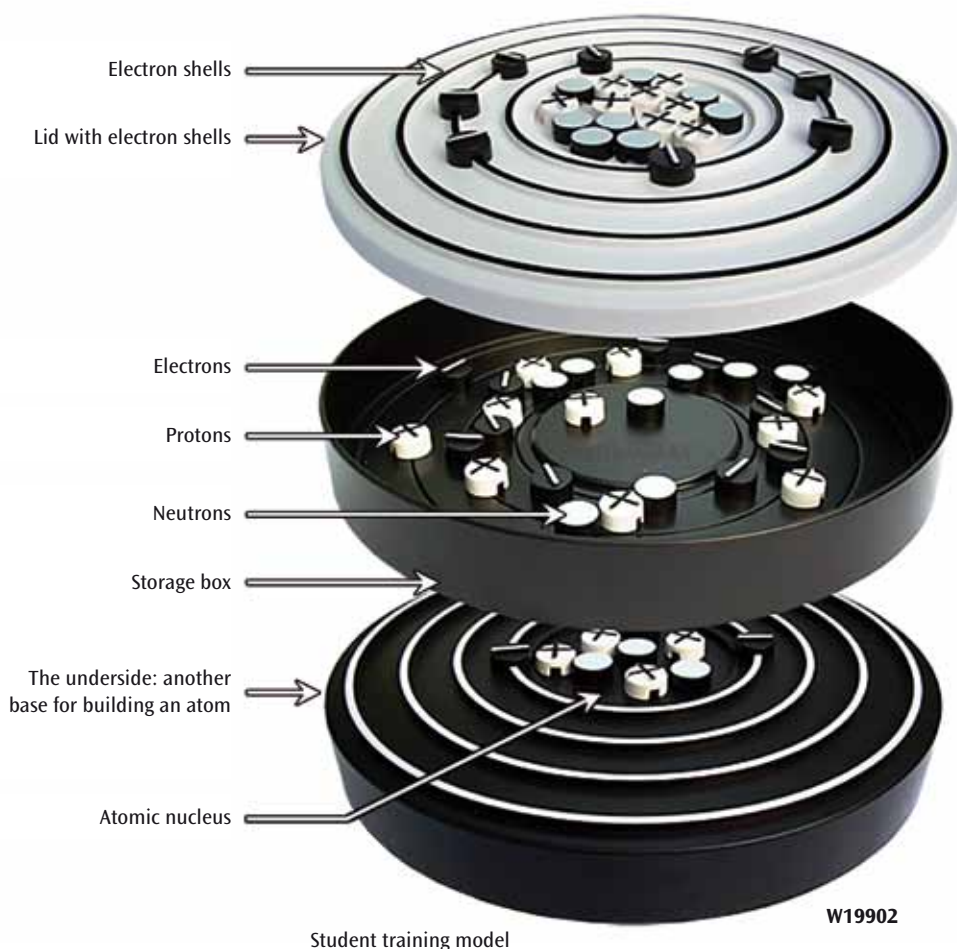
D/E/S/F/I/P

W19901

Student Training Model

Supplied with 2 atoms, 30 protons, 30 neutrons and 30 electrons

W19902



Student training model

W19902

Sensory Physiology Kit

Very interesting experiments for the secondary level of education. This sensory physiology kit allows students to conduct various experiments in the fields of hearing, seeing and feeling. All the contents of the kit are supplied. The experiments and the underlying principles are of course described in detail in the supplied instruction manual.

Experiment topics:

- Sense of touch (tactile sense)
- Perception of distances between tactile spots
- Heat and cold perception of the skin
- Blind spot
- Optical and haptic illusions Colour vision
- Flicker colours and motion after-effect
- Inversion of the image in the brain using inverting goggles
- Directional hearing
- Hearing own body noises

Supplied with: Carrying case with foam inserts, instrument for directional hearing, resonance tube, calipers, tactile hair, cold/hot probe, 4 transparent plastic cards for geometrical-optical illusions, "blind spot" test card, light-proof goggles with 8 attachments, 2 inversion prisms for the goggles, controllable motor with wall plug transformer, 3 pattern discs, experiment instructions on CD-ROM (pdf file) in German or English.

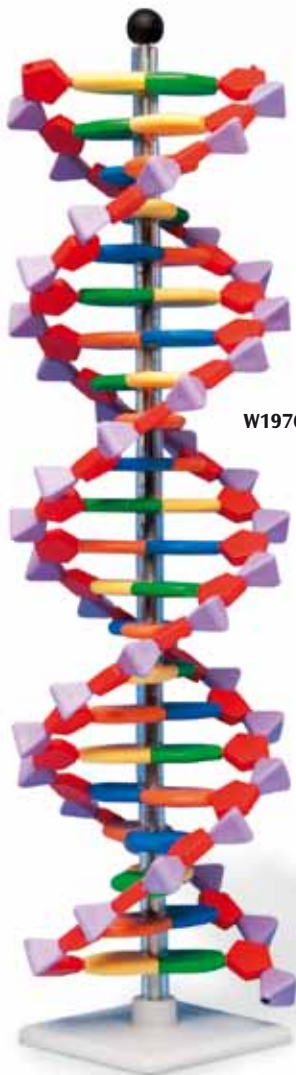
38x29x11 cm

 D/E

W16120



W16120



W19760

BEST SELLER

miniDNA™ 22 Layer Molecular Model

The miniDNA™ system comprises abstract shaped colour coded parts to represent the nitrogenous bases, pentagonal sugar & pyramidal phosphate parts required to make the Double helix model of DNA.

Contents:

- 11 Thymine (orange)
- 11 Adenine (blue)
- 11 Guanine (green)
- 11 Cytosine (yellow)
- 44 Deoxyribose (red)
- 44 Phosphate (purple)

Supplied with assembly instructions and its own stand.
Packed in a plastic box.

44 cm; diam 11 cm

 E

W19760

Nerves of Steel – Great experiments for simulating the conduction of impulses along nerve fibres according to Prof. Dr. Matthias Ducci / Prof. Dr. Marco Oetken

Exciting experiments for interdisciplinary teaching of year 11 to 13 classes. A model system for simulating the conduction of impulses is now finally available! Many biology teachers have complained about the lack of suitable model systems for simulating the conduction of impulses along nerve fibres, considering that neurophysiology is an established component of the advanced level syllabus. We have developed a unique electrochemical model experiment for effective illustration of this complex topic, in cooperation with Prof. Dr. Matthias Ducci (teacher training college PH Karlsruhe) and Prof. Dr. Marco Oetken (teacher training college PH Freiburg). Try it – you'll love it!

Nerves of Steel

The model experiments are based on the property of iron to develop a protective oxide coating in acid solutions under specific conditions. This impressive analogical model is based on the reversibility of the process of passivation and the appearance of a reactivation along a long iron rod. The materials provided allow the students to use the model to demonstrate continuous and saltatory conduction as well as the principle of transmission of neurotransmitters.

The following experiments can be carried out:

- Simulation of continuous conduction along non-myelinated axons
- Simulation of saltatory conduction by means of a model experiment
- Transmission of information by neurotransmitters

The set includes:

- 1 plexiglas trough,
- sand paper,
- 3 iron rods,
- 1 zinc electrode,
- 15 jackets for isolation of sections of the iron rod,
- detailed experimental instructions.

The necessary chemicals (hydrogen peroxide, sulphuric acid, sodium chloride solution) are not included.

12x12x35 cm; 0.5 kg

D/E/P

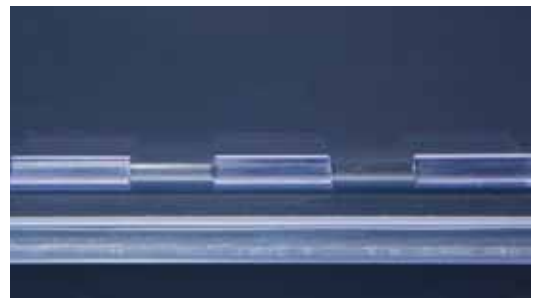
U11120.....



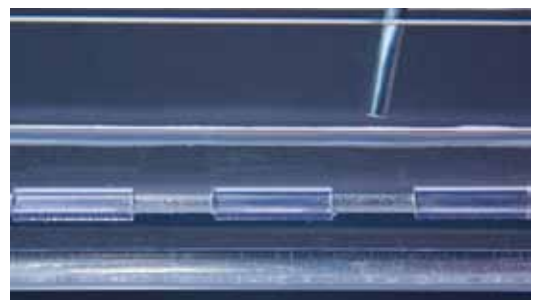
U11120



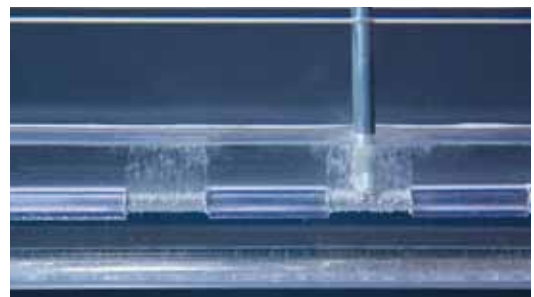
Prof. Dr. Matthias Ducci



Starting position of the simulation of saltatory conduction



The zinc electrode is put into the electrolytic solution

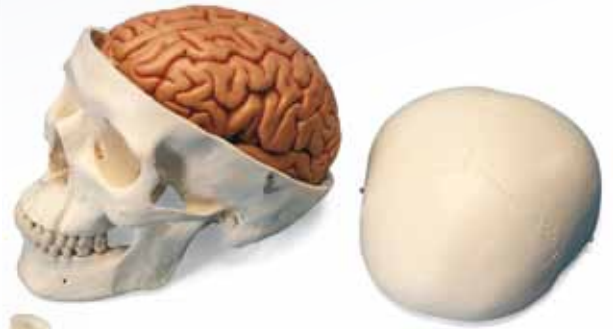


After the zinc electrode contacts the iron rod a reaction can be seen through the bubbles which represents the conduction of impulses of nerve fibres



3B Scientific® Skull Kit –
Didactic Version, 22-part
A291

Classic Skull with Brain,
8-part
A20/9



Ossicles – magnified 20 times
A100



Dental Disease,
magnified 2 times, 21 parts
D26

Cancellous bone
A99



Sam Deluxe Skeleton, on
5-foot roller stand with brake
A13

Further Information:
www.3bscientific.com



Disc-Torso, 15 slices
VA20



Classic Unisex Torso,
14-part
B13



3B BONElike™
Vertebral Column
A794

NEW



3B Scientific History



The international 3B Scientific group of companies is the world's largest and most experienced manufacturer of anatomical teaching aids. The oldest production site was set up as early as 1819 in Budapest, Hungary. The continuously growing success of 3B Scientific is the result of global expansion, based on the production and sales of high-quality medical and scientific teaching aids available at fair prices. The internationally registered brand name 3B Scientific® can be found around the world in the fields of natural sciences, medical training and patient education. The product range includes products for lectures in physics and biology as well as anatomical models, software and charts, medical simulators, acupuncture and other therapy products. The company has been awarded the DIN EN ISO 9001:2008 certification for the excellent quality of its services, products and organizational structures. This official step towards quality management emphasizes the continuing process of innovation, product improvement and customer orientation that is associated with the brand name 3B Scientific®.

3B stands for: *Best Quality Best Value Best Service*



...going one step further

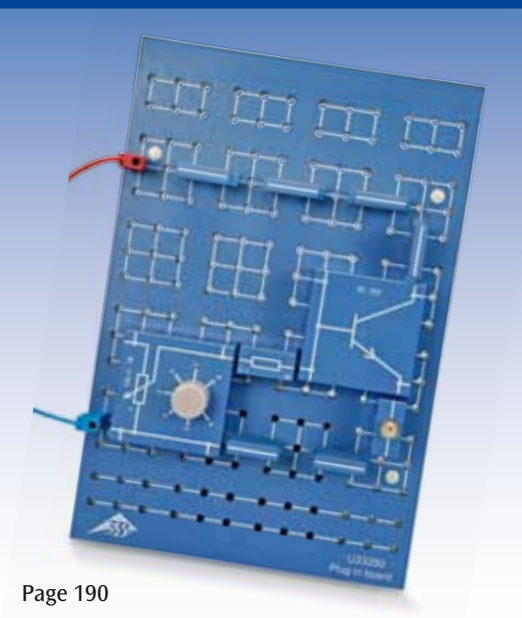
- 1819 Calderoni founded in Budapest, Hungary
- 1912 Training Workshops of the German Hygiene Museum founded in Dresden
- 1948 Paul Binhold Lehrmittelfabrik founded in Hamburg
- 1950 Production of the first plastic skeleton
- 1952 First skeleton manufacturing plant opened
- 1963 New headquarters at Rudorffweg, Hamburg
- 1965 Introduction of the Torso product line
- 1970 Introduction of the Binhold company logo
- 1979 Anatomical models first exported to the USA
- 1983 First manufacturing of injection moulded skeleton parts
- 1986 Care simulators added to the product range
- 1988 Anatomical models first exported to Japan
- 1991 DHM Lehrmittelfabrik GmbH founded in Dresden
- 1993 Acquisition of Calderoni and foundation of Biocalderoni in Hungary
- 1995 American 3B Scientific founded in Atlanta, USA
- 1996 New logo for the 3B Scientific Group
- 1997 Nihon 3B Scientific founded in Niigata, Japan
- 1998 France 3B Scientific founded in Bartenheim, France
- 1998 Merger of Paul Binhold Lehrmittelfabrik GmbH and DHM Lehrmittelfabrik to form 3B Scientific GmbH
- 1999 China 3B Scientific founded in Suzhou, China
- 2000 DIN EN ISO 9001 certification
- 2001 Introduction of the full 3B Scientific® product range for physics
- 2002 Italy 3B Scientific founded in Bologna, Italy
- 2003 España 3B Scientific founded in Valencia, Spain
- 2003 UK 3B Scientific founded in Weston-super-Mare, United Kingdom
- 2004 All-European distributor of SEIRIN® acupuncture needles
- 2004 Acquisition of ELWE Didactic GmbH in Klingenthal
- 2005 Acquisition of TELTRON® brand name and production
- 2005 Russia 3B Scientific founded in St. Petersburg.
- 2006 Brasil 3B Scientific founded in Joinville, Brasil.
- 2007 Thai 3B Scientific Co Ltd., founded in Bangkok, Thailand
- 2009 DIN EN ISO 9001:2008 certification
- 2011 Implementation of SAP as business controlling software



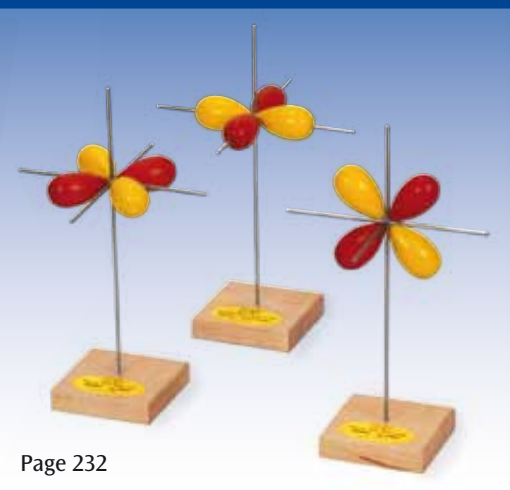
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