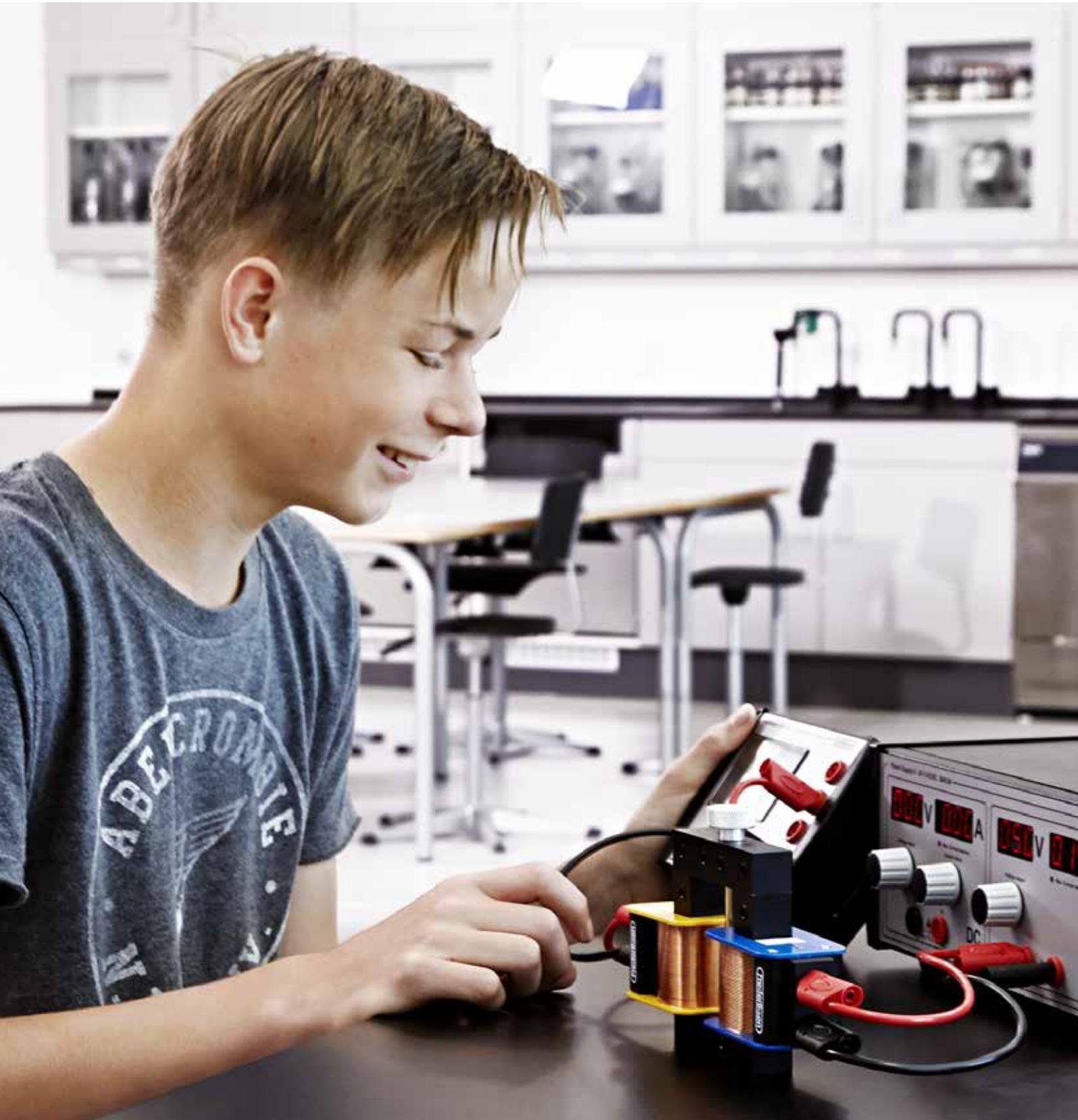
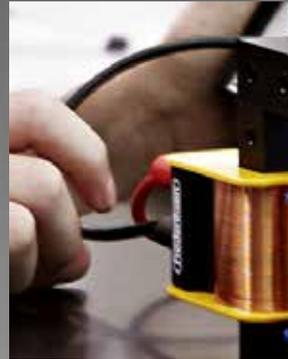


# PHYSICS



# PHYSICS



Today, perhaps more than ever, science holds the key to our future. At Frederiksen, we believe that encouraging enthusiasm for science is not an additional option – we simply have to inspire innovative young minds if we are to meet the challenges of our future. Why? Because science matters, and because the rising generation of scientists, engineers and technicians are shaped in a classroom.

We know that not everybody is meant to be a scientist. But we believe that everybody has the right to learn. And learning is encouraged through dedicated teachers and great teaching conditions.

Our range is continuously being expanded with new products. We invite you to visit our website to see what's new, and get inspiration and ideas.

At Frederiksen, we like to do more than simply supply goods. Many of the products also include extras such as instructions or other support material, prepared by us or members of our network. One important aspect of our service is our employees, with their scientific backgrounds, who are always ready to help and answer your questions.



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Monday-Thursday: 8.00-16.00  
Friday: 8.00-15.30



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# NEW

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# NEW

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# Conditions of sale

## **Products**

Frederiksen reserves the right to amend product specifications without prior notice.

The equipment is intended for educational use and should not be used for other purposes.

## **Returns**

Items may only be returned following prior agreement.

## **Warranty**

Frederiksen offers a warranty of two years from the invoice date.

The warranty covers manufacturing and material defects. The warranty does not cover equipment that has been mistreated, poorly maintained, damaged or incorrectly assembled and equipment that has not been repaired by our workshops.

## WEIGHTS AND MEASURES

Weights and measures

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## WEIGHTS AND MEASURES

### Trundle wheel

Measuring wheel with handle. Indicates each revolution with a click corresponding to 1 metre. Graduated in cm, 5 cm and 10 cm divisions.

Item no. 142800



### Tape measure, plastic 10 m

Graduated in mm, cm and metres. Glass reinforced plastic tape measure in casing with winding mechanism.

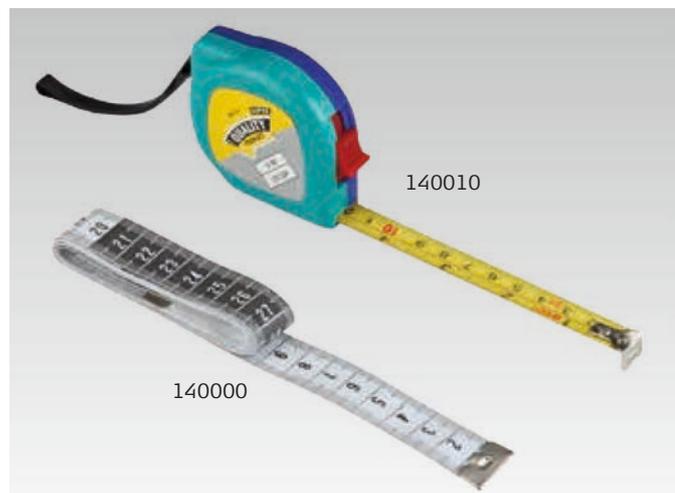
Item no. 140015



### Ranging pole

Length 1.7 m with red and white markings and metal tip.

Item no. 140030



### Ruler, wood

Graduated in mm and cm. Wooden ruler marked horizontally, with metal end fittings. Cross-section: 25 x 5 mm.

Item no. 140500 length 50 cm

Item no. 140510 length 100 cm

### Tape measure, plastic

Length: 150 cm. Graduated in mm and cm.

Item no. 140000

### Tape measure, metal

Length: 200 cm. Graduated in mm and cm. Metal tape measure in self-retracting casing.

Item no. 140010



### Tape measure, 20 m, steel

Steel tape measure in sealed ABS casing with comfortable grip. Practical belt hook. Reverse side of tape is blank. Length: 20 m.

Item no. 140020



### Measuring rod, square section

Length: 100 cm. Square section: 20 x 20 mm. Graduated in cm and dm. Colour printed.

Item no. 141000

### Folding ruler

Length: 200 cm. Millimetre graduations on both sides. Plastic.

Item no. 140530





### Distance meter, electronic

Simple, contactless, ultrasonic distance measurement. Can measure, for example, the length, width and height of a room and calculate the area and volume. Range 15 m. Battery not supplied. (9 V, e.g. 351010)

Item no. 141516

### Caliper gauge, plastic

Measuring range: 0-150 mm. Overall length: 170 mm. Equipped with a depth gauge and vernier scale for reading 1/20 mm increments.

Item no. 144000



### Caliper gauge, stainless steel

High-quality caliper gauge with a measuring range of 0-160 mm / 0-5.5 inches. With a vernier scale for reading 1/20 mm increments. Depth gauge and locking mechanism.

Item no. 144020



### Caliper gauge, digital

Simple to use and easy to read. With zeroing button. Resolution: 0.01 mm. Jaw length: 40 mm. Largest opening: 154 mm. Supplied in a robust case, including battery.

Item no. 144030

### Micrometer screw gauge

Maximum measuring length: 25 mm. Precision: 0.01 mm. Equipped with a torque screw.

Item no. 145050



### Mole demonstration kit

Use this kit to visualize the concepts of mole and amount of substance. Students will develop a greater understanding of the concept of the mole, as well as a greater knowledge of the physical properties of each element.

The kit contains four solids, three bottles for liquids together with 10 balloons for atmospheric air. Common to all substances is that they all consist of 1 mole. The three liquids are not included and have to be supplied at first use.

Item no. 141510

### Mole balloon, 24 L

Unit: 10 pcs

Item no. 151215



Spare balloons for 151210 Mole demonstration kit. Printed on the balloons is the text  $N_2$ ,  $O_2$ , Ar,  $CO_2$ , 29.0 g

As 1 mole of many different gasses have a volume of ca. 24 L at a pressure of 1 atm, the balloons can be used to visualize the difference between the masses of e.g. hydrogen and liquefied petroleum gas.

### Gun clinometer

A simple angle gauge in impact-resistant plastic for measuring the height of distant objects such as houses, trees and towers. Simple trigonometry formulas are used for the calculation. The necessary tables are supplied. Aim the "gun" at the highest point on the object and simultaneously set the angle, in degrees, between the horizon and the highest point.

Item no. 142905



### Measuring jug, 0.5 L

Plastic half-litre measuring jug with volume scale. Made from impact-resistant plastic. Capacity: 0.5 litre. Graduation: 10 ml.

Item no. 146500



### Measuring jug, 1 L

Plastic one-litre measuring jug with volume scale. Made from impact-resistant plastic. Capacity: 1.0 litre. Graduation: 10 ml.

Item no. 146510



### Measuring spoons

6 pcs from 1/8 teaspoon to 1 tablespoon.

Item no. 146805



### Weights, cubic centimetre

1 g weights in the form of plastic cubes with side length of 1 cm. The cubes have holes and studs, allowing them to be combined into larger units. They can only be combined into planes, not 3D figures. Supplied in a plastic bucket containing 1,000 pcs in 10 different colours.

Item no. 146900



### Graduated cylinder, tall

Borosilicate glass with hexagonal base. The colour scale is melted into the glass surface, making it highly resistant.

No.	Contents	Graduation	Height
011020	10 ml	0.2	150 mm
011030	25 ml	0.5	170 mm
011040	50 ml	1	210 mm
011050	100 ml	1	250 mm
011060	250 ml	2	330 mm
011070	500 ml	5	360 mm
011080	1000 ml	10	450 mm
011090	2000 ml	20	570 mm



### Graduated cylinder in PMP plastic, tall

Crystal-clear PMP plastic with raised scale and hexagonal base. Temperature resistant from 0° to +120° C.

No.	Contents	Graduation	Height
011810	10 ml	0.2	145 mm
011830	25 ml	0.5	170 mm
011840	50 ml	1	200 mm
011850	100 ml	1	250 mm
011860	250 ml	2	315 mm
011870	500 ml	5	360 mm
011880	1000 ml	10	440 mm

## WEIGHTS AND MEASURES



### Scale, pocket scale, 200 g / 0.01 g

Handy pocket scale with hinged lid. Case and weighing pan included. High precision at low cost.

Weighing range: 200 g

Precision: 0.01 g

Uses 2 x 1.5 V AAA batteries, not included

**Item no. 102770**



### Electronic laboratory scale by Kern

Quality scale from Europe's oldest weighing instrument maker. Comes with a 3-year guarantee. Powered by 9 V battery or mains adapter (included). Dimensions: 165 x 230 x 80 mm

No.	Model	Weighing range
102930	440-47N	2000 g / 0.1 g
102950	440-33N	200 g / 0.01 g



### Digital scale 5 kg/1 g

Digital scale with a slim design, large weighing plate and easy-to-read LCD display. Tare function.

Weighing range: 0 - 15000 g.

Precision: 1 g

Display: 5-digit LCD

Supplied with 3 x 1.5 V AAA batteries.

WxDxH: 200 x 200 x 21 mm

**Item no. 102808**

### Double-pan balance on stand

Sensitive balance scale on stand. Features a knife-edge bearing in hardened steel, zeroing screws, 28 cm long needle with scale, removable 120 mm diameter weighing pans, and plate for buoyancy experiments. The balance scale has a sensitivity of 50 mg. Dimensions: 35 x 20 x 40 cm



**Item no. 091600**

### Scale, 750 g / 0.1 g

Digital scale with tare and count function.

Weighing range: 0 - 750 g

Precision: 0.1 g

Supplied with 2 x AAA batteries

**Item no. 102890**



### Scale, 300 g / 0.01 g - with wind shield

Digital scale with tare and wind shield

Weighing range: 0 - 300 g

Precision: 0.01 g

Supplied with plastic wind shield and 2 x AA batteries

**Item no. 102900**



### Balance with weights

A reliable balance scale in hard plastic. Includes 10 brass weights (2 x 1 g, 2 x 2 g, 2 x 5 g, 2 x 10 g, 1 x 20 g and 1 x 50 g). Includes balance block for zeroing. The weighing dishes are capacious and removable. Weighs up to 2,000 g.

**Item no. 091700**



### Weights set

Weights set comprising 16 weights from 50 g to 10 mg (50 g - 20 g - 2 x 10 g - 5 g - 2 x 2 g - 1 g and 500 mg - 2 x 200 mg - 100 mg - 50 mg - 2 x 20 mg - 10 mg). Supplied in a plastic box with tweezers and plastic cover over the mg weights.

**Item no. 095530**

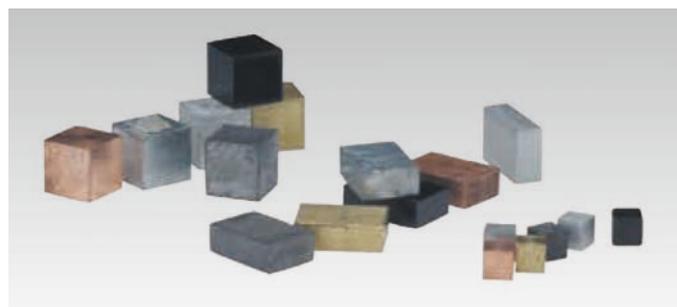


## Specific gravity cubes

For demonstrating the specific gravity of different materials. 6 different substances are included in the set: aluminium, iron, zinc, copper, lead and wood. The cubes measure 10 x 10 x 10 mm. Supplied in a plastic box.



Item no. 150000



## Specific gravity blocks

Box containing specific gravity blocks in 6 different materials: iron, lead, aluminium, zinc, copper and brass. Three sizes of each material are included.

Item no. 150010

## Specific gravity weights

3 different weights of the same volume: aluminium, copper and brass. The weights are equipped with a suspension hook and supplied in a plastic box.



Item no. 151010

## Specific gravity weight

Brass weight for determining specific gravity and for measuring volumes. Height: 28 mm.



Item no. 151080



## Specific gravity weights

6 different materials: aluminium, iron, zinc, bismuth, wood and cork. 3 of the weights have the same mass and diameter: aluminium, zinc and bismuth (41 gram, 22 mm). The other weights have different masses and sizes. The weights are easy to measure. Supplied in a plastic box.

Item no. 151005

## Specific gravity balls

Take one in each hand and feel if they weigh the same. Can steel balls float? This set allows many interesting questions to be posed to stimulate students' imaginations.



Item no. 152500



## Hydrometer

For determining the specific gravity of liquids. SG range: 1,000-2,000 g/cm<sup>3</sup>. Precision: 0.010 g/cm<sup>3</sup>. Length: 30 cm.

Item no. 153010



## Hydrometer with thermometer

For determining the salt content of sea water. Temperature table included.

Overall length: 26.5 cm.

Item no. 153030

## Alcohol meter

Floating weight for measuring the alcohol content of liquids. Calibrated for 20 °C.

Measurement range: 1 - 100 vol.%

Graduation: 1/1

Length: 30 cm

Item no. 153090



## Thermometer, Galileo

Based on the principle that the density of a liquid changes in proportion to its temperature. The temperature is displayed by means of small aluminium tags hanging from 7 small bulbs. The difference in the weight of the bulbs is less than 2/1,000 g, which yields a precision of 1 °C. When the temperature rises, the bulbs descend slowly; as the temperature falls, the bulbs rise up. The temperature is read from the tag on the lowermost floating bulb. Height: 44 cm. Measurement range: 18 to 24 °C

Item no. 060003



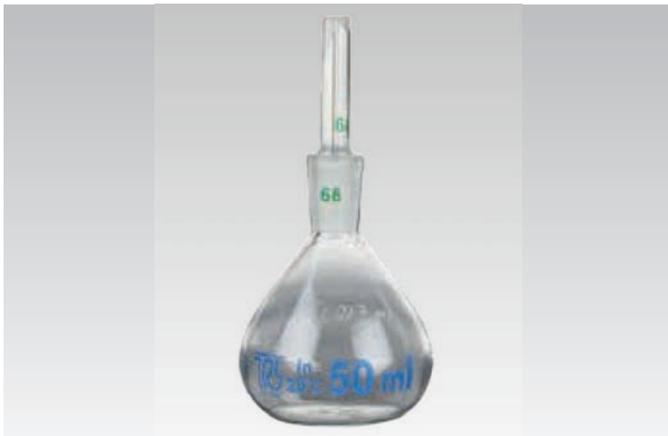
## WEIGHTS AND MEASURES



### Material samples

Set of 8 rods. Used for specific gravity experiments and so forth. Made from aluminium, lead, nylon, glass, rubber, iron, copper and brass. Supplied in a plastic box with a clear lid. Rod length: 102 mm.

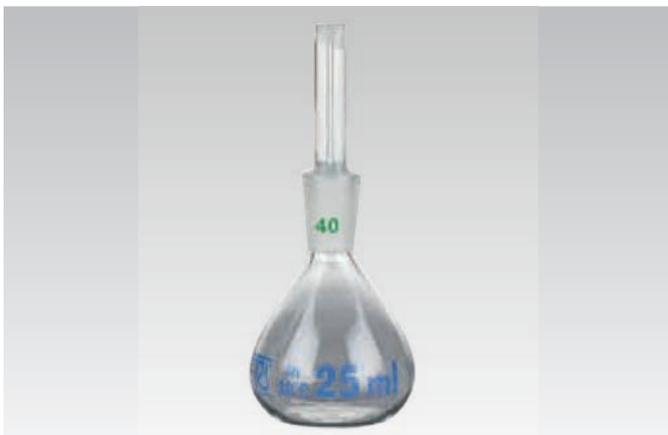
Item no. 269000



### Pycnometer, calibrated

For determining the specific gravity of liquids. Made from glass with a ground stopper. The volume is close to 50 mL - the precise value to three decimal places is inscribed on the flask.

Item no. 152000



### Pycnometer, uncalibrated

The same as 152000, but uncalibrated. Volume: 25 mL.

Item no. 152010

### Overflow vessel, aluminium

Solid aluminium model, for stones, weights etc. Can be used for Archimedes' Law and for determining specific gravity, for example.

Dimensions: Ø 77 x 127 mm

Item no. 164520



### Stop clock, table-top model

Quartz-controlled, analogue demonstration stop clock for table-top use or wall-mounting. Large dial with luminescent marking of both digits and hands.

The outer scale shows minutes and seconds from 0-60; the inner scale shows hundredths of minutes. Battery supplied.

Dimensions: 175 x 130 x 40/95 mm

Dial: Ø 110 mm

Item no. 149520



### Digital stopwatch

With time and date display: Hours, minutes, seconds, month, date and day of the week.

Precision: 1/100 seconds for the first 30 mins to 1 sec in 24 hours.

Option for displaying split times.

Hour setting: 12/24 hour mode (selectable).

Alarm and snooze function.

Battery: LR1130 (item no. 351510) included.

Weight: 40g

Item no. 148550



### Electronic counter

Universal counter and stopwatch that can be controlled by microphones, photo cells, electrical impulses and switches. Memory function makes it ideal for collision tests etc. Frequency counter. Pulse counter for radioactivity experiments. See the complete description on page 59.

**Item no. 200250**



### Digital countdown timer

Countdown timer in brushed aluminium. Longest setting period: 99 min. and 59 secs. Minutes: 35 mm tall digits. Seconds: 25 mm tall digits. Fold-out stand on the back. Integral magnet on the back for attaching to magnetic metal plate. External dimensions: 84 x 77 x 14 mm. Supplied with battery 1.5 V (AAA)

**Item no. 149205**



### Stopwatch

Designed for timing using photo cells, microphones, free-fall devices and other mechanical and electronic switches. Stopwatch function can also be manually activated. This electronic stopwatch is supplied with batteries and mains adapter. It can be used in conjunction with: microphones 248510 and 248600 (with cable 248601), photo cells 197550, 197515 and 197570 (with cable 248601) and free-fall apparatus 198010.

**Item no. 200260**

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## THERMOMETERS



### Glass laboratory thermometers

No.	Range	Column	Background	Resolution	Length	Diameter
057520	-10 to +360 °C	green	white	2/1	300 mm	Ø 6-7 mm
058210	-16 to +110 °C	red	white	1/1	260 mm	Ø 8 mm
058225	-20 to +110 °C	red	white	1/1	300 mm	Ø 7 mm
058500	-20 to +110 °C	red	yellow	1/1	275 mm	Ø 6 mm
059010	-10 to +110 °C	red	white	no scale	260 mm	Ø 6.5 mm

Note: None of the thermometers contains mercury. 057520 is suitable for making boiled sweets. 058500 has a triangular section to stop it rolling.

### Thermometer on plastic backing plate

Ideal educational thermometer. The thermometer column with its red, mercury-free liquid is recessed into the plastic plate and held firmly – even in boiling water.

Temperature range: -50 to +110 °C

Resolution: 2/1

Dimensions: 38 x 7 x 163 mm

Item no. 060010



### Maximum/minimum thermometer

The thermometer displays the highest and lowest temperatures within a period and has a reset button. Fitted in a black plastic casing with red alcohol column.

Measurement range: -30 °C – +50 °C

Item no. 060510



### Room thermometer

Blue, mercury-free column on a white background mounted on a white plastic plate.

Temperature range: -30 to +50 °C

Resolution: 1/1

Dimensions: 180 x 16 mm

Item no. 060000



### Field thermometer

Prismatic thermometer, mercury-free, with white background and blue column. Mounted in plastic housing with pocket clip.

Temperature range: -20 to +50 °C

Resolution: 1/1

Length: 135 mm

Item no. 061010



### Demonstration thermometer

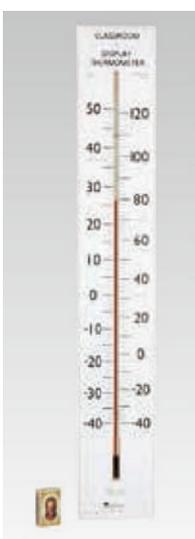
75 cm tall thermometer, wall-mountable, for use in classes.

With a Celsius scale (-40 – 50 °C) and a Fahrenheit scale (-40 – 120 °F).

Red column.

Resolution: 1/1

Item no. 059100



### Field thermometer

Small plastic thermometer with pocket clip. An excellent field thermometer which rapidly displays the correct temperature. Withstands minor knocks and bumps.

Measurement range: -20 – +50 °C

Length: 130 mm

Item no. 061006

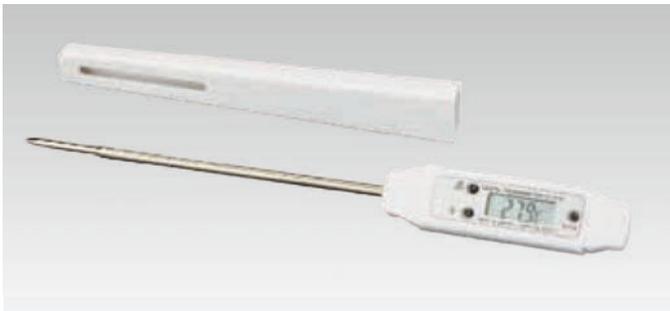




**Thermometer, digital**

Digital thermometer with a measurement range of -50 to +300 °C, resolution of 0.1 °C and absolute precision of 1 °C. Equipped with max/min, on/off and hold functions. Turns off automatically after 10 minutes. Length: 240 mm

Item no. 062102



**Thermometer, lab**

Suitable for laboratory use, as a sugar thermometer or as a field thermometer. Turns off automatically after 5 minutes. The thermometer is waterproof.

Measurement range: -40 to +200 °C Resolution: 0.1 °C

Item no. 062102



**Thermometer, infrared**

Infrared thermometer for measuring surface temperature by aiming it at an object or surface. After a second, the temperature is shown in the display. Optical resolution: 1:1, i.e. at a distance of 1 m, the temperature is measured over a circular surface 1 m in diameter. At a distance of 5 m, a 5 m wide spot is measured and so forth.

Measurement range: -20 to +220 °C

Resolution: 0.1 °C

Precision: +/- 2 °C / 2% (highest)

Item no. 260801

**Thermometer, digital mini with lead**

Small, handy thermometer with stainless steel temperature probe.

With max/min temperature memory.

Measurement range: -50 to 200 °C

Item no. 260704



**TYPE K**

**Digital thermometer type 305**

A robust digital thermometer for type K thermocouples. One thermocouple is included. The thermometer has "Hold" and "Max" buttons.

Temperature range: -50.0 to +1300 °C

Resolution: 0.1 or 1 °C

Display: 3 1/2 digit LCD

Dimensions: 147 x 70 x 39 mm

Battery: 9 V (3510.10)

Precision (-50 - 1000 °C): 0.3% + 1°C

Precision (above 1000 °C): 0.5% + 1°C

(Plus the tolerance of the probe.)

Item no. 260610



**Digital thermometer type 307**

The same as type 305 but with two inputs for type K thermocouples, and can also display the temperature difference. Two thermocouples (2606.53) are included.

Item no. 260615



**Thermocouples, type K**

Robust low-cost thermocouples, type K (NiCr-Ni), fitted with a blade connector and strong coiled cable. Can be used on all devices that accept thermocouples of this type.

The extra-thin wire probe 2606.54 uses two 0.08 mm wires and is therefore especially suitable for measurements where the heat capacity must be as low as possible.



No.	Type	Size	Max. temp.
260650	Liquid probe, pointed	Ø 3 x 105 mm	800 °C
260651	Liquid probe	Ø 3 x 200 mm	800 °C
260652	Air probe	Ø 8 x 200 mm	800 °C
260653	Wire probe	120 cm long	200 °C
260654	Wire probe, thin	120 cm long	180 °C

**Thermocouples, type K (NiCr-Ni) probes for digital thermometers**

No.	Type	Size	Max. temp.	Time constant
386801	Liquid probe UHT 6	Ø 3 x 150 mm See photo	1200 °C	1.3 s
386805	Air probe	Ø 6 x 185 mm Plastic handle	250 °C	0.5 s

Time constant means the time it takes for the probe to register 63.2% of full display.



## PRESSURE IN LIQUIDS

### Archimedes cylinder set

For demonstrating Archimedes law. Consists of a plastic weight with an eye and a transparent plastic container with two nylon loops: The upper loop is for suspension from a dynamometer or a balance, while the weight hangs from the lower loop. The plastic weight is immersed in water and therefore subject to buoyancy equivalent to the weight of the displaced volume of liquid. The buoyancy is compensated for by filling the plastic container with water. The inner volume of the container equals the volume of the plastic weight.

**Item no. 164010**



### Overflow vessel, aluminium

Solid aluminium model for stones, weights etc. A body is immersed in the cylindrical vessel, making the displaced liquid run out through the overflow pipe where it can be collected. Suggested applications: Archimedes' Law and determining specific gravity.

Dimensions:  
Ø 77 x 127 mm

**Item no. 164520**



### Cartesian devil

For demonstrating liquid pressure. The figure is immersed in a container of liquid and sinks when the pressure in the container is increased. Hollow glass figurine measuring approx. 45 mm tall. Container not included.

**Item no. 166000**



### Hydraulic press model

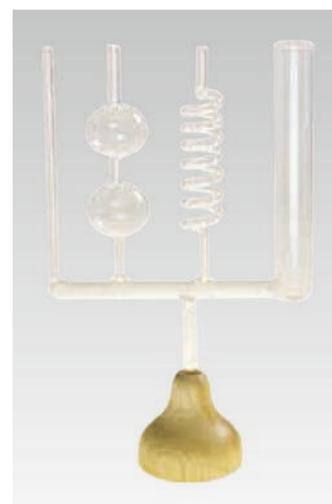
Two syringes of volumes 2 and 20 mL connected by a short PVC tube. The difference in diameter of the syringes illustrates the hydraulic press principle.

**Item no. 165000**

### Liquid level apparatus

The level of the liquid remains constant, regardless of the shape of the interconnected tubes.

**Item no. 163000**



### Plastic hydrostatic pressure bottle

Made from plastic, with 3 side holes. When filled with water, the shape of the jets demonstrates that pressure increases down through the liquid.

Dimensions: Ø 110 x 250 mm

**Item no. 161500**



## AIR PRESSURE

### Gas model with piston

In conjunction with 218500 Electromagnetic vibrator, the steel balls illustrate molecules in different states. The steel balls in motion represent gas molecules which lift a plastic piston due to repeated collisions. The model is supplied with piston, balls and a support for placing the apparatus on an overhead projector. Can be used to demonstrate gas states, Brownian motion and the boiling of a liquid. Excludes Electromagnetic vibrator.



Item no. 218555



### Boyle-Mariotte apparatus

For demonstrating the relationship between volume and pressure at constant temperature. The apparatus consists of a graduated cylinder with a piston. The cylinder is connected to a manometer by a narrow channel, to allow the pressure to be read. The cylinder is fitted with a screw valve.

Manometer:  $\varnothing$  100 mm

Length: 350 mm

Item no. 180500

### Barometer

Aneroid barometer in round metal case. Suitable for wall-mounting and use in the field.

Dimensions:  $\varnothing$  72 mm

Range: 940 – 1080 hPa

Range: 710 – 810 mmHg

Item no. 177110



### Metal tin with lid

Can be used to demonstrate that pressure within a trapped gas rises as temperature increases.

Dimensions:

$\varnothing$  100 x 125 mm

Item no. 264700



### Pneumatic lighter

For demonstrating the temperature rise when a confined volume of air is compressed. A highly flammable material placed in the transparent cylinder will be ignited when the piston is pushed down by hand. The lighter consists of a cylinder and piston, spare sealing rings and flammable material. A small piece of kitchen towel, paper napkin or newspaper can also be used. Supplied with instructions.

Item no. 264900



### Gasoline cannon with lighter

Consists of a plexiglas tube with a piezoelectric igniter (appearance may vary) fitted in a rubber stopper. The inside of the tube is moistened with a small amount of gasoline, and the supplied cork is inserted. When the igniter is operated, the explosive air mixture is ignited and the cork is fired.

Dimensions:  $\varnothing$  52 x 710 mm

Item no. 264800



### Urine bag 1500 ml

Plastic bag fitted with  $\varnothing$  6.5 mm plastic tube. Can be used to demonstrate the ability of air to support heavy objects, e.g. lifting a book by inflating the bag underneath it. Also suitable as storage for small volumes of gases. Valve not included. (039510 Pinch valve is suitable).

Volume: approx. 1.5 L. Pack of 25.

Item no. 073100

## VACUUMS



### Water jet vacuum pump, plastic

Made from polypropylene. 1/2" and 3/4" pipe threads. Coupling nut with O ring. Fitted with a check valve. Overall length 270 mm.

Item no. 069020



### Water jet vacuum pump, brass

Chrome-plated brass with coupling nut with 1/2" thread. Fitted with a check valve. Conical 11-12 mm hose connector. Overall length 140 mm.

Item no. 069030

### Water jet vacuum pump with manometer

Chrome-plated brass with manometer graduated from 0 to -1.0 bar. With coupling nut with 1/2" thread and conical 11-12 mm hose connector.

Precision: 0.025 bar. Overall length 160 mm.

Item no. 069040



### Vacuum pump, manually-operated

Manual vacuum pump with built-in meter.

Item no. 069050

### Vacuum grease, silicone

High-vacuum silicone grease, also suitable as a grease for glass stoppers. Withstands temperatures from -40 to +250 °C. Jar containing 60 g of grease.

Item no. 890100-1



### Vacuum pump, 2-stage

Vacuum pump with a wide range of laboratory and industry applications. Sturdy, long-life construction. 2-stage rotary vane vacuum pump with oil injection and lubrication system. Topping-up oil included, but it is recommended to order extra 069530 Vacuum oil. Hose fitting: Ø8 mm, fits 0375.40 Vacuum hose.

Suction capacity at 750 mm Hg: 70 L/min

Ultimate vacuum: 0.05 mBar

Motor: 245 W 1440 rpm

Net weight: 12.5 kg

Dimensions: 315 x 240 x 120 mm

Connection: 230 V / 50 Hz

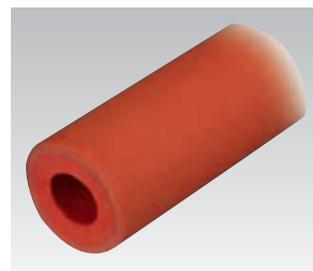
Item no. 069525

### Vacuum hose

Vacuum hose in soft rubber suitable for the water jet vacuum pumps, the vacuum pump and the air pump plate.

Dimensions: Ø 8/18 mm

Item no. 037540



### Vacuum oil

High-quality oil (1 L) for electrical vacuum pumps.

Item no. 069530



**Vacuum meter**

Scale from 0 to -1.0 bar with 0.05 bar graduations. Includes hose fitting.

Manometer: Ø 50 mm

Item no. 070010



**Bell jar with knob**

Compatible with 178000 Air pump plate.

Dimensions: Ø 180 x 310 mm (internal approx. 240 mm)

Item no. 178510



**Air pump plate with sockets**

Use with 178510 Bell jar to demonstrate the physics of low pressure. Made from PVC with rubber feet. Vacuum access with tap and thumb screw for return air. Fitted with two electrical conduits terminating in telephone jack sockets. Hose connector diameter: 10 mm.

Dimensions: Ø 215 x 40 mm

Item no. 178000

**Bell jar with tube**

Same as 178510 but with a tube for a rubber stopper (e.g. 1790.01 Rubber stopper 31/38 mm).

Item no. 178520



**Dasymeter**

For demonstrating the buoyancy of air when placed in a vacuum. Hollow plastic ball suspended on a bar with an adjustable weight.

Dimensions: 135 x 120 x 6 mm

Item no. 174000

### Jar with hose connector

For simple experiments with overpressure and underpressure. Ordinary jam jar with screw top and seal, with a nickel-plated hose connector in the lid that fits 038515 and 038520 PVC hoses. The hose connector is sealed with an O ring. Dimensions: Ø 98 x 178 mm  
Opening: Ø 82 mm

**Item no. 178600**



### Metal can for vacuum experiments

For demonstrating pressure phenomena. Supplied with stopper and hose connector.

Dimensions: Ø 92 x 225 mm

**Item no. 173200**



## THERMAL EXPANSION



### Magdeburg hemispheres

For demonstrating the effects of atmospheric pressure. Made from chrome-plated brass with rubber gasket. With strong handles, hose connector and valve. Ø 110 mm.

**Item no. 173500**

### Gasket

Gasket for 173500 Magdeburg hemispheres.

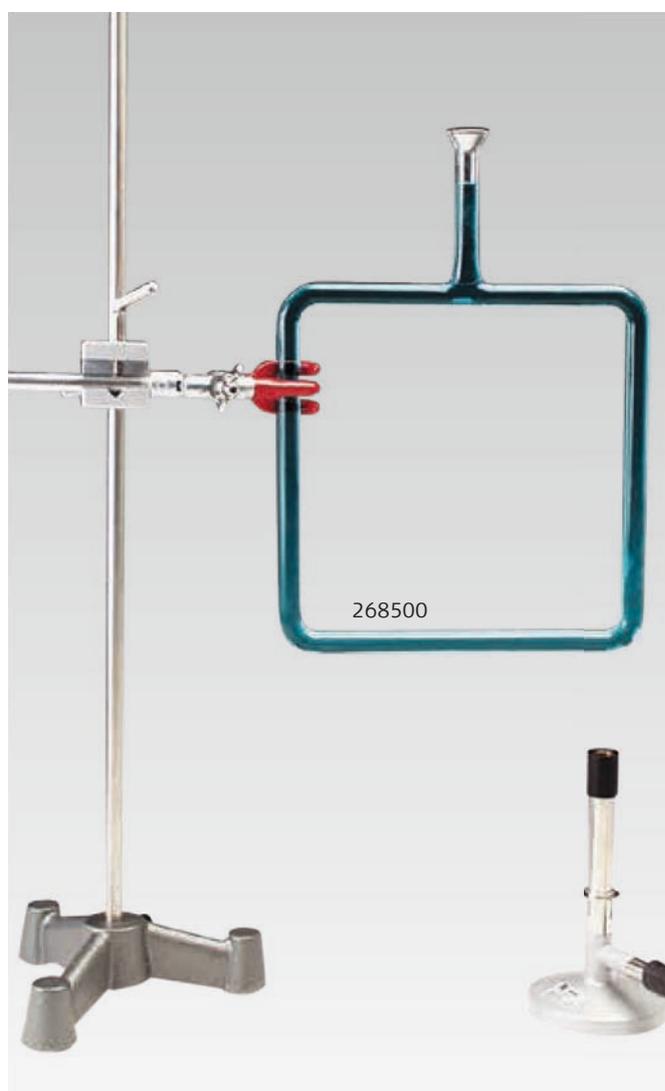
**Item no. 173501**



### Magdeburg hemispheres, rubber

Student version for demonstrating the effects of atmospheric pressure. Press the two rubber cups together and try to pull them apart again.

**Item no. 173515**

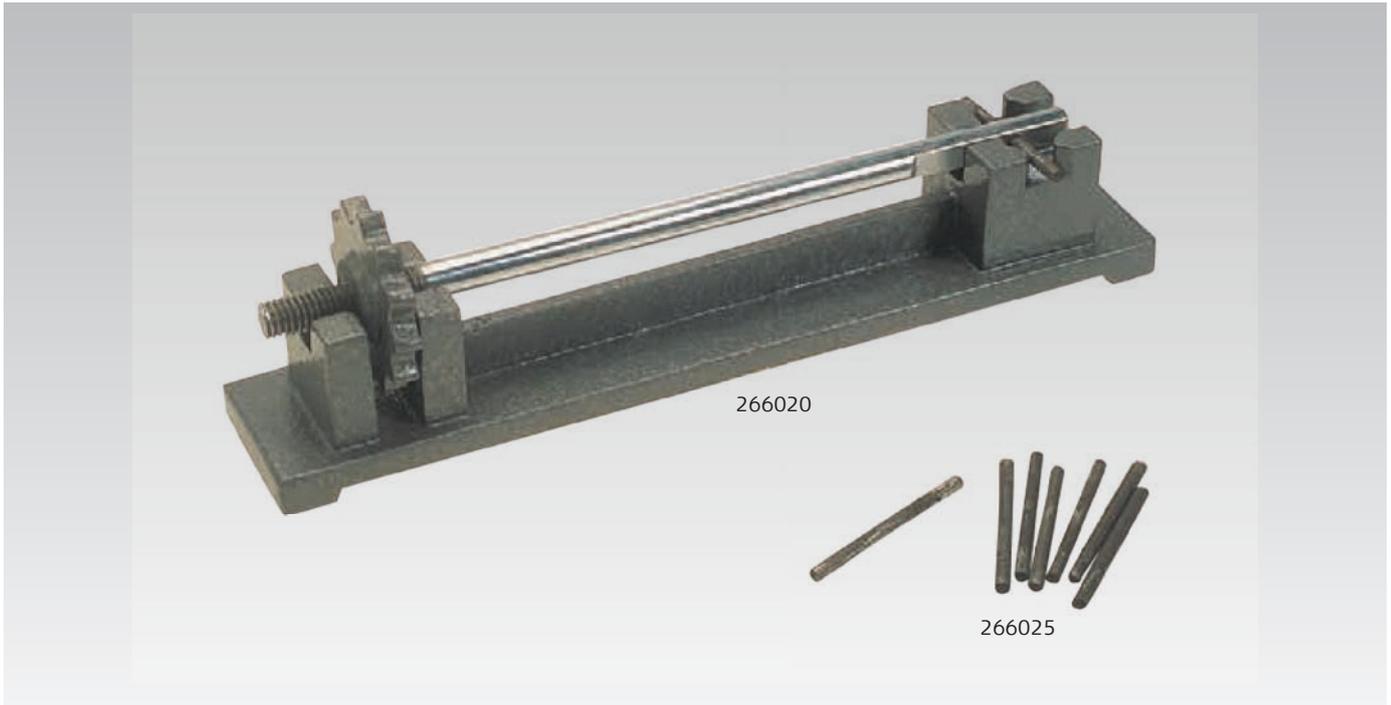


### Circulation pipe

To demonstrate circulation in a pipe system due to heating. To be filled with water and sawdust. By heating one end of the pipe, the circulation can be clearly observed. Made from Ø 10 mm glass pipe with hopper for filling.

Dimensions: 280 x 200 mm

**Item no. 268500**



### Bar-breaking apparatus

For demonstrating expansion due to heating and contraction due to cooling. Supplied with 10 cast iron rods which will break when the centre bar expands or contracts from heating or cooling.  
Length: 320 mm

Item no. 266020

### Bars for bar-breaking apparatus

Pack of 50 cast iron bars for 2660.20 Bar-breaking apparatus.  
Dimensions:  $\varnothing$  4 x 80 mm

Item no. 266025



### Ball and ring

For demonstrating the expansion of solid bodies due to heat. Consists of a brass ring and a ball, each fitted with a plastic handle. Only the ball itself needs heating, and just for a short while. Instructions supplied.

Ring ext./int.:  $\varnothing$  38/25 mm

Ball:  $\varnothing$  25 x 25 mm

Length: 260 mm

Item no. 266500

### Bimetallic strip

Bimetallic strip with a notch for fixing with a clamping screw.  
Dimensions: 0.5 x 10 x 150 mm

Item no. 267000



## THERMAL ENERGY

### Specific heat weights

Set of three specific heat weights consisting of:  
272502 Aluminium 100 g  
272501 Brass 200 g  
272504 Bismuth 200 g

Item no. 272510



### Specific heat cylinders

No.	Metal	Size
272511	Brass, 100 g	Ø 25x31 mm
272501	Brass, 200 g	Ø 25x55 mm
272502	Aluminium, 100 g	Ø 30x61 mm
272506	Bismuth, 100 g	Ø 25x26 mm
272504	Bismuth, 200 g	Ø 25x46 mm

### Insulated cups

Styrofoam cups for experiments that require low heat capacity and good insulation. Supplied in packs of 25.

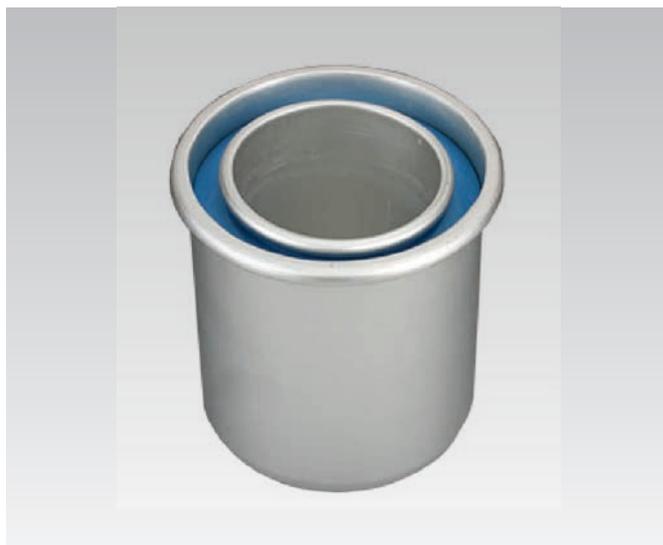
No.	Volume (approx.)	External diameter	Height
274500	180 ml	7.5 cm	8.5 cm
274650	250 ml	8 cm	10 cm
274550	350 ml	8 cm	11 cm
274600	450 ml	11 cm	8 cm



### Lid with immersion heater

Used with 274500 Insulated cups to confirm Joule's law. Plastic lid with hole for inserting a thermometer. Fitted with 2.2 ohm heating element connected to 2 telephone jack sockets.  
Dimensions: Ø 65 x 75 mm

Item no. 274510



### Calorimeter

Consists of inner and outer beakers separated by styrofoam insulation. Made from aluminium with beaded edges and polished base.

Capacity: 350 ml.

Weight, inner beaker: approx. 84 g.

Dimensions: (outer) Ø 100 x 120 mm, (inner) Ø 70 x 90 mm

Item no. 274050

Item no. 274005 Stirrer for calorimeter. Length: 160 mm



### Joule's law apparatus

Used with 2740.00 Calorimeter to confirm Joule's law. Lid in clear acrylic with stirrer and hole for inserting a thermometer. Fitted with 2 x 2.5 ohm heating coils connected to 3 safety sockets.

Height: 120 mm

Item no. 274010



**Immersion heater**

300 Watt immersion heater for connection to 220 V AC. Heating element: Ø 45 mm. Overall length including handle. 160 mm

**Item no. 275010**



**Leather pouch with 2 kg of lead shot**

Used for experiments on the conversion of kinetic energy to thermal energy. The shot is in a robust leather pouch with a cap. The leather bag is dropped repeatedly from a specific height, and the rise in temperature in the lead shot is measured with a thermometer.

**Item no. 275500**

**HEAT RADIATION**



**Heat radiation plate**

Used to demonstrate the significance of the surface for heat radiation. Steel plate with one bright and one black side, fitted to a nickel-plated shaft with a wooden handle. The plate is heated and the sides held alternately to the cheek.

Dimensions: 175 x 175 x 1 mm. Length: 370 mm

**Item no. 270000**

**Crooke's radiometer**

Demonstrates the conversion of radiant energy into kinetic energy. Rotor consisting of 4 mica discs painted black on one side held in a glass ball with a base.

Ball: Ø 70 mm

Base: Ø 60 mm. Height: 210 mm.

**Item no. 269500**

**Crooke's radiometer, double**

The same as 270000 but comprising 2 rotors which turn in opposite directions.

Ball: Ø 70 mm.

Base: Ø 70 mm. Height: 290 mm.

**Item no. 269510**



**Stefan-Boltzmann lamp**

For investigating the radiation intensity of a hot object and confirming the Stefan-Boltzmann law. The temperature is determined on the basis of the filament's electrical resistance and reaches more than 2,500 K. Separate leads run from the lamp to an extra set of safety sockets in order to determine the voltage drop across the filament without any contribution from the leads and connectors.

**Item no. 277022**

**IR sensor, broadband**

This sensor is sensitive to electromagnetic radiation in the wavelength range from 0.25 µm to 20 µm, i.e. from visible light out into the infrared range, i.e. thermal radiation. The detector's response is independent of wave length and the output signal is therefore proportional to the radiant flux per unit area. The sensor is individually calibrated. The conversion factor from volts to W/m<sup>2</sup> is stated on the sensor. The unit is fitted with a DIN connector and can be used with 251560 Battery box, since the sensor requires 5 V DC. The output can be read using an ordinary voltmeter. The sensor can be directly connected to Pasco's analogue inputs. Incl. support, but not the base.

**Item no. 287281**



## MELTING AND CASTING



### Rose's metal

Used for melting point experiments. Consists of an alloy of 25% lead, 25% tin and 50% bismuth. The metal's melting point is below the boiling point of water and is used for the observation of phase changes, determining melting point and so forth. Supplied as a bar. Weight approx. 100 g.

**Item no. 272030**



### Tin

Pure tin rods suitable for casting.

**Item no. 888000-2 250 g**

**Item no. 888000-4 1 kg**



### Crucible

Iron crucible with wooden handle. Overall length 280 mm. Ø 75 mm.

**Item no. 037000**



### Mould for tin figures

Molten tin is poured into the refractory mould. Once the tin has solidified, the mould can be opened and the resulting figure removed. The mould can then be reused. The mould is fitted with a handle.

Dimensions: 90 x 90 mm

**Item no. 272200**



### Heat pack

For demonstrating heats of fusion and solidification. When the pack is activated, the sodium acetate contents solidify, causing the temperature to rise to the compound's melting point (approx. 35°C). The experiment can be repeated after heating the pack in water.

**Item no. 272400**

## CONDUCTION OF HEAT

### Material samples

Set of 8 rods. Used to demonstrate the thermal conductivity of different materials. Can also be used for experiments with specific gravity, since all the rods have a volume of 2 cm<sup>3</sup>. Made from aluminium, lead, nylon, glass, rubber, iron, copper and brass. Supplied in a plastic box with a clear lid.

Length: 102 mm. Weight: 130 g.

Item no. 269000



### Heat conduction device

A tealight is used to heat the metals simultaneously in the centre. The heat spreads at different speeds through the metals to the recesses, where candle wax can be placed and seen to melt.

Item no. 670081



### Heat conduction device

For demonstrating the differing thermal conductivities of materials. A holder with rods of steel, brass, copper and aluminium. The rod ends are drilled out to accept wax or sulphur from a match head. Heating the iron ring will cause the sulphur to ignite, depending on the thermal conductivity of the rods. Fitted with a steel supporting rod with a wooden handle. Dimensions: 290 x 140 mm

Item no. 269010

### Heat conduction rods

Consists of four metal rods of steel, brass, aluminium and copper embedded in a plastic holder. Each of the rods has a liquid crystal indicator to show the temperature up through the rod. The liquid crystal turns green at a temperature of 40°C, and this field moves up the rod as the heat is conducted. This demonstrates that some metals conduct heat better than others. Ready for a new experiment once it has cooled down. The rods can be used repeatedly, but only below 100°C.

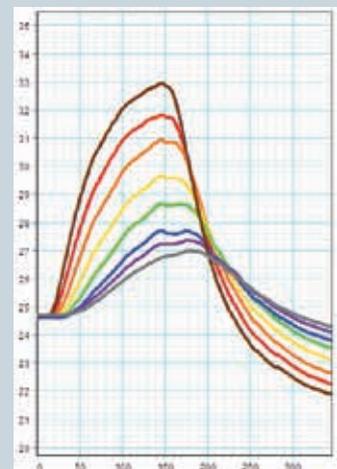
Item no. 269200



## CONDUCTION OF HEAT WITH DATA COLLECTION

A good insight into the dynamics of heat conduction can be gained by measuring the temperature trend at many sites simultaneously.

One end of a copper rod is first dipped in hot water and then transferred to a beaker of cold water. Next, temperature sensors are positioned at eight evenly-spaced sites along the rod. The results can be seen in the graph on the right.



## MELTING AND CASTING

### Galileo Thermometer

Based on the principle that the density of a liquid changes in proportion to its temperature. The temperature is displayed by means of small aluminium tags hanging from 7 small bulbs. The difference in the weight of the bulbs is less than 2/1,000 g, which yields a precision of 1 °C. When the temperature rises, the bulbs descend slowly; as the temperature falls, the bulbs rise up. The temperature is read from the tag on the lowermost floating bulb.

Height: 44 cm

Measurement range: 18 - 24 °C

Item no. 060003



### Storm glass

This storm glass or "Goethe barometer" is considered to be the world's oldest barometer.

Height: 18 cm

Item no. 060004



### Leidenfrost dish

Dish made of steel. The dish is heated to several hundred degrees Celsius and a few drops of water are added. Some of the water will remain liquid, even though the boiling point of water is exceeded. The liquid forms a small ball which moves on a cushion of steam. The experiment demonstrates the poor conductivity of steam and the high surface tension of the liquid.

Dimensions: Ø 56 x 6 mm

Item no. 263500



### Nitinol Memory Wire

The wire is soft and easily pliable at room temperature. On heating (for example, by immersing in hot water), a phase change occurs which makes the wire straighten itself out again. In the hot state, the wire is rigid and elastic.

Dimensions: Ø 0.75 x 900 mm

Item no. 272100

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## WAVE PROPERTIES

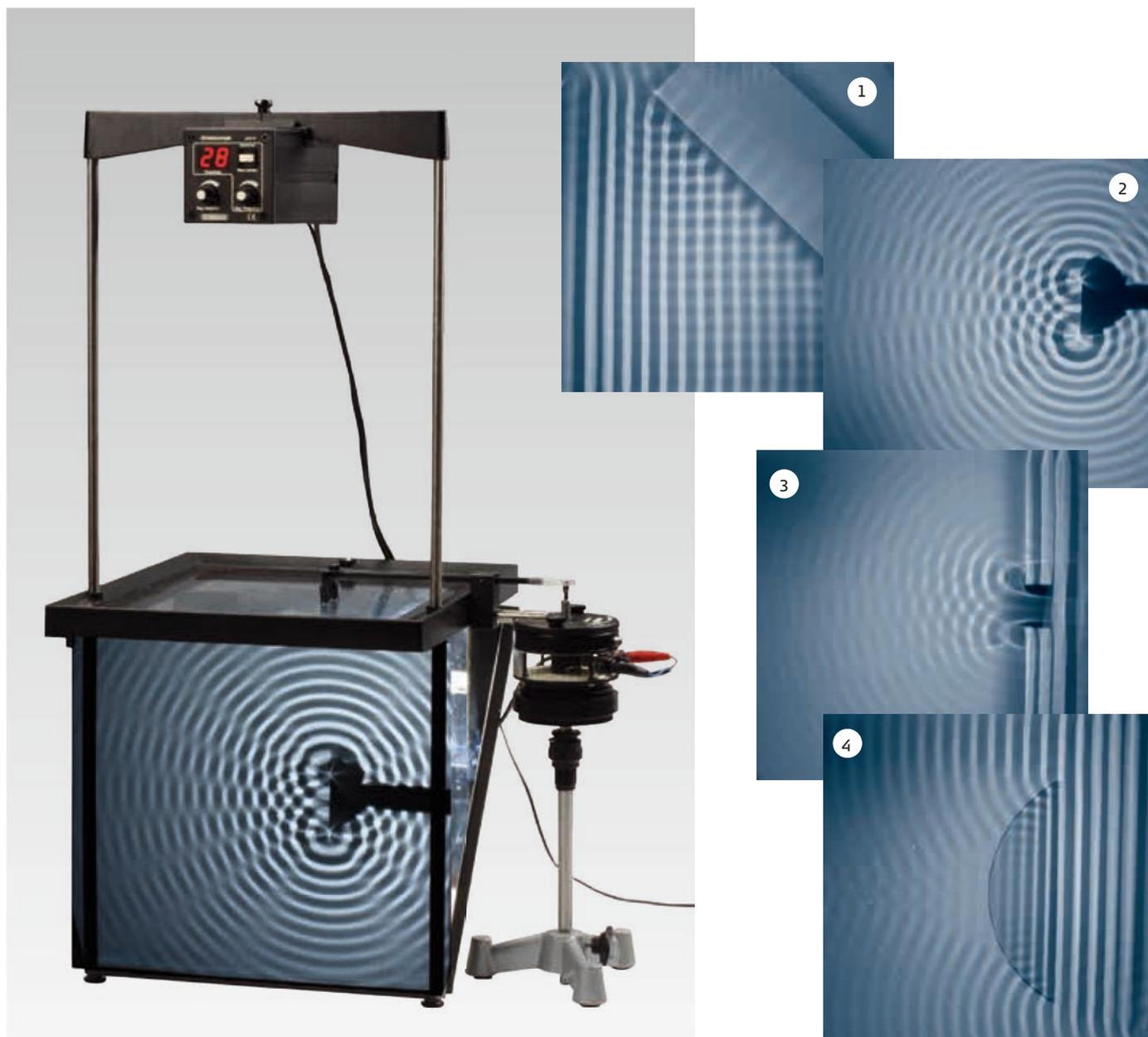
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### Ripple tank

The fundamental properties of waves are identical, whether we are talking about water waves, sound waves or electromagnetic waves such as light. So the ripple tank provides a good introduction to all types of wave propagation and interference. The wave generator is controlled either synchronously by flashes from the stroboscope unit, which appears to freeze the wave motion, or with a small frequency shift, which makes the waves move as if in slow motion. The wave patterns can be observed on the table top, on the supplied frosted glass plate or projected onto the wall.

Typical ripple tank applications:

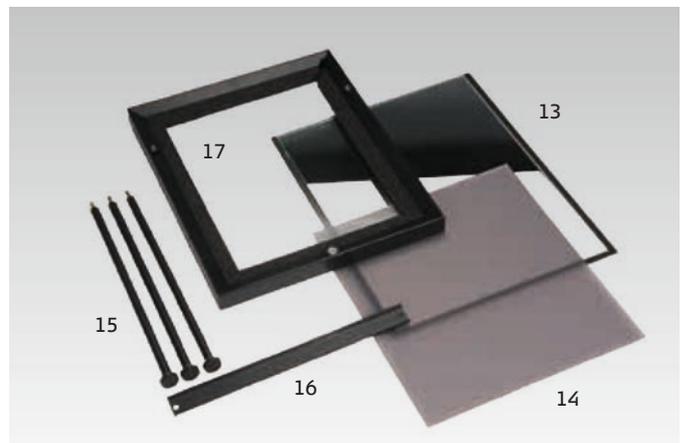
- 1) Reflection and refraction: By using the linear dipper, plane waves are produced, which are reflected by the angled barrier.
- 2) Interference: Occurs when two point source dippers produce circular waves. Distance and frequency can be adjusted.
- 3) Plane waves also create interfering circular waves when they pass through a double slit consisting of three barriers.
- 4) Wave speed depends on the depth of the water layer: Add water, so that the transparent lens is covered by a thin layer of water and observe how the wave length changes across the lens.





**The complete ripple tank comprises:**

- 1) 221101 Stroboscope unit (may also be included in an upgrade to our previous model 221050 Ripple tank)
- 2) 355050 Power adapter for stroboscope unit
- 3) 221062 Crosspiece and supports, i.e. mount and posts for stroboscope
- 4) 218500 Electromagnetic vibrator
- 5) 221032 Lever arm for vibrator
- 6) 218505 Lever arm support
- 7) 218506 Rod with cross bar
- 8) 218507 Height adjustment
- 9) 2210,0016 Accessory set
- 10) 110075 Connection cable
- 11) 110080 Remote Control and cable
- 12) 221031 Bottle containing surfactant
- 13) Plane mirror
- 14) Projection screen
- 15) Height-adjustable legs, 3 pcs.
- 16) Cross piece - front legs
- 17) Ripple tank
- 18) Lenses, 3 pcs.
- 19) 221025 Wave dipper, parallel



The entire ripple tank is supplied in a fibreboard box with inserts for the individual parts and comprehensive instructions.

**Item no. 221100**



### Electromagnetic vibrator

This vibrator produces mechanical vibrations when used with a signal generator (such as 250250 Function generator). The unit is fuse-protected and lockable to protect moving parts while changing accessories. A string holder, mounting post and base, and a spare fuse (408533) are included.

Max. input: 6V/1A

Dimensions: Ø 100 x 120 mm

Item no. 218500

### String holder

String holder with post for attaching an elastic string or spring to an electromagnetic vibrator for experiments on standing waves.

Item no. 218512

### Rod with cross bar

Fits threaded hole in base of vibrator 218500.

Item no. 218506

### Rubber string

2 metres of rubber string for demonstrating standing waves. Accessory for 218500 Electromagnetic vibrator.

Item no. 218540

### Piano wire ring

For use with 218500 Electromagnetic vibrator to demonstrate the relationship between frequency and the number of vibrational nodes.

Diameter: 250 mm

Item no. 218510



### Flat springs for resonance experiments

Various lengths. For use with 218500 Electromagnetic vibrator. Fundamental frequencies at 11, 15, 21, 36 and 50 Hz can be readily observed. Interesting standing waves can be seen up to 300 Hz and heard up to 900 Hz.

Item no. 218530



### Chladni plates

A thin layer of fine sand is spread over the plate, and resonance patterns ("Chladni" figures) can be observed at certain generated frequencies. For use with 218500 Electromagnetic vibrator. The plate resonances are also audible.

Item no. 218520 Chladni plate, square

Item no. 218525 Chladni plate, round

Item no. 218526 Chladni plate, round, plastic

### Sand for Chladni plates, 400 g

Item no. 883300-3



## Function generator

Our function generator is ideal for experiments with standing waves on a string – but of course it is up to all the tasks a function generator is normally presented with. It can easily cope with experiments on electrical circuits at 5 or 10 MHz. Or when you want a voltage that rises linearly from 0 to 10 V in 500 seconds. The frequency is set using a speed-sensitive button. You turn it slowly to set the least significant digits on the display. If you turn it faster, the response accelerates smoothly.

- Step: Based on a selected fundamental, the frequency can, for example, step through the overtones
- Sweep: The frequency is set to sweep an optional area, to detect any resonances
- Directly drives connected loudspeaker, vibrator, etc.
- PC connection: The generator can be connected to your PC as a USB memory stick (using a standard USB cable)
- Waveforms: Seven built-in waveforms not enough? Simply define your own waveform, using a spreadsheet, for example
- Find out more at [www.frederiksen.eu](http://www.frederiksen.eu)

Item no. 250350



## Student function generator

### Developed for education

We have developed 250310 as an affordable alternative to the advanced Function Generator 250350 - focusing on covering the most common experiments.

The function generator is operated with three buttons: Waveform, Frequency and Amplitude. There is a single output, provided with 4 mm safety sockets. The output can easily drive a speaker or vibrator with ample amplitude for resonance and diffraction experiments.

### Three waveforms

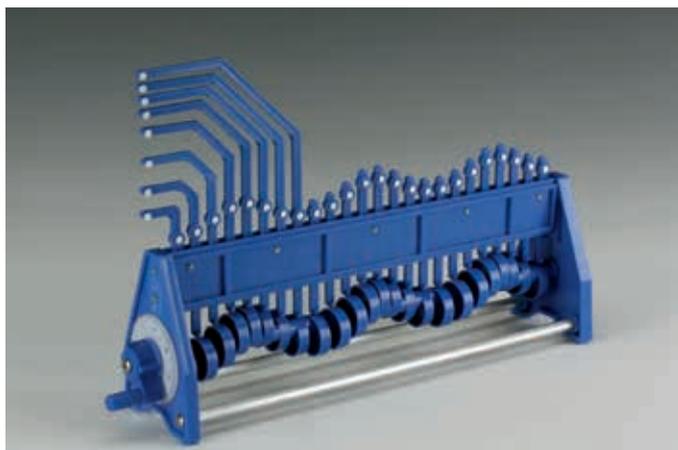
The generator provides sine, triangle or square wave signals. Distortion of the sine wave is less than 0.25 % in the audible range (20 Hz - 20 kHz) and remains below 1 % throughout the frequency range (0.05 Hz - 50 kHz).

### Built-in power amplifier

The signal amplitude is continuously adjustable from 0 V to a peak voltage of 7.5 V (15 V p-p; 5.3 V RMS). More than 1 A peak current can be supplied. The output is overload protected.

Supplied with 12V power adapter

Item no. 250310



### Wave machine

For demonstrating longitudinal and transverse waves. The apparatus has a camshaft with a handle which, when turned, acts on a series of vertical plastic rods with white dots on the top. The last 8 rods have an angled extension to allow observation of matching longitudinal and transverse waves. A 360° graduated scale is provided at the handle to allow the phase angle to be read.

**Item no. 221200**



### Slinky spiral spring

Our best, long Slinky, which is ideal for demonstrating longitudinal and transverse waves. Ø 75 x 150 mm.

**Item no. 215570**



### Slinky

Budget model, suitable for demonstrating wave motion. Ø 77 x 110 mm.

**Item no. 215575**



### Spiral spring

Spring for demonstrating pulse propagation, transverse waves, standing waves and other fundamental concepts. It is 3 metres long, rugged and easy for the whole class to see.

**Item no. 215565**



### Spiral spring

Used to demonstrate transverse waves and to create standing waves. Length: 1.8 m.

**Item no. 215562**



### Strobe light, digital

The flash rate can be adjusted from 1 to 300 flashes per second or 60 to 18,000 flashes per minute. The display has a switch for impulses per second, impulses per minute and external triggering. Safety sockets for external triggering to control the flash rate and impulse output for connecting to a digital counter. Trigger input max. 300 Hz. Thread in the base for attaching a tripod. Dimensions: 180 x 240 x 120 mm

**Item no. 201560**

## SOUND



### Sound level meter, digital

Robust, user-friendly sound level meter with 4-digit display that updates up to twice a second. Measurement ranges: 30 dB to 130 dB. Choose between dBA and dBC metering. The instrument features a max./min. function. Supplied in a case with manual, battery and wind shield.

#### Specifications

Resolution: 0.1 dB.  
Precision: 1.5 dB  
Frequency range: 31.5 Hz - 8 kHz

Item no. 252831



### Loudspeaker, two-way

Loudspeaker for experiments with tone, auditory perception and hearing. (For interference experiments, we recommend 250500 Loudspeaker on post instead.) Fitted with safety sockets. Supplied with 10 mm support post; can be fitted on other standard supports, such as 000600 Stand Base. 80 - 18000 Hz, 4 Ohm, 20 Watts RMS

Item no. 251052



### Loudspeaker on post

Use with 250250 Function generator to produce sound vibrations from a point source of sound. Mounted on a Ø 10 mm post and fitted with safety sockets. Base not included.

Output: 20 Wrms  
Impedance: 25 Ω  
Diameter: 67 mm  
Height: 160 mm

Item no. 250500



### Clapper board

Made from two hinged hardwood blocks, it produces a sharp, well-defined sound. To measure the speed of sound, the sound pulse can be recorded by microphones that start and stop a timer. Suggested accessories: 2 x 248600 microphone, 2 x 248601 DIN – 6-pin cable and 1 x 200250 Electronic counter. Dimensions: 27 x 50 x 300 mm.

Item no. 248200



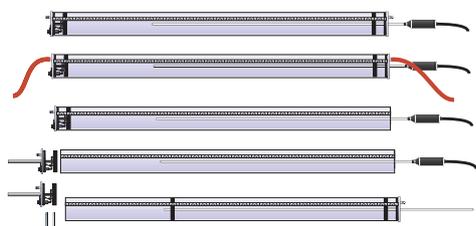
### Microphone

This new microphone can be connected to both analogue and digital inputs – the choice is yours. The unit has a modular output connector, so we have developed a range of cables, each with a jack for the microphone and, on the other end, a jack for your specific interface requirement. In this way, you can use the microphone with your speakers, stopwatch, datalogging equipment and, for example, an oscilloscope (via 251560 Battery box). The microphone can be used to determine the speed of sound or to investigate the tones and overtones of musical instruments. The microphone is supplied with full instructions, but WITHOUT cables.

Item no. 248600

All the supplied cables have a modular jack on one end, which connects to the microphone, and a connector on the other end as shown in the table.

Item no.	Connector	Application
248601	DIN – 6-pin	200250 Counter, 200260 Electronic stopwatch, 251560 Battery box
248602	DIN – 5-pin	251560 Battery box, Pasco interfaces (500, 550, 759, 850)
248608	BTD	Cable BTD to modular
512560	Jack	200250 Counter, PS-2159 Pasco digital adapter



### Resonance tube for sound experiments

The resonance tube is a highly flexible piece of apparatus which can be disassembled for experiments with open and half-open tubes. The equipment causes minimal noise disturbance to others since the sound source will often be enclosed within the tube during an experiment. In conjunction with 251550 Microphone probe, it is possible to study in detail standing waves in the air column.

The resonance tube is fitted with a centimetre scale. The removable cap at one end is fitted with a loudspeaker, which connects to 250250 Function generator using the supplied cable. The cap at the other end has an aperture for either a microphone or the supplied piston. Both end caps feature a hose connector, to allow the tube to be filled with a gas, such as CO<sub>2</sub>. Can be mounted in 2 x 000600 Tripod Stand Base using the supplied fork mounts. (Microphone, generator and mounting bases are not included). Dimensions: Ø 70 x 1000 mm

Item no. 248010



### Microphone probe

A miniature microphone probe is mounted at the end of a stainless steel probe for measuring sound pressure levels in hard-to-access places. The probe includes a 2 m long lead with DIN plug for 251560 Battery box for microphones, to which a voltmeter or oscilloscope can be connected. Idea for experiments with 248010 Resonance tube for sound experiments.

Frequency range: 20 - 20,000 Hz

Probe dimensions: Ø 8 x 740 mm

Item no. 251550



### Battery box for microphones

Battery box functions as a voltage supply for microphones and various sensors. Suitable for all analogue sensors from Pasco and Vernier with DIN plugs and supply voltage of +5V. The device can connect newer microphones to older electronic counters or to oscilloscopes. The two "Mic" inputs with 6-pin DIN sockets (270 degrees) are used for 248600 Microphone, for example. The "Sensor" input with 8-pin DIN socket is used for 251550 Microphone probe, for example. Outputs in the form of 5-pin DIN sockets and Ø 4 mm safety sockets. Includes 351010 9 V Alkaline battery but not 355010 mains adapter.

Dimensions: 143 x 84 x 37 mm

Item no. 251560



### Kundt's tube, plexiglas

For demonstrating standing waves and determining the wave length of sound in air. Features a millimetre scale and movable piston for adjusting the column of air. Accessories required: A suitable tuning fork, such as 224010, and 224561 Striking hammer.

Dimensions: Ø 30 x 660 mm

Item no. 247500

## TUNING FORKS



### Tuning forks on resonance boxes

Set of two tuning forks in nickel-plated stainless steel. Each mounted on a resonance box in lacquered pine with thick felt pads. Used for resonance and beat experiments. Supplied complete with striking hammer and slider to change the frequency. Frequency 440 Hz.

Item no. 224520

Item no. 224561 Spare: Striking hammer

Item no. 224562 Spare: Runner for tuning fork



### Tuning fork set, C scale

Eight tuning forks from  $c^1$  (256 Hz) to  $c^2$  (512 Hz) made from nickel-plated steel with engraved frequencies. Supplied in a case.

Item no. 223500



### Tuning fork, wide

Aluminium tuning fork with high sound output, making it a suitable sound source for Doppler effect and resonance tube experiments. Width: 30 mm

Item no. 224000 Frequency: 1700 Hz. Length: 118 mm

Item no. 224010 Frequency: 1000 Hz. Length: 104 mm



### Tuning fork

Made from nickel-plated steel with engraved tone and frequency. Frequency: 440 Hz.

Item no. 222500 120 mm

Item no. 223001 145 mm

### Tuning fork for demonstrations

It is easy to observe the tuning fork's oscillations by eye, due to its large amplitude and low frequency (not audible at around 5.4 Hz). Made from nickel-plated steel. Length: 750 mm

Item no. 222000





### Singing tube

By twirling the tube round in circles, up to 5 different pitches can be produced. The faster the tube is twirled, the higher the pitch. The frequency of the pitch is determined by the standing wave that arises inside the tube as air flows past the mouth of the tube.

Item no. 247610



### Musical tubes

Set of 8 colourful plastic tubes that produce a C octave. When used with the supplied end caps, the tones can be decreased by an octave. Let the students play with the set and discover which factors determine pitch.

Activity suggestions included.

Length: 300 - 600 mm

Item no. 247620

### Electric bell with rubber feet

Electric bell with safety sockets and rubber feet. The sockets can be connected to a switch (such as 415000); alternatively a short circuit can produce a persistent ring. The bell can be used to demonstrate the non-propagation of sound in a vacuum (e.g. 178000 and 178510, see page 15).

The mechanism can be observed by removing the small plate covering the workings.

Uses 2 x 1.5 V D batteries (351007, not included)

Item no. 456210



### Tones and sounds – CVK case

This case introduces students to different concepts such as frequency, resonance, sound waves etc. Through different instruments, tuning forks, cassette tapes and resonances boxes, the students can explore the properties of sound for themselves. For groups of 15. Teacher's guide supplied.

Item no. 599100



### Ultrasound

This apparatus from Unilab clearly demonstrates short wavelength (8 mm) wave phenomena. The horn creates a more directional characteristic and can be detached if required. The devices are equipped with adapters for safety cables. Without the supplied exponential horn, the boxes measure 150 x 95 x 60 mm.



### Ultrasound transmitter, Unilab

Transmits ultrasound at a frequency of 40 kHz. Frequency can be modulated. Can be used with 253500 Ultrasound receiver and 254500 Slave transducer.

Item no. 253000



### Ultrasound receiver, Unilab

The receiver can deliver a DC voltage to a voltmeter proportional to the strength of the captured ultrasound signal. Alternatively, the demodulated signal can be sent to an audio amplifier. Can be used with 253000 Ultrasound transmitter.

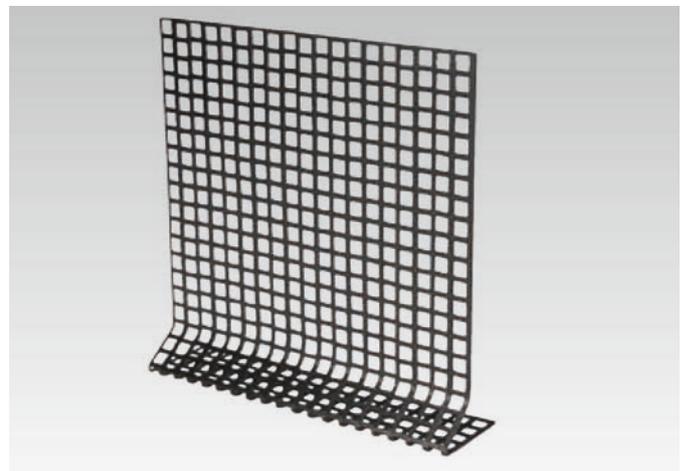
Item no. 253500



### Slave transducer for ultrasound, Unilab

Used for interference experiments with ultrasound. To be connected in parallel with Ultrasound transmitter 253000, when two transmitters in phase are required (equivalent to double slit).

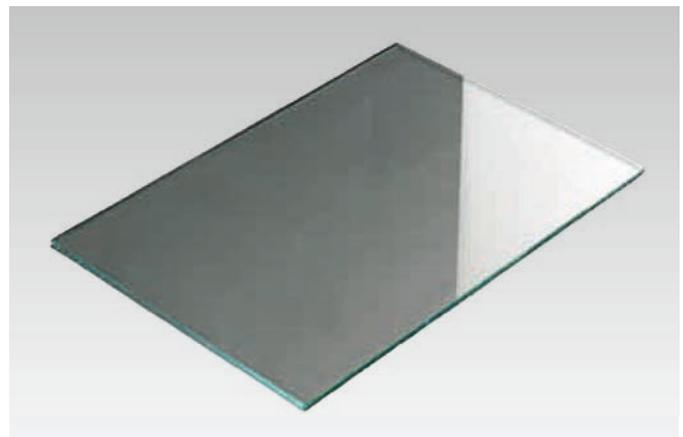
Item no. 254500



### Perforated plate for ultrasound.

Functions as a semi-transparent mirror for interference experiments using ultrasound.

Item no. 254000



### Reflector

Dimensions: 180 x 120 x 2 mm for mounting in two x 305000 Plate holder.

Item no. 304000 Glass plate, clear

## LASERS

### Laser, He-Ne, modulatable

This new model He-Ne laser emits light at a wave length of 632.82 nm (in air) with a maximum output of 1 mW. The emitted light is coherent, i.e. its components are all in phase. The laser light is emitted in a thin beam of diameter approx. 0.49 mm, depending on the distance from the laser. The polarisation of the light changes spontaneously and randomly round the longitudinal axis.

This modulatable laser is equipped with a BNC socket, for connecting a signal generator, CD player or similar. The light beam will then vary in intensity in line with the received signal. In conjunction with 489550 Photodetector, it is possible to demonstrate optical communication. The maximum modulation frequency is 1 MHz.

The laser has a threaded adapter for mounting optical systems such as lenses, optical fibres, and so forth.

It has a mechanical beam stop, so the beam can be interrupted without shutting down the laser tube.

Powered by 230 V AC.

The laser is fitted with a keyed safety switch.

Includes 2 x 10 mm support posts

Dimensions: 440 x 77 x 77 mm

**Item no. 288550**



### Green diode laser with power adapter

Robust diode laser for educational use, equipped with a key switch and including power adapter. There is a thread in the base for a support stand.

Wave lengths: 532 nm, beam cross-section: 4 x 2 mm

Dimensions: 154 x 58 x 30 mm

**Item no. 288780**



### Laser pointers

Keenly priced laser pointers. Their output is less than 1 mW (class II). Incl. batteries.

Item no.	Wavelength	Colour
142070	670 nm	Red
142080	532 nm	Green
142095	405 nm	Violet



### Optical fibre model

The apparatus consists of a bended rod of acrylic glass, 500 mm in length and 10 mm in diameter, with two windings of approx. 50 mm dia. The light incident on one face of the rod is guided through the rod and its windings by repeated total reflection and is emitted at the other face of the rod as a divergent light beam.

**Item no. 142100**



## LASER ACCESSORIES



### Photodetector

The photodetector can be used to demonstrate communication by laser light, fibre optic communication, plotting of interference patterns etc. Sound signals can be played directly via the built-in loudspeaker or transferred via a BNC socket. A mini jack socket supplies a direct current which is proportional to the mean intensity of the light. Maximum signal frequency: 1 MHz.

Item no. 489550



### Fibre optics set

For experimenting with the transmission of signals through optical fibres. Consists of holders 288610 and 488551, and 2 m of 288700 optical fibre.

Item no. 288650

### Optical fibre holder for lasers

Threaded adapter for lasers with centring hole for 288700 Optical fibre. The cable is secured and centred by means of an O ring.

Item no. 288610

### Optical fibre holder for photodetector

Fits 488550 Photodetector, for connecting 288700 Optical fibre.

Item no. 488551

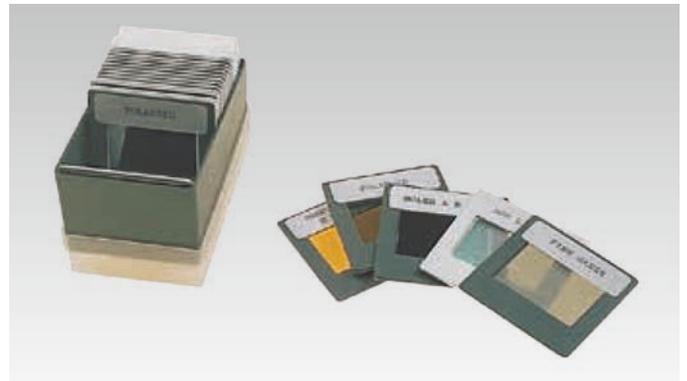


### Optical fibre

Flexible optical fibre allowing light to be carried along a curved path to wherever it is required. Easy to cut to the desired length by scalpel or similar.

External covering:  $\varnothing$  2.2 mm; optical fibre:  $\varnothing$  1 mm.

Item no. 288700



### Laser refraction set

The set contains 18 slides for demonstrating Fraunhofer and Fresnel diffraction. Contents: 6 slides with 1 to 6 slits of the same width of 0.06 mm and spacing of 0.20 mm. 3 slides with coarse line gratings. 2 slides with fine line gratings (80 and 300 l/mm). 1 slide with fine gauze (300 mesh). 1 slide with wedge-shaped single slit. 1 slide with wedge-shaped double slit. 1 slide with holes of 1.0 – 0.60 – 0.40 and 0.30 mm. 1 slide with transmission hologram. 2 slides with polarising filters. Instructions included.

Item no. 327200

### Model of optical grating

Using machine screws with a well-defined thread pitch and 0.30 mm nylon line, it is possible to make a relatively simple optical grating. On a projection surface at a distance of 6-10 metres from the grating, the diffraction of a laser beam is clearly observable. This provides a clear understanding of what an optical grating is. Set of 4.

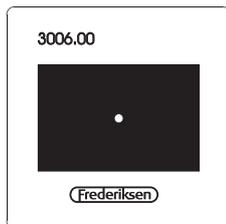
Item no. 324400



### Circular aperture slide

Aperture consisting of  $\varnothing$  1 mm hole in 50 x 50 mm slide without glass.

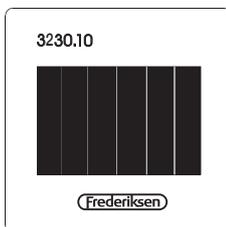
Item no. 300600



### Single slits of varying widths

Aperture consisting of 5 single slits of different widths for demonstrating the diffraction of light through a slit. The slits measure 0.04 - 0.08 - 0.14 - 0.20 - 0.26 mm. Mounted in slide (no glass): 50 x 50 mm.

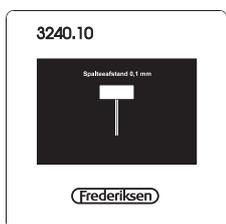
Item no. 323010



### Double slit

Double slit with 0.1 mm spacing. Mounted in 50 x 50 mm slide, without glass.

Item no. 324010

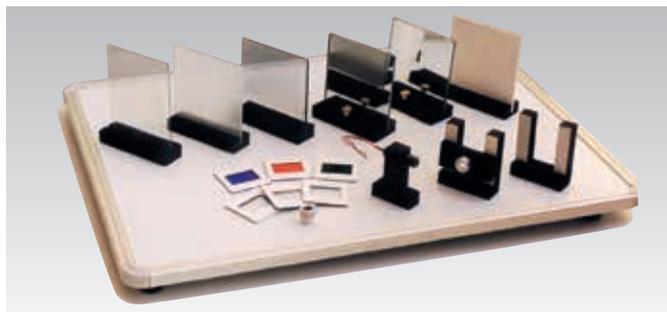


### Apparatus for determining the wavelength of light

When monochromatic light from the apparatus is observed through a double slit, a series of interference stripes appear. The position of the stripes is marked using the luminescent sliders, and their average separation is determined using the device's millimetre scale. By measuring the distance between the double slit and the device, the wavelength can be calculated. Supplied with two colour filters, red (308500) and blue (308530) and a double slit aperture (324010). Equipped with  $\varnothing$  10 mm support rod. Instructions included.

Item no. 324000

## LASER SETS



### Laser optics set

Using this set, the following can be investigated: the Michelson interferometer, diffraction by gratings, apertures, etc., polarisation of light and holography. All optical parts are attached magnetically to the supplied mounting plate. Except for the mounting plate, all parts are supplied in a handy storage and carry case.

Contents: Diode laser (class 2), voltage adaptor, convex lens, mirror, semi-transparent mirror, matt glass panel, screen, colour filters, polarising filter, various diffraction elements, hologram, glass panel for demonstrating interference, manual.

Item no. 288750

### Fibre optics set

Experiments with analogue and digital (serial) data transfer by optical fibre. Beyond demonstrating the principles, the set can also be used to measure the significance of various non-ideal circumstances such as air gaps and bends of insufficient radius.

Contents: Transmitter and receiver modules, frequency generator, microphone with amplifier module, amplifier with loudspeaker, voltage adapter, optical fibres, fine emery paper, cylinders for bending experiments – even a small multimeter is supplied. The set is supplied in a foam-lined case.

Item no. 288770



### Laser communication set

The set can be used to transmit sound and video signals via a laser beam. Contents: Laser transmitter (class 2), modulation unit, microphone, receiver, loudspeaker, voltage adapters.

The modulation unit operates in the frequency range from 100 Hz to 20 MHz. The set is supplied in a storage and carry case.

For transmission of live images, also requires a camera with a composite video output and a standard analogue television. As well as standard video cables with phono jacks, two 111600 BNC to phono adapters are required.

Item no. 288760

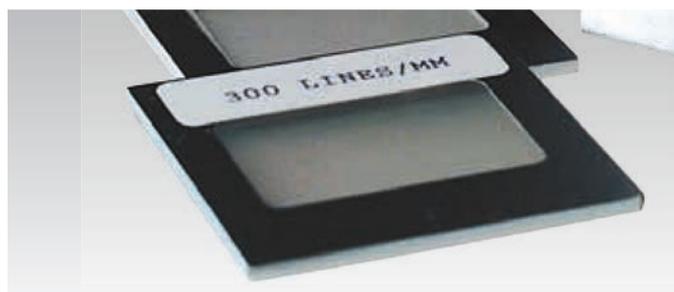
## SPECTROMETERS AND GRATINGS



### Spectrometer

For determining the wavelength of visible light through diffraction in an optical grating, or refraction in a prism. The instrument features an easily legible scale, graduated in 0.1 degrees, and a holder for both prisms and gratings, as well as an adjustable prism table. Students will find it easy to operate and read off the spectrometer and to position the adjustable elements to best effect. The collimator is equipped with an adjustable aperture. Features 15x eyepiece with reticle.

Item no. 321530



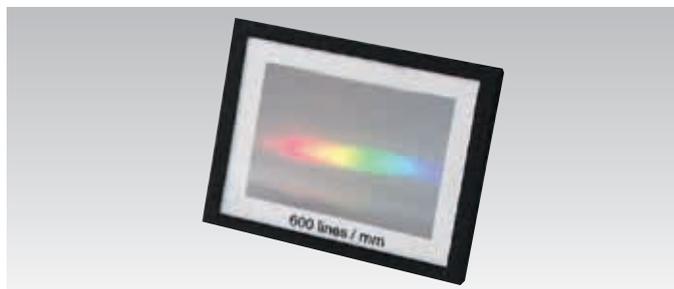
### Optical gratings 24 x 36 mm

Diffraction gratings mounted between 2 parallel glass plates.  
Grating area: 24 x 36 mm  
Dimensions: 30 x 45 mm

Item no. 324500 300 l/mm (Precisely: 295.27 l/mm)

Item no. 324510 600 l/mm

Item no. 324520 1200 l/mm (Precisely: 1181.1 l/mm)



### Optical gratings 30 x 45 mm

Diffraction gratings mounted between 2 parallel glass plates.  
Grating area: 30 x 45 mm  
Dimensions: 48 x 63.5 mm

Item no. 325000 100 l/mm

Item no. 325010 200 l/mm (Precisely: 196.85 l/mm)

Item no. 325020 300 l/mm (Precisely: 295.27 l/mm)

Item no. 325030 600 l/mm

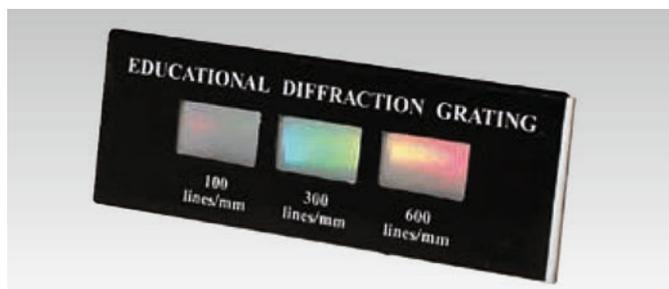


### Optical grating, glass

Diffraction grating on a glass plate for use with 321530 Spectrometer, for example, for determining the wavelength of spectral lines. Dimension of glass plate: 38 x 50 x 4 mm. Grating area: approx. 25 x 25 mm

Item no. 325505 300 l/mm

Item no. 325510 600 l/mm



### Optical gratings, 3-in-1

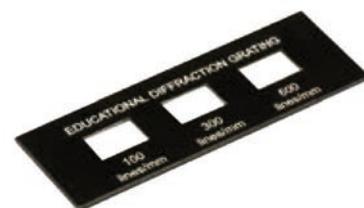
The original version from Paton Hawksley. Three gratings of, respectively, 100, 300 and 600 lines/mm, mounted between parallel glass plates in a 90 x 30 mm cardboard frame. (The mid-size grating is actually 7,500 l/inch = 295.27 l/mm). Each grating has an area of 9 x 16 mm.

Item no. 326000

### Optical gratings, 3-in-1

A combined diffraction grating with 100, 300 and 600 lines/mm.

Item no. 324530



### Optical gratings, cardboard

30 optical gratings, 500 lines/mm, card-mounted. The same size (50 mm x 50 mm) as other optical gratings, to fit grating mounts.

Item no. 324570

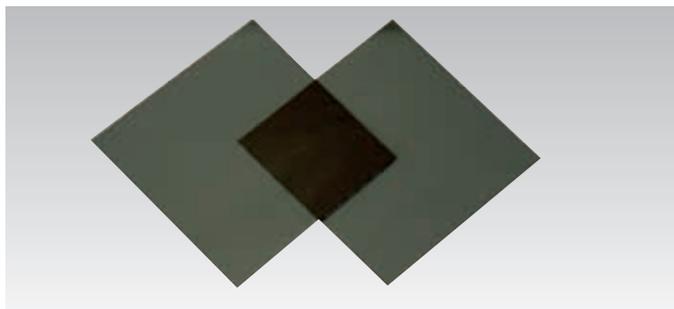


### Optical grating, sheet

The 600 x 150 mm film sheet with 500 l/mm can be used as a bright output optical grating, for example with an OHP.

Item no. 324580

## POLARISED LIGHT



### Polarising filters, unmounted

Unmounted polarising filters for producing plane-polarised light. These quality filters block the light when positioned at 90 degrees to each other (transmitting only 0.005%).

The protective film must be removed before use.

**Item no. 327000** 1 pair. Dimensions: 50 x 50 mm

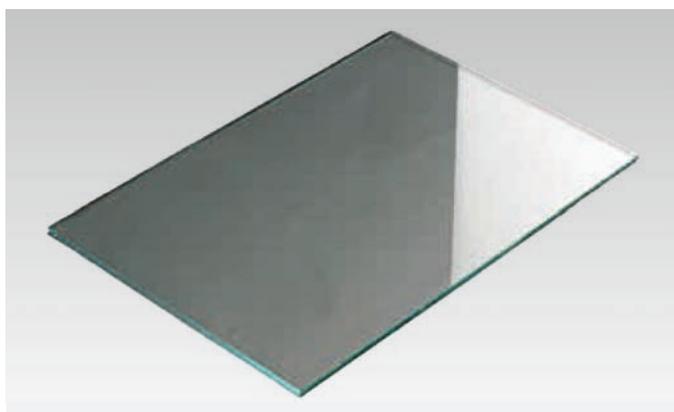
**Item no. 327011** 1 pc. Dimensions: approx. 200 x 250 mm



### Polarising filters, slides

As 327000, but sold as a pair mounted in 50 x 50 mm slides without glass. 1 pair. Dimensions: 50 x 50 mm.

**Item no. 327020**



### Glass plate, clear

Clear glass plate for mounting in 30500 Plate holder, and for use with a polarisation filter, for example, to find Brewster's angle.

Dimensions: 180 x 120 x 2 mm.

**Item no. 304000**

## LIGHT SOURCES

### Lamp holder E-27 on post

Threaded E-27 holder mounted on 100 mm long, Ø 10 mm support rod. Fitted with mains connection. Base not included.

**Item no. 413010**



### Infrared lamp

230 V / 250 W infrared lamp with E 27 fitting. Lamp diameter 120 mm.

**Item no. 287500**



### Torch, LED

A strong and bright LED flashlight in a solid, moulded rubber casing which is non-slip and drop-proof. Specifications: 3 white LEDs, 10 lumens, approx. 34-hour battery life and up to 30-metre beam. Batteries not incl. (2 x 351007).

Dimensions: Ø 70 x 191 mm

**Item no. 280641**



### Torch with 9 LEDs

Torch with 9 LEDs. This flashlight is approx. 9 cm long. Uses 3 x AAA batteries (351004), sold separately.

**Item no. 280612**

**Halogen lamp,  
105 W**

Ideal for use with solar cells, for example. Connects to 230 V mains. Supplied with a support rod but not a foot.

**Item no. 280130**



**Halogen lamp,  
350 - 400 W**

Ideal for use with solar cells, for example. Connects to 230 V mains. Supplied with a support rod but not a foot.

**Item no. 280135**



**Candles**

For use in optical experiments. Pack of 20, Ø approx. 12 mm.

**Item no. 281000**



**Tealights**

Pack of 100 tealights.

**Item no. 005310**



**Reflector lamps for colour mixing**

If a white canvas is illuminated using 3 primary colour lamps, the light will be perceived as white. By creating shadows and turning the lamps off and on, the colours' additive composition can be observed. The lamps are 230 V and have reflectors and E 27 fittings. They can be used in a standard architect's lamp or with lamp holder 413010. Two price categories are available:

Item no.	Colour	Output
426311	Red	80 W
426313	Blue	80 W
426314	Green	80 W
639165	Red	60 W
639162	Blue	60 W
639160	Green	60 W



**Lux meter**

Digital light meter with large measurement range and a big, display with 4 digits. Works in 3 different measurement ranges that shifts automatically according to the different light levels. Symbols with either x10 or x100 or shown for the high ranges, and the displayed reading should therefore be multiplied with this number.

With max/min funktion and auto power off (after 15 minutes of idle) Delivered with battery (9 V) and english manual. Measurement ranges: 0-20 lux, 0-20.000 lux, 0-200.000 lux. Resolution: 0.1 lux for the range 0-200 lux. Sample rate: 2,5x/sec. Accuracy: +/- 5 % below 10.000 lux and +/- 10 % over 10.000 lux

**Item no. 188800**

## Olympiad box 1

The International Physics Olympiad 2013 included experimental exercises on light and solar cells. The equipment that DTU (the Technical University of Denmark) developed for the event can now be purchased from Frederiksen. The equipment is essentially new, having been used just once – this is the real deal.

The equipment has been designed around a large plastic box with a range of apertures and holders that can be placed in the slots in the box. The following are also included:

- Two solar cells
- An LED light source
- A power adapter for the light source
- Variable load resistance
- Two multimeters
- Cables with alligator clips
- Plastic cuvette for refraction experiments
- Instructions for the exercises

The original exercises can be downloaded from the internet – but they are very demanding for students. We have therefore prepared lab manuals in a version suitable for less exceptional students.

The instructions included cover

- Investigating distance dependency
- The characteristics and maximum output of solar cells
- Joining solar cells in series and in parallel
- The refraction of light in water

The Olympiad box 1 is suitable for both physics-chemistry students at age 16 and upper secondary physics students (to age 18).

**Item no. 488590**



## Olympiad box 2

Laser distance meter – the fastest stopwatch in school.

A plastic cuvette is reused from Olympiad box 1 as well as, for the official tasks on the internet, the black plastic optics box. Olympiad box 2 adds the following:

- Laser distance meter
- Optical fibres
- Felt pad for screening
- Scissors
- Instructions for the exercises

And for use in the official exercises:

- Angle iron
- Neodymium magnet
- Adhesive pads

The original exercises can be downloaded from the internet – but they are very demanding for students (especially in terms of mathematics). We have therefore prepared lab manuals in a version suitable for less exceptional students.

The experiments included cover

- The speed of light in an optical fibre
- The speed of light in water

Olympiad box 2 is suitable for physics at upper secondary level.

**Item no. 488595**



## COLOURS

### Colour filters, acrylic

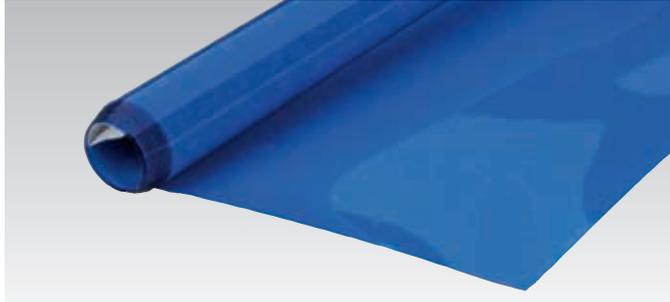
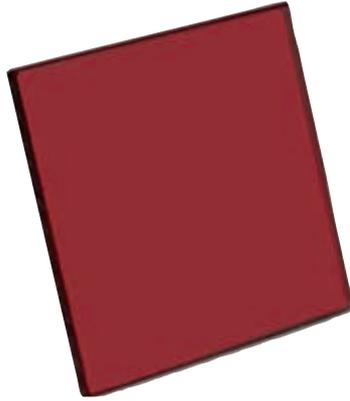
Colour filters made from 3 mm thick, 50 x 50 mm acrylic plate, which fit our aperture holders.

Item no. 308500 Red

Item no. 308510 Yellow

Item no. 308520 Green

Item no. 308530 Blue



### Colour filters, foil

Transparent coloured foils in rolls of 500 x 1220 mm. The filters are reasonably colour-selective and correct in relation to international standards. The filters can be cut up for OHPs, to A4 size or, for example, 60 mm x 60 mm for student use.

Item no. 308900 Primary red

Item no. 308910 Yellow

Item no. 308920 Primary green

Item no. 308930 Primary blue

Item no. 308950 Cyan

Item no. 308960 Magenta

### Coloured film A4 - 5 different colours

5 different coloured plastic sheets in A4 format. Good for colour mixing experiments, and many other uses. Easy to cut using scissors.

Item no. 670131



### Colour disc, rotating

Also referred to as Newton's disc, when it is rotated it fades to white, providing a simple demonstration of additive colour mixing.

Mounted on stand. Ø 200 mm

Item no. 670124



### Colour wands

Set of 6 transparent acrylic colours red, green and blue (RGB) is called additive colour mixing. The colour mixer allows red, green and blue light to be mixed which, in the right proportions, produce white light. Uses 3 x 1.5 V AA batteries. (351005)

Item no. 308540



### Colour mixer, blue, red and green

The mixing of the primary colours red, green and blue (RGB) is called additive colour mixing. The colour mixer allows red, green and blue light to be mixed which, in the right proportions, produce white light. Uses 3 x 1.5 V AA batteries. (351005)

Item no. 309000



## ULTRAVIOLET LIGHT



### UV lamp 254/365nm

Hand-held UV lamp for visualising fluorescent substances (365 nm) or discharging a zinc plate on an electroscope (254 nm).

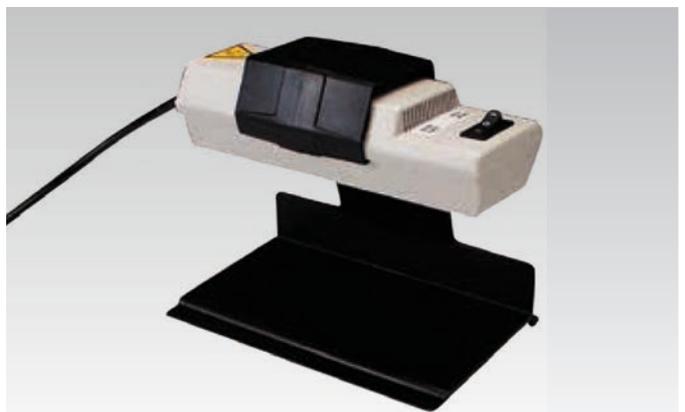
Technical specifications:

Wavelengths: 254 and 365 nm

Output: 4 W

Dimensions: 198 x 71 x 53 mm, weight: 0.45 kg

Item no. 544300



### Stand for UV lamp

Stand for UV lamp 544300.

For mounting the UV lamp, so that it shines downwards.

Item no. 544310

### UV lamp 11W

Ultraviolet lamp, that emits ultraviolet light in the wavelength range of 350 to 400 nm (UVA) and maximally at 370 nm. The lamp connects directly to the mains and has an on/off button. Note: The ultraviolet light from this lamp presents no health risk to the eyes or bare skin.

**Item no. 287100**



### UV lamp, battery-powered

Diffuse ultraviolet lamp with a wavelength of around 365 nm.

**Item no. 287110**



### Ultraviolet bulb

Black light 125 W lamp with outer casing of Wood's glass. Can be used to produce fluorescence in optical laundry detergents, investigating food-stuffs, mineralogy, and fluorescent inks and paints. The lamp emits ultraviolet light in the wave length range of 310 to 410 nm with a maximum at 365 nm (mostly UVA, but with a small amount of UVB). The lamp is fitted with an E27 socket, but must NOT be connected directly to the mains supply. Fit the bulb into 287000 Socket and power it via 284050 Control transformer for spectrum lamps.

**Item no. 286000**



### Zinc sulphide screen

Phosphorescent plate that continues emitting light for some time after having been illuminated. This effect depends on the light source emitting some ultraviolet in addition to visible light, which means that the screen can be used to detect UV light. Includes Ø 10 mm mounting post. Dimensions: 110 x 105 mm

**Item no. 307500**

### Phosphorescent plate

Similar to 307500, but unmounted. Dimensions: 70 x 95 mm

**Item no. 307510**



### UV torch

This flashlight is suitable for studying fluorescence; for example, our 287140 UV beads rapidly change colour when illuminated. Emits long wave UV light (350-400 nm).

**Item no. 287115**

### UV torch, student

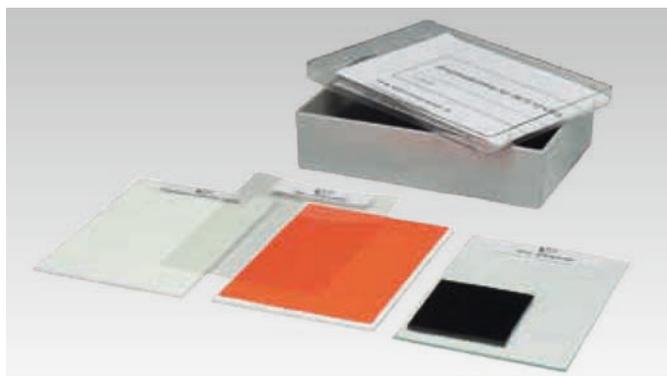
Emits long wave UV light (395-400 nm) Uses 3 x AAA batteries, sold separately.

**Item no. 287120**

### UV beads

UV beads which are white-ish in artificial light but become coloured under UV light. Approx. 100 beads.

**Item no. 287145**



### UVA accessory set

UVA accessory set containing an ordinary glass plate, a fluorescent plate, a phosphorescent plate, a UVA filter, UVA plastic film and ordinary plastic film. Instructions included.

**Item no. 287210**

### Fluorescent plate, 70x95 mm

Plate that fluoresces when illuminated by UV light. Can be used to demonstrate fluorescent chemicals and which materials block UV light. Dimensions: 70 x 95 mm

**Item no. 307600**



## OPTICS AND PRISMS

### Newton's prism

Glass prism with polished surface.

Dimensions: 34 x 34 x 35 mm

Item no. 298500



### Prism, right-angled

Right-angled glass prism with polished surface.

Dimensions: 40 x 54 x 40 mm

Item no. 298515



### Glass prisms

Dimensions: 30 x 30 x 30 mm

Item no. 298520 Crown glass

Item no. 298530 Flint glass



### Prism table on mount

Ø 62 mm disc mounted on Ø 10 mm stainless steel rod. Features an adjustable spring clamp for holding prisms from 10 mm to 50 mm tall.

Item no. 299000

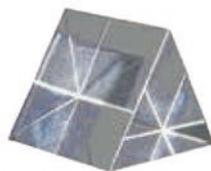


### Prism, glass

Made from optical glass. Equilateral. For experiments with light.

Dimensions: 42 x 42 x 32 mm

Item no. 298550



### Direct vision prism

Compound prism for demonstrating the spectrum of light.

Dimensions: 20 x 20 x 70 mm

Item no. 300500

### Holder for Direct vision prism

Prism holder mounted on a Ø 10 mm support post. Equipped with a clamping device for the prism and felt covering.

Item no. 300510

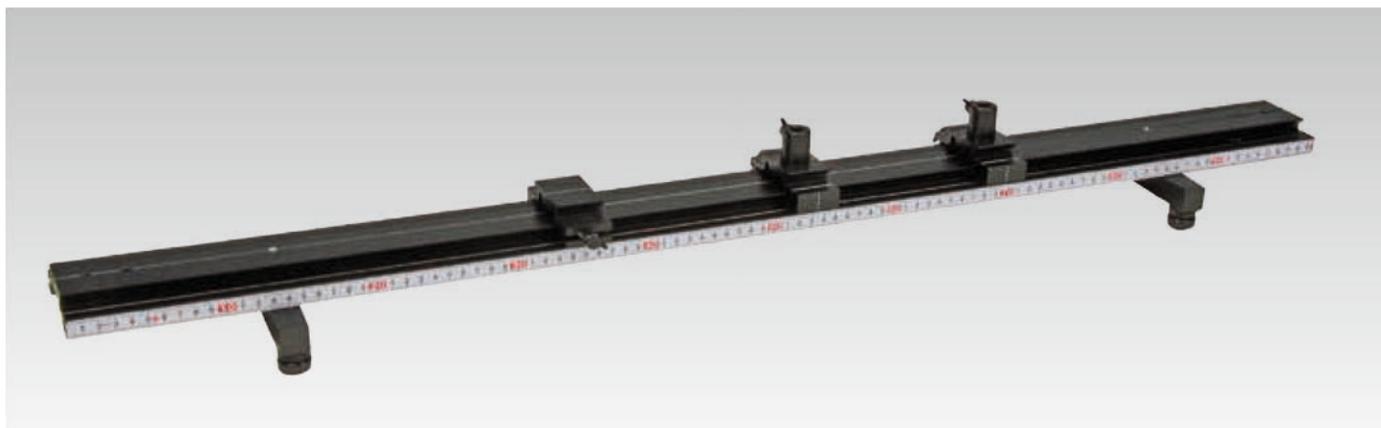


### Hollow prism

Hollow 60° prism made from 3 mm glass with removable lid for use in demonstrating the refractive index of liquids.

Dimensions: 50 x 50 x 53 mm

Item no. 300000

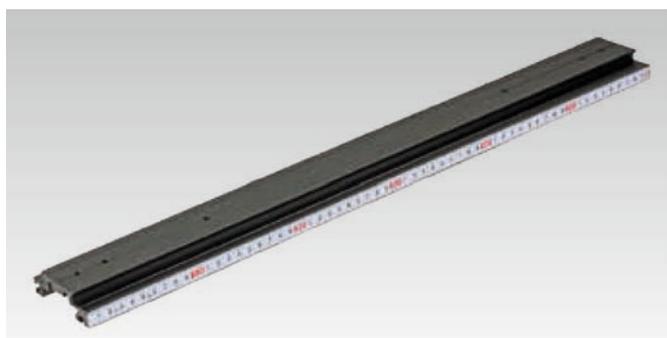


### Optical bench with saddles

Optical bench for mounting light sources, lenses, prisms, apertures and so forth in a stable line. The profiled rail is made from black anodised aluminium and features a ruler on the side. Supplied with the following standard parts: 2 pcs 294610 Saddle with  $\varnothing$  10 mm mounting hole. 1 pc 294620 Saddle with  $\varnothing$  10 hole for 290000 Optical disc. 2 pcs transverse feet with adjustment screws.

Dimensions: 1000 x 66 x 140 mm, profile cross-section: 82 x 26 mm

**Item no. 294600**



### Optical rail, 60 cm

Profiled rail for extending an optical bench or as a standalone profiled rail for mounting saddles. Can be used as a base for installations requiring fixed spacing, as a measuring set-up for radioactivity measurements, etc. Made from black anodised aluminium. Features a ruler on the side.

Dimensions: 600 x 82 x 26 mm

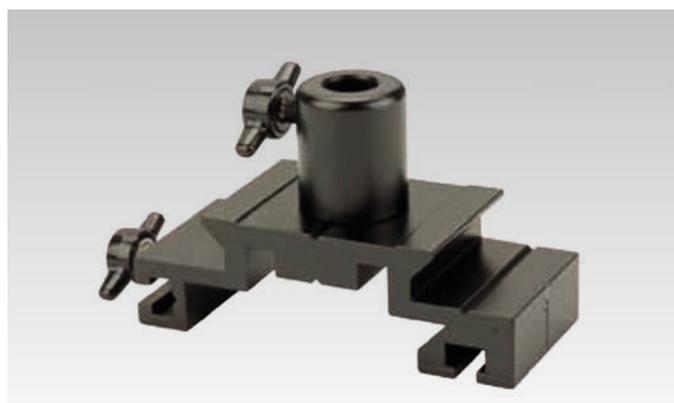
**Item no. 294640**

### Optical rail, 2 m

The same as 294640 Optical rail, but 2000 mm long.

Dimensions: 2000 x 82 x 26 mm

**Item no. 294646**

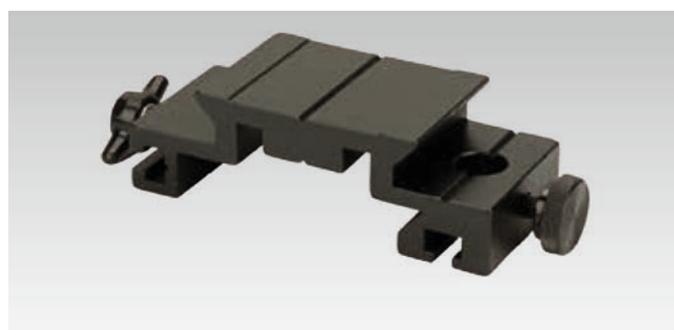


### Saddle with $\varnothing$ 10 mm mounting hole

For mounting equipment with max.  $\varnothing$  10 mm mounting post. Made from black-painted metal, with a measuring line and thumbscrews.

Dimensions: 35 x 50 x 84 mm

**Item no. 294610**

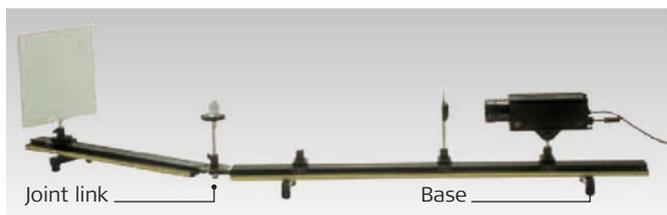


### Saddle for optical disc

For mounting 290000 Optical disc. Equipped with  $\varnothing$  10 mm mounting hole. Made from black-painted metal, with thumbscrews.

Dimensions: 35 x 50 x 84 mm

**Item no. 294620**



### Joint link for optical bench

Articulating link for optical rails. Made from black-painted aluminium with graduated scale and  $\varnothing$  10 mm mounting hole. Supplied with mounting thumbscrews.

**Item no. 294650**

### Base for optical bench

Base with adjustable levelling screws, with locking mechanism and rubber feet. Made from black-lacquered aluminium. Supplied with mounting screw and hex wrench. Suitable for 294640 Optical rail.

Dimensions: 125 x 50 x 25 mm

**Item no. 294630**



### Profiled rail without saddles

The profiled rail is suitable for securing items of equipment that need specific spacing or must be fixed relative to each other. The profiled rail is for use with one or more 294610 Saddles, which have a  $\varnothing$  10 mm hole and tightening screws.

Dimensions: 370 x 82 x 26 mm

Item no. 294635



### Student Reuter lamp with festoon bulb

A simple but bright lamp for experiments with lenses, prisms and gratings. For the light source, a festoon lamp is used with the filament positioned immediately above the support post, to make it easy to set up the lamp on an optical rail. The lamp is fitted with a fan which stops the housing getting too hot to hold, even though the festoon lamp consumes 15 W.

Item no. 280030



### Reuter lamp

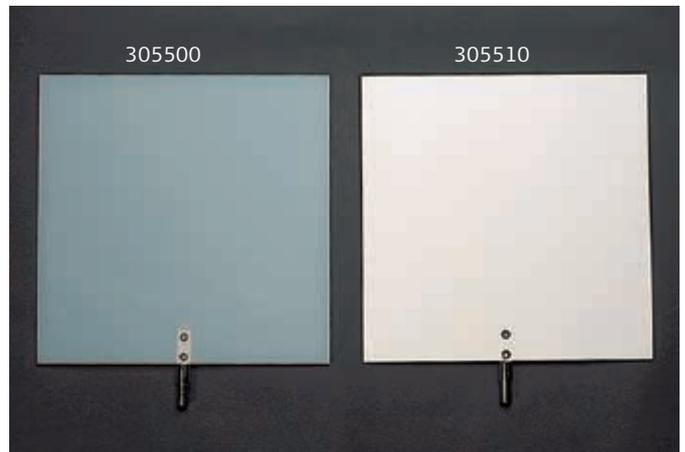
Emits light in a well collimated beam. Focus and the lamp socket's horizontal positioning in its housing can be adjusted by shifting or turning the handle on the rear of the lamp. The Reuter lamp is equipped with a bi-pin connector for 427010 halogen bulbs, 12 V/50 W. The lamp housing is ventilated and its surface temperature will not exceed 50°C.

Power supply: 12 V AC/DC. Consumption: 3 - 4.2 A.

Dimensions, lamp housing: 310 x 76 x 105 mm

Item no. 280050

## PROJECTION SCREENS FOR OPTICAL BENCHES



### Projection screen, white

Projection screen made from matt white laminate. Equipped with  $\varnothing$  10 mm support post.

Screen size: 250 x 250 x 2.5 mm

Item no. 305510



### Aperture holder for Reuter lamp

Holder for apertures, colour filters and the like. The aperture holder is mounted on the Reuter lamp's lens socket, can swivel and accepts apertures mounted in standard slides.

Item no. 280055

### Projection screen, frosted

Made from 3mm plexiglas with one matt side. Equipped with  $\varnothing$  10 mm support post.

Screen size: 250 x 250 x 3 mm

Item no. 305500

## LENSES FOR OPTICAL BENCHES



### Lenses in holder on rod

Lenses mounted in a rectangular shielding sheet (100 x 100 mm) with printed focal length. Fitted with a  $\varnothing$  10 mm steel rod for use with an optical bench.

Item no.	Focal length
295010	+30 cm
295020	+10 cm
295030	+5 cm
295040	-20 cm

### Lens set, $\varnothing$ 50 mm

The set consists of 6  $\varnothing$  50 mm unmounted lenses. They can be mounted in 290201 Lens and aperture holder. The lens set is suitable for a range of optical imaging experiments, determining focal length etc. and also for experiments with laser light. The set includes the following lenses: -5 cm, -10 cm, +5 cm, +10 cm, +20 cm, +100 cm.

Item no. 290300



### Lens and aperture holder

Holder for loose  $\varnothing$  50 mm lenses and 50 x 50 mm apertures. The 80 x 72 mm shielding plate incorporates a spring-loaded holder for lenses and apertures from 1 to 16 mm thick. Excl. saddle.

Item no. 290201

### Lenses, unmounted, $\varnothing$ 50 mm

Item no. 297520 Magnifying glass, converging lens, +20 cm

Item no. 297620 Reducing glass, diverging lens, -20 cm



### Block for 6 lenses

Black block with holes for six lenses or apertures on rods. Dimensions: 40 x 80 x 120 mm

Item no. 576040



## IMAGING - STUDENT EDITION



### Reuter lamp, student

Reuter lamp with ordinary 425040 Incandescent bulb 6V, 1A. Suitable for optical experiments using 291500 Optical table. The lamp housing is black anodised, has a removable rear section, E10 socket, and safety cable sockets. Supplied with  $\varnothing$  10 mm support rod and 1 bulb. Dimensions:  $\varnothing$  30 x 110 mm

Item no. 280020



### Aperture holder on base

Suitable for apertures etc. mounted in 50 x 50 mm slides. Features a shielding plate, 80 x 120 mm, with a heavy, stable metal base.

Item no. 297000



### Lenses in holder with base

$\varnothing$  40 mm lenses mounted in a shielding plate, 80 x 120 mm, with a heavy, stable metal base. Focal length engraved on the plate.

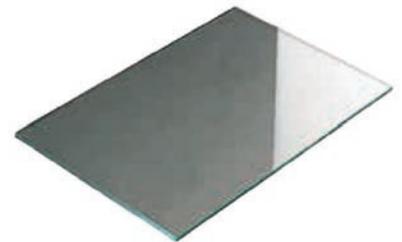
Item no.	Focal length
296500	+30 cm
296505	+20 cm
296510	+10 cm
296520	+5 cm
296530	-20 cm

### Screens and mirrors

To mount in 305000 Plate holder.  
Dimensions:  
180 x 120 x 2 mm

Item no. 304000 Glass plate, clear

Item no. 304020 Glass mirror



### Plate holder

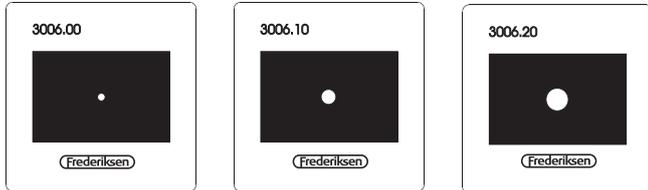
Plate holder for screens and mirrors, made from polished stainless steel. Width: 20 mm; height: 40 mm.

Item no. 305000



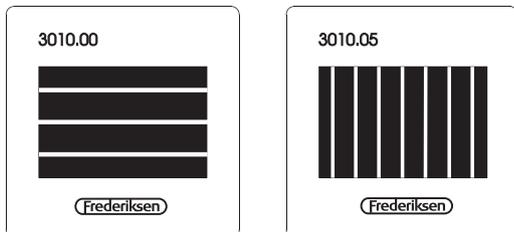
## APERTURES

Unless otherwise stated, all apertures fit aperture holders 295080 and 297000 and are mounted in 50 x 50 mm slides without glass.



### Circular aperture slide

Item no.	Description
300600	aperture $\varnothing$ 1 mm
300610	aperture $\varnothing$ 2 mm
300620	aperture $\varnothing$ 4 mm



### Aperture with slits

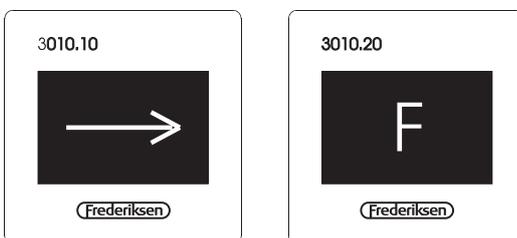
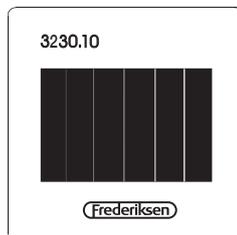
Item no. 301000 Aperture with 3 horizontal slits

Item no. 301005 Aperture with 7 vertical slits

### Single slits, various widths

Aperture for demonstrating the diffraction of light through a slit. The slide includes 5 single slits of different widths: 0.04 - 0.08 - 0.14 - 0.20 - 0.26 mm.

Item no. 323010



### Aperture with arrow

Aperture shaped like an arrow and mounted in a slide with lightly matted glass. Used in imaging applications. Width of slit: 1 mm

Item no. 301010

### Aperture with "F"

Aperture shaped like an "F" and mounted in a slide with lightly frosted glass. In imaging applications, makes it easy to see if the image is inverted.

Item no. 301020

### Matt glass plate

Matt glass plate for optical experiments; dimensions 50 x 50 x 3 mm fits aperture holders 295080 and 297000.

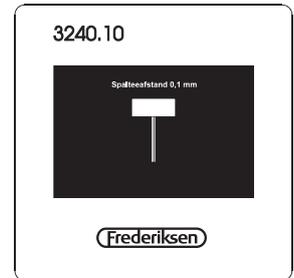
Item no. 301050



### Double slit

Double slit with 0.1 mm spacing.

Item no. 324010



### Aperture holder on rod

Aperture holder for 50 x 50 mm apertures, mounted on a 100 x 100 mm shielding plate. Equipped with  $\varnothing$  10 mm rod.

Item no. 295080



### Iris diaphragm

Aperture, max. opening  $\varnothing$  20 mm, mounted on a 100 x 100 mm shielding plate. Equipped with  $\varnothing$  10 mm rod.

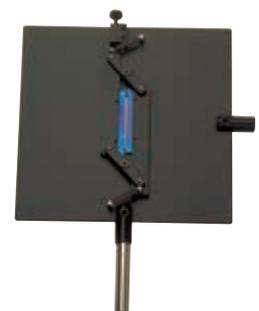
Item no. 296000



### Adjustable slit

Precision slit, 42 mm long, continuously adjustable from 0 to 9 mm using a spring-loaded knob. Made from black-painted brass and mounted on a black anodised aluminium, 150 x 150 mm, shielding plate. Supplied with  $\varnothing$  10 mm support rod which can be fitted both horizontally and vertically to the plate.

Item no. 323000



## MIRRORS



### Set of mirrors, convex/concave

Two unmounted mirrors, one convex, one concave, to fit 290201 Lens and aperture holder.

Dimensions:  $\varnothing$  50 mm. Focal length:  $\pm$ 10 cm

Item no. 290310

### Plane mirror, acrylic

A set of 10 mirrored plastic, non-splinter sheets that can be cut using scissors. Mirrored on one side.

Dimensions: 90 x 65 x 1.2 mm

Item no. 306600

### Plane mirror, glass

Mirrored glass plate for mounting in 305000 Plate holder.

Dimensions: 180 x 120 x 2 mm

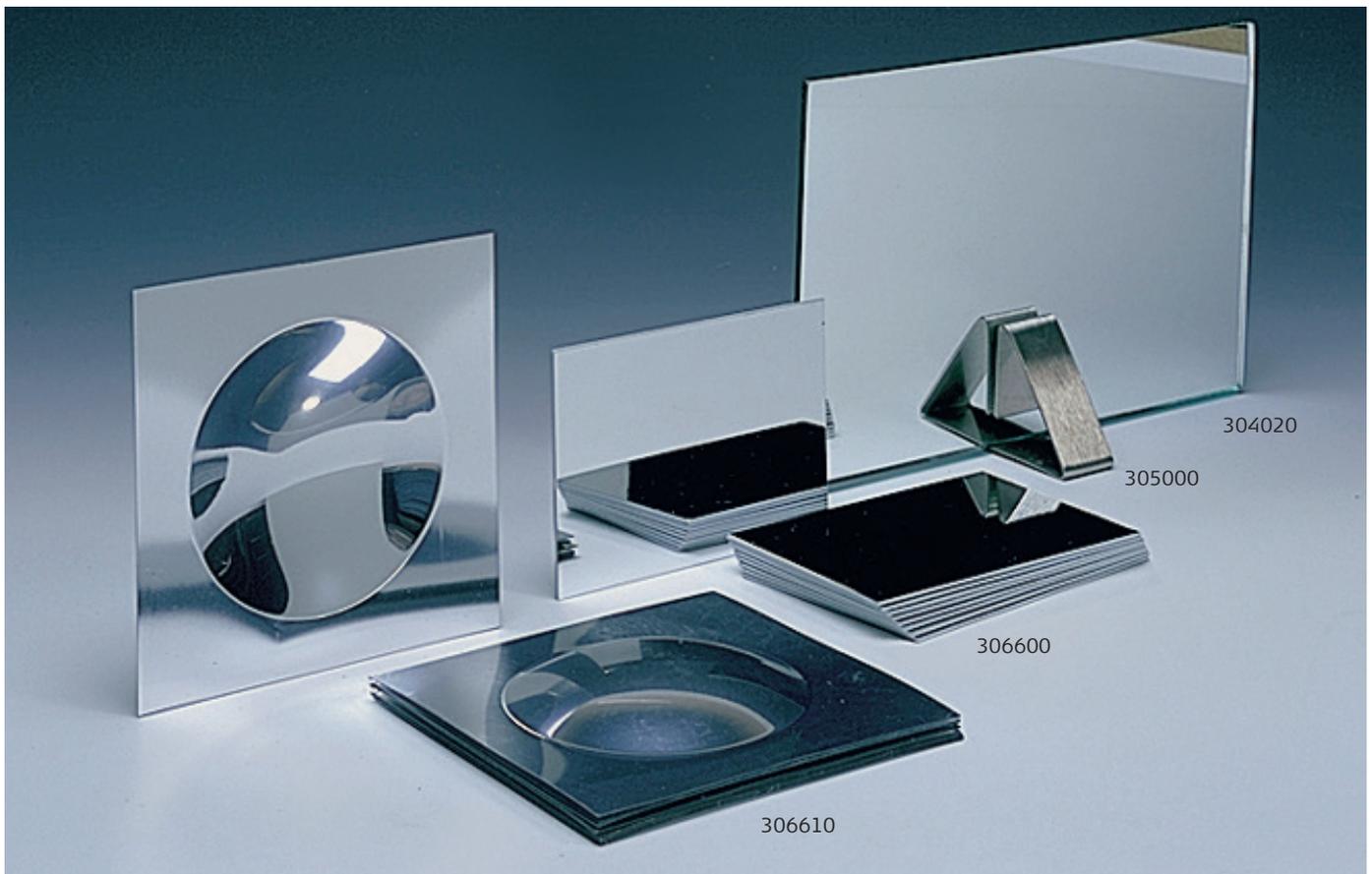
Item no. 304020

### Concave/convex acrylic, small

Plastic sheet mirrored on both sides and moulded into a concave mirror. Contents: 10 pcs.

Dimensions: 100 x 100 x 1.5 mm

Item no. 306610



## DEMONSTRATIONS USING LENSES



### Optical disc

Optical disc, diameter 250 mm, for use on an optical bench. Made from 2.5 mm matt white laminate with centre crosshairs, and graduated per degree. Bolder marking of 10 and 30 degree graduations. The disc is equipped with a  $\varnothing$  10 cm centre pin and supplied with a  $\varnothing$  10 mm support rod, with a fitting for horizontal or vertical mounting. For installation on an optical bench, use Saddle for optical disc (294620).

Item no. 290000



### Lens set

A complete set of plexiglas prisms and mirrors for demonstrating refraction and reflection in conjunction with 290000 Optical disc. The prisms are made from crystal-clear highly polished plexiglas with matt bottom surface. A bendable mirror with attachment screws can function as both a plane mirror and a concave mirror with different focal lengths. The lenses are 19 mm thick and 70 - 80 mm long. The set is supplied in a handy case with foam lining to keep the set tidy and prevent scratches.

Item no. 290100



### Mirror on block

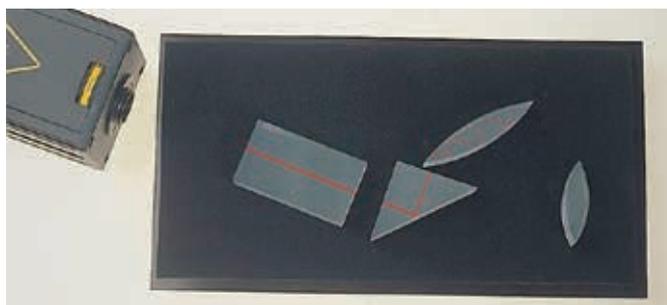
Item no. 290800 Size: 19 x 90 mm

Item no. 292500 Size: 15 x 50 mm

### Pins

100 pcs pins for marking out light paths. For use with lenses and, for example, a styrofoam sheet.

Item no. 291710



### Smoke lens set

Once you have tried smoke lenses in your optics experiments, you'll never go back. Students can see the light beams as they pass through the lenses. Refraction and internal reflection can be observed with unmatched clarity. These lenses are especially suitable for use with lasers. The set consists of 4 x 20 mm thick lens made from a special acrylic resin: two convex lenses with focal lengths of 50 mm and 100 mm, a 90/45° prism and a rectangular block.

Item no. 291200



### Optical table

Optical table with inclined top for projecting parallel beams of light from 280020 Student lamp with 3-slit aperture attachment. The table is supplied with thick 1 cm squared lined paper with a prominent centre line. The table is made from black powder-coated steel sheet. Size, surface: 255 x 180 mm. Height: 72 and 98 mm

Item no. 291500

### Lined paper for optical table

Thick lined paper for 291500 Optical table. With 1 cm<sup>2</sup> grid and prominent centre line. The lines parallel to the centre line are numbered, starting from the centre line. Contents 25 pcs.

Dimensions: 179 x 239 mm

Item no. 291510

## REFRACTION OF LIGHT IN LIQUIDS AND AIR



### Refraction vessel, parallel plane

Plexiglas vessel ideal for optical experiments; features parallel plane sides. Dimensions: 370 x 130 x 150 mm.

Item no. 301500

Item no. 301510 Lid for 301500 Refraction vessel



### Refraction vessel, large

20 L vessel of clear polystyrene with sharp corners to minimise optical distortion. The top edge is bent outwards to create a flat edge. Dimensions: 400 x 220 x 240 mm

Item no. 761525

Item no. 302010 Lid for 761525 Refraction vessel

### Sodium fluorescein

Fluorescent dye for revealing the path of a ray of light; available as a powder or in solution.

Item no. 829800-05 Powder. 50g

Item no. 829900-2 Solution 0.4%  
in ethanol. 200 ml



### Smoke spray

For visualising light beams in air.

Item no. 327305



### Rotatable mirror with indicator

Rotatable mirror mounted on a base. For use in a refraction vessel for observing the angles of incidence and reflection within a fluorescein solution.

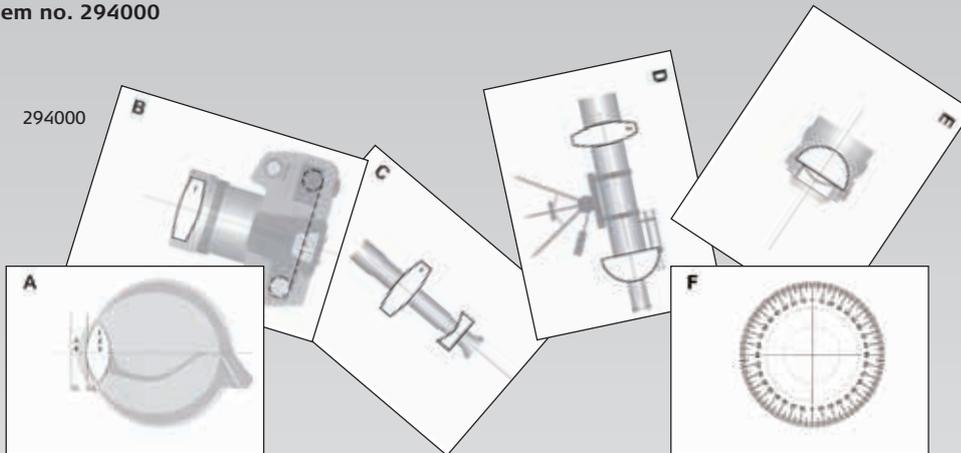
Item no. 302500

## OPTICS SET

### Optics set with lenses

Classic set. Demonstration model with magnetic components. A range of backgrounds (also magnetic) are included, to quickly create models of telescopes, the eye, with or without glasses, and so forth. The set comprises 8 lenses, 3 types of mirror, rectangular and triangular prisms and a model of an optical fibre. A white board (with steel backing) for mounting the components is included. 288790 Laser ray box is a perfect accompaniment to this set.

Item no. 294000



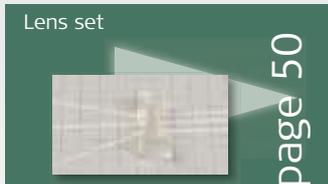
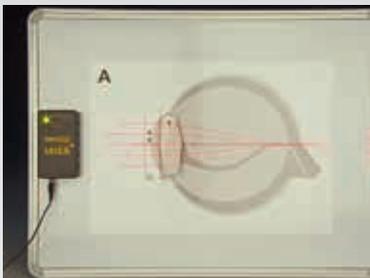
### Laser ray box with 5 rays

Good powerful light source with parallel rays and magnetic rear. A button allows you to select 1, 3 or 5 rays. Suitable for Optics set 294000.

Item no. 288790



288790

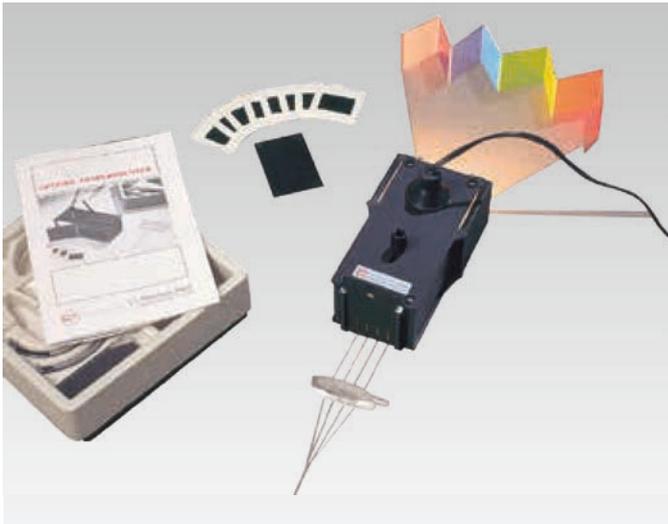


### Optics set with laser ray box

An inexpensive and complete optics set including a laser, used to demonstrate the optical path through lenses etc. Includes magnetic lenses and templates.

Item no. 294100





### Optics set with light box

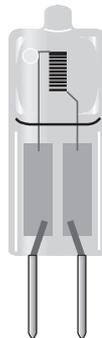
Our classic optics set, comprising a light box, lenses, apertures, colour filters, plane, parabolic and circular mirrors and more – 24 pieces in all. A highly capable set. Up to 3 different colour filters can be inserted at one end of the light box and the coloured light mixed using the adjustable mirrors. Suitable for use in ordinary classrooms, since most experiments can be conducted without needing blackout. The equipment is simply constructed and easy for students to use. The set's key component, the light box, is fitted with a 426555 Halogen bulb (12 V/2 A). The end of the box accepts apertures for creating light rays that can be paralleled using built-in adjustable lenses. Supplied in a practical storage case with compartments for the individual parts. The only required accessory is 670286 Mains adapter, 12 V, or an ordinary power supply. Spare parts are available. Please call for information.

**Item no. 293500**

### Bulb, halogen

Spare bulb, halogen 12 V/2 A for 293500 with pin fittings.

**Item no. 426555**



### Optics set with lenses and light box

A budget version of the popular optics set. Includes many components, including apertures, filters, lenses and mirrors. The light box requires 12 V and 2 A for a power supply or mains adapter (e.g. 670286.). More information available at [www.frederiksen.eu](http://www.frederiksen.eu). Supplied in a case.

**Item no. 293600**



### Mains adapter

Mains adapter for light boxes 293500 and 293600. Specifications: 12 V, 2 A

**Item no. 670286**

## ACTIVITIES WITH LIGHT



### Mirage

You can see it but not feel it! Mirage, as the name implies, is an optical illusion. When teaching optics, Mirage is ideal of piquing students' curiosity.

It consists of 2 concave mirrors placed together. One of the mirrors has a circular opening. If you look through the opening at an object placed on the bottom of the second mirror, the object appears to be floating free in the air. Magic or science? Instructions included.

**Item no. 306700**



### Diffraction glasses

See the world through new eyes! Everything is more colourful with these glasses consisting of a two-dimensional optical grating. Ideal for use in class to demonstrate spectral tubes and the colour spectrum of light. Contents: 10 pcs. The grating has 205 lines/mm.

**Item no. 324560**



### Speed of Light

- Determine a fundamental constant of nature
- Fast and easy setup
- Direct time-of-flight measurements with pulses of light
- Experiments can be performed in a normal classroom

Watch the progressive delaying of light pulses as they travel longer and longer.

Very short but powerful pulses of light are emitted from the box. When the light pulses hit the special retroreflective foil of the reflector they are directed back towards the source – with no need for tedious adjustments. Via a beamsplitter, the light pulses finally hit a high speed photodiode, converting them into electric pulses to be displayed on an oscilloscope. A separate synchronization signal marks the time of pulse emission and constitutes a reference for timing the pulses. Coax cables are included.

The oscilloscope is not included.

Good results are obtained with a 25 MHz (or better) digital oscilloscope - but even a 20 MHz analogue oscilloscope can be acceptable.

**Item no. 201710**



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## COLLISIONS AND THE CONSERVATION OF MOMENTUM



### Air track

The carts on the air track glide almost frictionlessly, making this equipment ideal for investigating uniform motion, uniformly accelerated motion, Newton's 2nd Law, elastic and inelastic collisions. The air track is made of aluminium and is resting on 3 adjustable rubber feet. A rule is fitted on both sides. The ends of the rail have end stops which are mounted using thumb screws. The air track is constructed to have a linear deviation of less than 0.02 mm. Supplied with a standard accessory set consisting of 2 x 196000 and 1 x 195003.

**Item no. 195050**

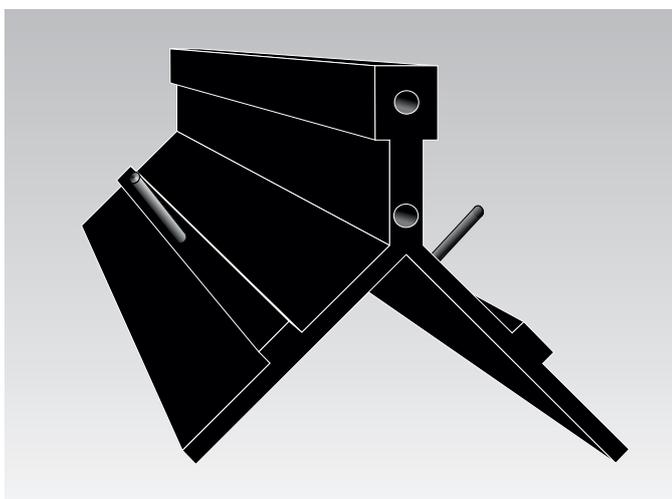


### Accessory set for air track

As the standard accessory set but with no cart.

The set comprises the following parts:

- Weight for cart, 50 g, (196010) 4 pcs
  - Fork with plug, (195500) 3 pcs
  - Holder with mount and plug, (195510) 3 pcs
  - Holder with pin and plug, (195520) 1 pc.
  - Tube with wax and plug, (195530) 1 pc.
  - Holder with hook and plug, (195540) 1 pc.
  - Aperture with plug, 25 mm (195560) 2 pcs
  - Pulley with plug, (196500) 1 pc.
- Supplied in a plastic case.

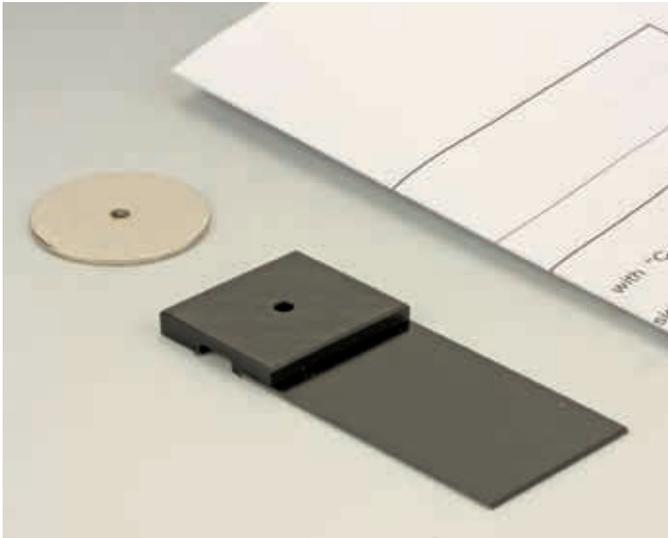


### Cart for air track

Made of black-painted aluminium. Features mounting holes for accessories. Length: 125 mm. Weight: 170 g. Two of these carts are supplied with 195000 Air track.

**Item no. 196000**

## EXTRA ACCESSORIES FOR THE AIR TRACK



### Flag for side mounting

Flag for mounting on the side of cart no. 196000. Supplied with a compensation weight to be placed on the other side of the cart. Total weight: 10 g. Width: 30 mm. For use only with old C-profile air track 195000 and photocell 197515.

Item no. 195585



### Flag with notch

Features a cut-out for starting/stopping old counters of type 2001xx or older using photocell units. Starts and stops the counter in the event of a falling signal. Measuring length: 25 mm.

Item no. 195570



### Slotted weights with holder

Used for accelerating an air track cart. The set consists of a 2 g holder, 2 weights of 1 g, 1 weight of 2 g, 1 weight of 5 g, 1 weight of 10 g. Total weight: 21 g. This allows combinations of weights from 2 g to 21 g.

Item no. 196300



### Air blower for air track

Steplessly adjustable, sound-dampened blower for air track no. 195000. With a fuse and power indicator light. Operating voltage: 230 V, 50 Hz Dimensions: 294 x 251 x 208 mm. Weight: 5.5 kg. Supplied with hose (197001) and mains lead.

Item no. 197070

## Electric launcher

The set consists of an electromagnet whose keeper is fitted to the cart. By mounting a fork with a rubber band (195210) in the electromagnet, the cart can be fired when the current in the electromagnet is interrupted. The force at which it is fired can be altered by tightening or loosening the rubber band. Reproducibility is very high. Contents: Iron core 20 x 20 x 51 mm with mounting screw (196400) Coil 400 windings (462520) Keeper with plug (195210)

**Item no. 195200**

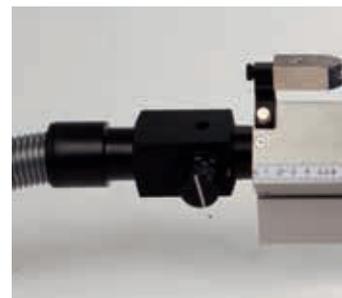


## Air switch

Used to immediately interrupt the air stream to the air track. Made from plastic with a rotary knob for switching off the air supply.

Dimensions: 100 x 50 x 85 mm.

**Item no. 196700**



## Adjustable end stop

For mounting on the air track to shorten its length. Fitted with a 4 mm hole for a plug.

**Item no. 196800**



## Switch box

To be placed between the power supply and the electric launcher 195200. When the switch is operated, the box sends a signal to start counter 200250. Equipped with safety sockets.

**Item no. 198510**



## Coupled harmonic oscillators for air track

Coupled harmonic oscillators allow harmonic oscillations to be studied on the air track. Up to 5 carts can be connected to study coupled harmonic oscillations or wave propagation.

A single cart can be used with one or more springs in order to study a simple harmonic oscillation.

### Set consists of:

- Carts for air track, 3 pcs  
(to supplement the 2 supplied with the air track)
- Weights for carts, 6 pcs  
(to supplement the 4 supplied with the air track)
- Springs, 6 pcs
- Spring holders, 12 pcs
- Adjustable end stop, 1 pc.

**Item no. 197200**



## Protective cover

Protective cover for air track no. 195000. With a lead-filled edging.

**Item no. 196900**



## Photocell unit for mounting on stand

For pendulum period measurements, air track timing, measuring period of rotation etc.

The photocell registers when the light beam in the gap is broken. The unit features control lamps to identify functions. It connects to electronic counters of type 200250 or 200260 using the supplied cable with DIN plug. Similar photocells can be daisy-chained and connected to the same counter input. Made from impact-resistant plastic with threads for vertical and horizontal mounting using the supplied  $\varnothing$  10 mm support post.

Dimensions: 160 x 120 x 28 mm (W x H x D). Gap width: 90 mm.

**Item no. 197550**



### Electronic counter

Universal counter with large display that is easy to read at a distance. The counter is specially designed for classroom counting and timing exercises.

**Start/Stop:** Electronic stopwatch function with a time resolution down to 0.01 ms.

**Collision:** For collision experiments (conservation of momentum). Measures up to 4 passage times using two photocells.

**Acceleration:** Using two photocells, measures passage times and the time between photocells.

**Period:** Measures a signal's period length. For pendulum experiments using photocells, the counter can be set to ignore every second impulse, to obtain the correct cycle time.

**Frequency:** Measures frequencies between 0.01 Hz and 1.25 MHz.

**Count:** Counts (typically radioactivity) either with manual start and stop or for fixed time intervals.

**Item no. 200250**

### SpeedGate

A double photogate with built-in timer and display. By itself capable of precise speed measurements – in addition to all the usual tasks of a single photogate.

Two SpeedGates can be used for collision experiments; the double display will show the two latest measurements.

Connect two (or more) SpeedGates using cable 197571 to measure time interval between the gates e.g. for acceleration experiments. The whole chain is reset with one button press.

Period and Pendulum Period modes.

The timer functions can even be utilised with external signals. For instance: Two microphones (248600 with cable 197571) and a SpeedGate makes a complete setup for measuring the speed of sound.

Easy to work with – the display even orients itself automatically when rotated.

**Item no. 197570**

**Cable: Item no. 197571**

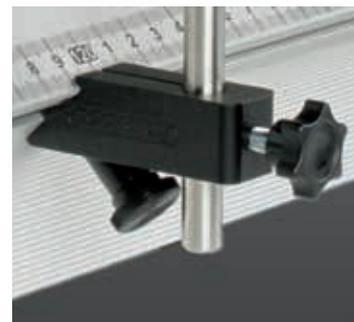
**Cable, safety plug to modular, 1,5 m: Item no. 197572**



### Electronic stopwatch

Designed for timing in conjunction with 197550 Photocell unit, 198010 Free-fall apparatus and microphones. This electronic stopwatch is supplied with batteries and mains adapter. See page 8 for more details.

**Item no. 200280**

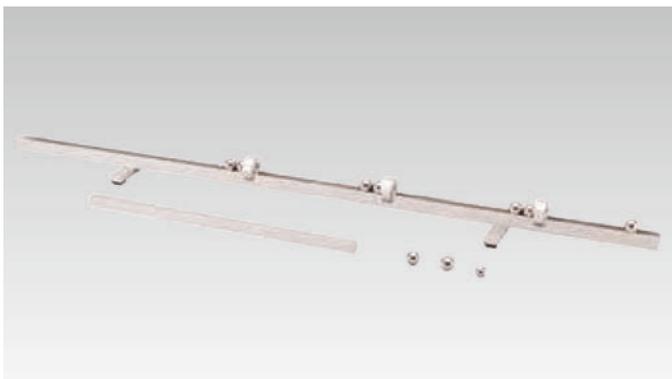


### Mounting bracket

Use this mounting bracket to easily mount the SpeedGate or other photo cell units on the 195050 Air Track.

**Item no. 195055**





### Magnet gun

The magnet gun is a simple but spectacular experiment in which a slowly rolling ball sets in motion a sequence involving several magnets and balls, and ends up shooting out a ball at high speed. The experiment exploits the ball's magnetic attraction. It is a useful jumping-off point for discussing energy, motion, momentum and magnetism. The gun is 100 cm long and is supplied with 10 balls. Guidelines included (Norwegian).

**Item no. 344020**



### Newton's Cradle, large

Collision apparatus which is ideal for introducing the conservation of momentum and kinetic energy in collisions. Features 5 x Ø 25.4 mm nickel-plated steel balls suspended on a robust wooden frame. Dimensions: 227 x 183 x 222 mm

**Item no. 211510**

### Collision apparatus, small

Small, budget version of Newton's cradle with metal stand that operates to the same principles as the larger version 211510.

Dimensions: 124 x 110 x 153 mm, ball Ø 20 mm.

**Item no. 211520**



### Ninja balls

For a convincing demonstration of momentum transfer. Drop the set from a low height and see how high the top ball is able to fly.

**Item no. 211005**



### Happy and sad balls

Elastic and inelastic collisions. The balls look identical, feel identical but behave very differently, since they have extremely different elastic properties. One type repulses any motion while the other acts as if it were "dead".

**Item no. 211010 2x2 balls**

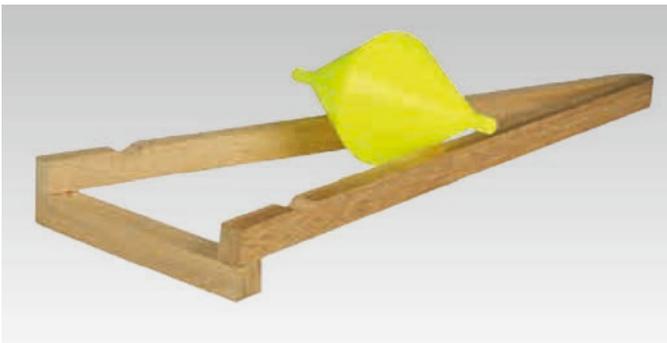
**Item no. 211020 2x10 balls**



### Newton's g-ball

Used for simple experiments with gravity. The ball contains a digital stopwatch that can record from 0.01 to 29.99 seconds. The display is zeroed by holding down the button. Timing starts when you release the ball and stops when it hits the floor/ground. The mechanism is well-protected, and the screen is bright, but the ball must be dropped onto a soft surface. The maximum drop height is approx. 12 m.

Item no. 198020



### Double cone with ramp

The double cone appears to roll uphill when placed at the bottom of the ramp, but does it really? Stimulate students' curiosity with this simple, classical paradox – and try it out on staffroom colleagues!

Item no. 192010



### Air cushion vehicle using balloons

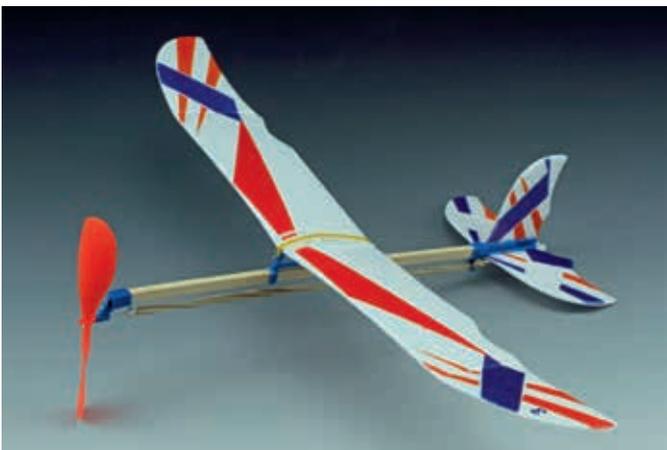
For demonstrating the effect of friction. The vehicle consists of a CD disc with a connector for a rubber stopper with a hole in the centre. The balloon fits onto the rubber stopper. Air from the balloon passes through the hole, making the vehicle hover on the resulting air cushion.

Item no. 194505

### Balloon, round, various colours

Round balloons, suitable for use with air cushion vehicle 194505.

Item no. 194510



### Rubber band powered plane, 16

Item no. 212500

### Rubber band powered plane, 19.7

Item no. 212510



### Tornado cap

Create a tornado in a bottle! This little cap joins two bottles together – one empty and one full. When inverted, the water runs from one bottle to the other, creating a tornado as it goes.

Item no. 161700

## MOTION IN THE GRAVITATIONAL FIELD

### Free-fall tube

For demonstrating that all bodies fall at the same speed in a vacuum. The supplied valve and stopper are fitted in the plexiglas tube. Using a magnet, a steel ball in the tube clamps a small piece of paper, which allows them both to be released simultaneously. For use with, e.g., 069525 Vacuum pump. Dimensions: Ø 30 x 900 mm



Item no. 197700



### Free-fall apparatus

Precise and straightforward device for measuring free fall. The apparatus connects to 200250 Electronic counter or 200260 Electronic stopwatch via standard safety cables. Supplied with two Ø 12 mm and two Ø 16 mm gold-plated steel balls and a ping pong ball with the same mass as one of the steel balls. Find out more at [www.frederiksen.eu](http://www.frederiksen.eu).

Item no. 198010



### Falling bodies apparatus

Ball shooter for illustrating the principle of independent horizontal and vertical motion: The throwing motion can be seen as composed of free-fall and horizontal motion. The shooter fires one ball horizontally and the other is released in free-fall. The supplied 19 mm steel balls are stored in the device.

Dimensions: 180 x 170 x 50 mm

Item no. 199000



### Falling bodies apparatus, linear

Like 199000, this apparatus is used to demonstrate the principle of independence but with the option of a variable horizontal speed.

Item no. 199010

Item no. 199011 Spare balls for Falling bodies apparatus, linear

### Curved ball track for collisions in 2 dimensions

For experiments with elastic and inelastic collisions in two dimensions. At the point of collision, the balls have no vertical motion, so the fall time to the floor is constant. On the floor, the distance covered is measured in two dimensions. This gives the horizontal components of the velocities and, from this, the momentum of each of the two balls can be calculated. The set consists of a curved ball track with mounting hardware, a plumb line, two 12 mm steel balls, one 12 mm glass ball, and a hollow 25 mm wooden ball. Necessary accessories are a Clamp (001510) and Carbon paper (199210).



Item no. 199220

### Carbon paper

10 sheets of A4 carbon paper for recording points of impact. Use with e.g. 199220.

Item no. 199210



### Steel balls

Item no.	Diameter
199710	40 mm
199720	28 mm
199730	25 mm
199740	20 mm
199750	18 mm
199760	16 mm
199770	12 mm
199780	10 mm
199785	6 mm

### Physical pendulum/Bessel pendulum

The physical pendulum is used to study moments of inertia and the motion of rigid bodies. The centre of gravity, pivot point and moment of inertia can be varied in innumerable ways. For calculation, Steiner's theorem is useful, as well as a number of formulae for moments of inertia of the pendulum's different components.

The Bessel pendulum is a reversible pendulum and is used to determine acceleration due to gravity. The reversible pendulum can be inverted – there is a pivot point at each end. The pendulum is adjusted so that the oscillation period is identical for both pivot points, despite their different distances from the centre of mass.

The apparatus consists of a knife bearing, a stainless steel bar with a series of laser-cut holes, two steel bobs and one aluminium one, along with nuts and bolts. Comprehensive instructions are included, with a summary of the relevant theory.

Photocell, counter and stand hardware are not included. A clamp (001510) is recommended for attaching the pendulum.

**Item no. 218100**

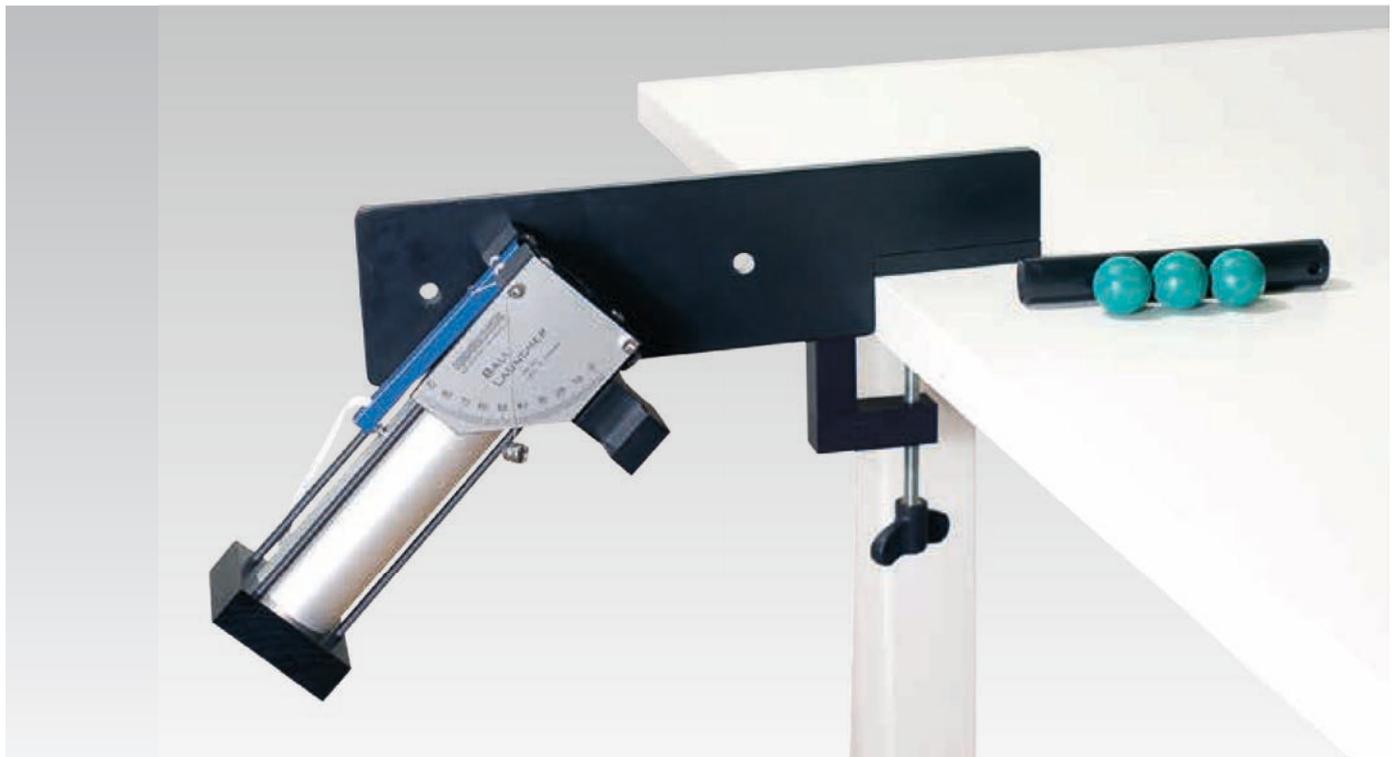
### Ball launcher

The launcher is supplied with a bracket that permits both vertical and horizontal launches (from 0 to 90 degrees). It comes with a ramrod and 3 plastic balls. The spring can be tensioned in 3 different positions in order to achieve different launch speeds and throws. The ball will typically be thrown 1.1 m, 2.3 m and 4.5 m at an angle of 45 degrees. The launcher yields highly reproducible results and the typical impact point deviation will be less than 1%. The launcher is designed so that the launch height is nearly the same for all angles.

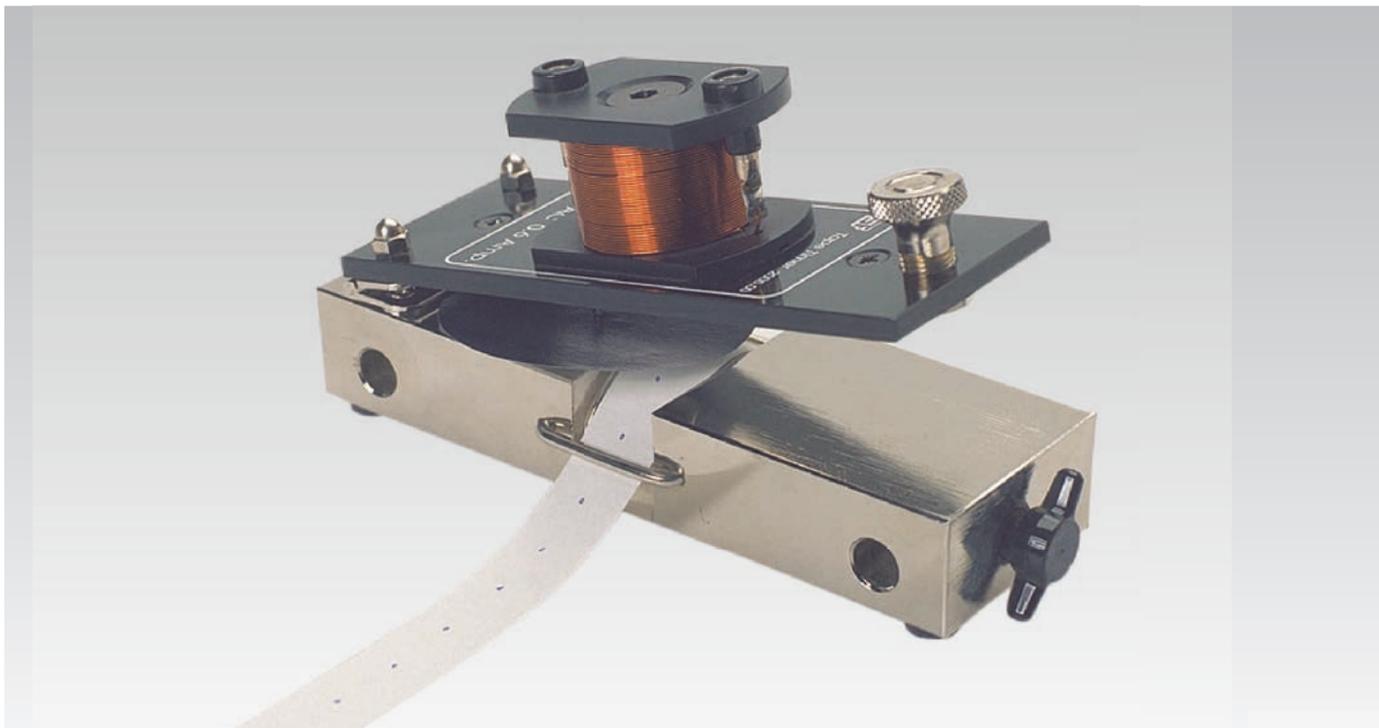
A bracket (199570) is available which can be fitted to the launcher with a thumbscrew to take photocells (from Pasco, Vernier and Fourier) 10 cm apart.

**Item no. 199560**

**Item no. 199570**



## TIMING EQUIPMENT



### Timer

Timer for investigating linear motion. An electromagnet punches dots through carbon paper twice every AC 50 Hz period. This makes dots on the ticker tape at an interval of 0.01 sec. The timer has safety sockets and  $\varnothing$  10 mm holes with wing screws for tightening.

For use with: 200530 Carbon discs for timer and 200520 Ticker tape. The timer connects to AC 6-8 V, 50 Hz. Power consumption: approx. 0.6 A.

**Item no. 200500**

### Carbon discs for timer

Pack of 50,  $\varnothing$  64 mm, carbon discs with central hole for timer no. 200500.

**Item no. 200530**



### Timer weights

Nickel plated iron weights  $\varnothing$  32 mm with attachment mechanism for ticker tape timer.

**Item no. 200550 0.5 kg**

**Item no. 200560 0.25 kg**



### Rod with sleeve

For mounting timer 200500. Painted sleeve with stainless steel  $\varnothing$  10 mm rod. Overall length: 230 mm.

**Item no. 200570**



### Ticker tape

Roll of 325 m ticker tape for timer 200500. Width: 18 mm.

**Item no. 200520**

### Ticker tape holder

Holder for 200520 Ticker tape. Made from black plastic with bearing and  $\varnothing$  10 mm stainless steel mounting rod.

**Item no. 200580**



## ROCKETS

### Rocket with pump

The rocket is filled with a suitable quantity of water and then air is pumped in. The plastic rocket has eyes for attaching to a horizontally tensioned string, allowing it to be fired horizontally powered by CO<sub>2</sub> cartridges fitted in the supplied holder. Pump and launch pad included.

Length: 260 mm.

Item no. 212000 Set



### Accessories for 212000

Item no. 212001 Extra holder

Item no. 212002 Extra rocket 212000

Item no. 212010 Nitrous oxide (N<sub>2</sub>O) cartridge

Item no. 212020 Firing pin, to activate 212010 N<sub>2</sub>O cartridge



### Rocket with launch pad

The rocket is powered by air from a pump with a car valve, e.g. 151520 and can fly up to 70 metres. The launching speed can be varied by choosing from four "stoppers" which cause the rocket to be released at four different pressures. Incl. launch pad with six launch angles (35°-60° and 90°).

Item no. 212300

Item no. 212304 Spare stoppers



### "Rokit" rocket

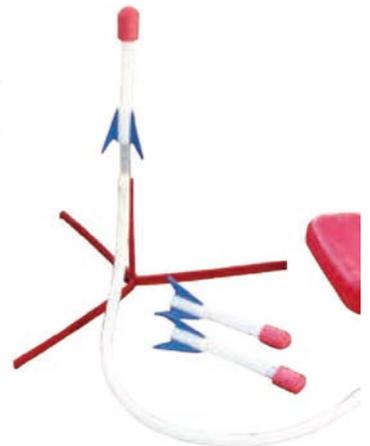
To construct the rocket, half fill the bottle with water and then fit the plug and fins. The bottle is then pumped up with air until the plug releases and the rocket flies off. Includes bottle, control fins, hose with valve but a pump is not supplied. Compatible with 151520 Floor pump with manometer.

Item no. 212100

### Rocket, stomp model

A simple yet fun rocket that flies higher the harder you stomp on the air cushion. The rockets have a soft rubber cap so as not to damage anything they hit. Expected max. height: 20 m. The set is supplied ready for use, including 3 rockets, launch pad, air hose and air cushion.

Item no. 212121



### Spare rocket for 212121

Item no. 212122

### Floor pump with manometer

Floor pump with manometer, suitable for rocket launches. Compatible with 212300 and 212100.

Item no. 151520



## PERIODIC MOTION



### Mathematical pendulum with suspension

For investigating the oscillation period of an ideal (simple) pendulum, where the entire mass is in the bob. Consists of two-point suspension, pendulum string and two lenticular bobs of different materials but the same volume. The bobs have different masses, but the same air resistance.

Item no. 218210

### Prytz oscillation apparatus

For demonstrating Hooke's Law and studying harmonic motion of an oscillating mass suspended from a spring. A mirrored scale prevents parallax errors. Supplied with a weight holder and four weights of 10, 20, 50 and 100 g and three different sets of springs. For mounting on a  $\varnothing$  10 mm support post. Use, for example, 000840 Support post and 000100 A-base (not incl.).

Item no. 218000

### Spring set for Prytz oscillation apparatus

Spare spring set for 218000.

Item no. 218001



### Set of springs

Five springs of the same length but with different spring constants. Each have an eye at one end and a hook at the other.

Item no. 215580



### Spiral springs, oscillations

Our series of springs designed for elastic oscillations are available in different sizes and spring constants.

Item no.	Diameter	Length	Spring constant
215510	11 mm	32 mm	approx. 8.4 N/m
215520	11 mm	74 mm	approx. 3.2 N/m
215530	11 mm	115 mm	approx. 2.1 N/m
215540	31 mm	33 mm	approx. 5.0 N/m
215550	27 mm	155 mm	approx. 4.7 N/m

### Tip:

The windings in these springs are tight. We recommend extending them before using them in experiments. Fix one end and draw the spring out in a controlled fashion several times until there is suitable separation between the windings. This will also then allow a reactive force when compressed.

## ROTARY MOTION



### Conical pendulum

The uniform circular motion of the conical pendulum allows the following to be investigated: centripetal force vs radius of orbit, centripetal force vs orbital period and determination of  $g$ .

The disc moves almost without friction on its ball bearing, while the bob's angle with the vertical is read on the graduated, balanced disc. The pendulum's length can be varied using four interchangeable wires with hooks. 207010 Conical pendulum is specially designed for 202550 Gear motor (not included).

**Item no. 207010**



### Gear motor with winding shaft

The gear motor operates on 0 - 12 V DC and yields gearing of 21:1 with a stable, slow motion. The motor is fitted with a removable winding shaft. With a thread, it can be used for slow, linear motion. The motor is suitable for use with 207010 Conical pendulum.

**Item no. 202550**



### Bicycle wheel gyro

For demonstrating the conservation of angular momentum. The system's moment of inertia is adapted to the rotating platform with stool no. 213500. Supplied with 1.5 m of nylon cord with handle.

**Item no. 213600**



### Rotating platform

For demonstrating the conservation of angular momentum. The system consists of a rotating  $\varnothing$  480 mm platform with a stool. Equipped with 5 legs, ball bearings and levelling screws.

Height: 150 mm

Weight: 9.5 kg

**Item no. 213500**



### Rotary bearing with pulley

The rotary bearing consists of a pulley, with a sleeve and thumbscrews to attach to a  $\varnothing$  10 mm rod. The bearing is mounted on a  $\varnothing$  10 x 110 mm rod with doubled, dust-proof ball bearings. The sleeve is made from anodised aluminium. The rod is stainless steel. Length: 200 mm.

**Item no. 205500**



### Motor mounted on base

2-6 V DC motor mounted on a base with two safety sockets. Pulley included.

Dimensions: 70 x 100 mm

**Item no. 472010**



### Motor/generator with winding shaft

The original Frederiksen universal motor/generator. Sturdy, smooth-running DC motor which can also be used as a generator. Fitted with a dual pulley with cylindrical winding shaft with choice of diameter:  $\varnothing$  8 /  $\varnothing$  12 x 12 mm. With a  $\varnothing$  10 x 35 mm stainless steel support post. Operating voltage: 0-12 V DC. Connects using safety sockets.

Dimensions: 225 x 40 x 40 mm.

**Item no. 202500**

### Flywheel

For demonstrating energy storage. Steel flywheel  $\varnothing$  60 mm, with  $\varnothing$  12 mm hole for mounting on motor/generator 202500.

**Item no. 501000**



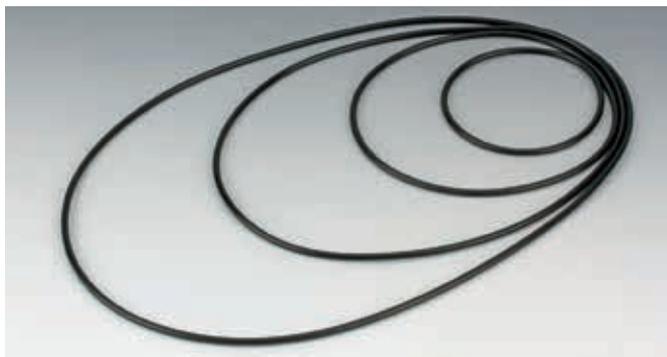
### Stroboscope discs

Used to freeze motion. Can be used with motor no. 202500 and a lamp to produce stroboscopic light. Made from overprinted clear plastic.

Diameter: 170 mm. Mounting hole:  $\varnothing$  8 mm.

**Item no. 202000 Stroboscope disc 1 aperture**

**Item no. 202010 Stroboscope disc 12 apertures**



### Drive belts, set

Set of 4 flexible drive belts made from black synthetic rubber. The belts measure approx. 240 mm, 390 mm, 580 mm and 780 mm. Oil-resistant.

**Item no. 203700**



### Drive belt, long

Drive belt made of 2 mm square-section elastic. Pack of 10. Circumference: 400 mm

**Item no. 203710**

## SPRING SCALE DYNAMOMETERS



### Dynamometers, Frederiksen

Our original, precision spring scale dynamometers made from clear acrylic, with the upper section coloured according to the measurement range. The dynamometer can be zeroed.

Size 0.1 N – 20 N: Ø 16 x 265 mm  
 50 N – 100 N: Ø 20 x 310 mm

Item no.	Measurement range	Graduation	Colour
103800	0.1N	0.002N	Silver
103810	0.2N	0.004N	Beige
103820	1N	0.02N	Yellow
103830	2N	0.04N	Red
103840	5N	0.1N	Blue
103850	10N	0.2N	Green
103860	20N	0.4N	Purple
103870	50N	1N	Orange
103880	100N	2N	Gold



Item no. 103910 Case only, foam-lined



### Dynamometer

Acrylic dynamometer at a budget price.

Item no.	Measurement range	Graduation	Colour
103710	2.5 N	0.05 N	Blue
103720	5 N	0.1 N	Green
103730	10 N	0.2 N	Brown
103740	20 N	0.5 N	Red
103750	50 N	1 N	Yellow



### Set of dynamometers in case, Frederiksen

Nine different precision dynamometers of types 103800 – 103880 with ranges 0.1-0.2-1-2-5-10-20-50-100 Newton. Supplied in a handy, foam-lined, partitioned case. Case size: 327 x 275 x 55 mm.

Item no. 103900

## FORCES AND WEIGHTS

### Friction blocks

Block with a hook for demonstrating the relationship between friction and different surfaces. Two versions available.

**Area:** Two different surface contact areas.

Dimensions: 300 x 50 x 25 mm

**Item no. 192510**

**Roughness:** Four different surface materials: rubber, felt, sandpaper and wood. Dimensions: 60 x 60 x 300 mm

**Item no. 192500**



### Force board

Inclined plane in aluminium with holder for dynamometer.

Length: 1 m

**Item no. 193810**



### Force table

For demonstrating the parallelogram of forces (vector addition of forces). Three free-running pulleys that can be fitted arbitrarily around the edge of the table. The magnitudes of the three acting forces can be altered using the three supplied slotted weights.

The kit includes: Graduated scale and rotating protractor, spirit level, holders (3 of 10 g each), weights (3 sets of 1 x 50, 5 x 20, 1 x 10, 2 x 5 g).

**Item no. 208400**

### Lever arm

Lever with holes showing arm length from the centre of mass. Made from 2-mm nickel-plated brass.

Dimensions: 320 x 15 mm

**Item no. 190500**



### Rod with pin

For suspending 190500 Lever arm. Made from stainless steel. Length: 95 mm.

**Item no. 190510**



### Weights with hooks – assortment

Two sets of weights with hooks at both ends: 2 x 200 g, 2 x 100 g, 2 x 50 g, 2 x 20 g, 2 x 10 g, 2 x 5 g.

**Item no. 191090**

### Weights with hooks

Weights with hooks at both ends.

**Item no. 191002 200 g - Item no. 191005 100 g**

**Item no. 191025 50 g - Item no. 191055 20 g**

**Item no. 191075 10 g - Item no. 191085 5 g**

### Slotted weights with holder

Slotted brass weights individually marked with their masses. Holder: 50 g. Weights: 9 x 20 g, 1 x 10 g and 2 x 5 g.

**Item no. 217710**



### Weights with hooks, set

Set of weights that can be hooked to each other (except for the 10 g one).

Contents: 1 x 1000 g, 1 x 500 g, 2 x 200 g, 1 x 100 g, 1 x 50 g, 2 x 20 g, 1 x 10 g.

**Item no. 670119**



### Pendulum bobs

Item no.	Item name	Material	Size
216500	Pendulum bob	Brass	Ø 18 x 43 mm
616510	Pendulum bob	Aluminium	Ø 18 x 43 mm
216600	Pendulum bob	Wood	Ø 25 mm
216610	Pendulum bob	Steel	Ø 25 mm
216620	Pendulum bob	Lead	Ø 25 mm
216000	Ball with eye	Steel	Ø 28 mm
216010	Ball with eye	Steel	Ø 20 mm

## PULLEYS

Pulleys are very useful for mechanical experiments using drives, cranes and hoists.



### Pulley on a rod

Plastic pulley, Ø 50 mm, mounted on a stainless steel rod.  
Size of rod: Ø 10 x 200 mm.

Item no. 208500



### Pulley with clamp

Plastic pulley, Ø 50 mm, fitted with a clamp, for mounting on standard Ø 10 mm support posts.

Item no. 209500



### Pulley with hooks

Plastic pulley, Ø 50 mm, with hooks at both ends.

Item no. 210610 Single pulley for tackles

Item no. 210620 Double pulley for tackles

Item no. 210630 Triple pulley for tackles



### Tackle, three-part

Three plastic inline pulleys of Ø 50 mm, Ø 40 mm and Ø 30 mm, with hooks at each end.

Item no. 210640



### Pulley with eyes

Free-running pulley with Ø 50 mm sheave of extra robust plastic, featuring a deep V groove to prevent the cord slipping out.

Item no. 210500 Single pulley for tackles

Item no. 210510 Double pulley for tackles

Item no. 210520 Triple pulley for tackles

## CONSTRUCTION KITS



### Big Wheel of Effects – gear construction set

Use gears to build different machines. 7 different suggested models with gears, chains, wheels and more besides. Ideas include a cable car, a lift and a roundabout. Contains 235 parts and assembly instructions.

Item no. 210815



### Super Water Power kit

Build more than 30 different models with motors powered by water or air. Pump water or air to make the vehicle move. Discover and learn lots about air pressure, water pressure, forces and energy. Easy-to-read instructions included. Contains 176 parts.

Item no. 210822



### Water Power – vehicles construction set

Build 15 models of cars and machines that use water and air pressure to operate.

Be astonished at how much energy can be stored in compressed air. Detailed building instructions for 15 models included. Contains 165 parts.

Item no. 210821



### Project pack of 25 cars

Provides essentially everything you need to build 25 cars. The kit includes axles, motors, wheels, gears, drive belts, leads, batteries, battery holders, switches, bulbs, sockets, and more besides. You should anticipate needing some tools and bodywork materials that are not included.

The materials in the pack can be added to later on. Extra parts are listed on the next page. Supplied with instructions (Norwegian).

Item no. 670291

## MECHANICS

### MODEL BUILDING SUNDRIES

#### Motor, unmounted

2-6 V DC. Axle  $\varnothing$  2 mm.

Item no. 472000



#### Spring clip for motor 472000

Steel with screw hole.

Item no. 472002



#### Spring clip, plastic for motor 472000

Plastic with screw hole and adhesive pad.

Pack of 10.

Item no. 670179



#### Pulley set for motor 472000

Pack of 5.

Item no. 670175



#### Pulley 20 mm

Pack of 5, fit 4 mm axles.

Item no. 670185



#### Pulley 30 mm

Pack of 5, fit 4 mm axles.

Item no. 670186



#### Pulley set

The pack contains 24 pulley wheels. 6 each of  $\varnothing$  50 mm,  $\varnothing$  40 mm, 30 mm and 20 mm. Fit  $\varnothing$  4 mm axles.

Item no. 670187

#### Solar cell motor

1,5-6 V. Motor  $\varnothing$  30 mm. Axle  $\varnothing$  2 mm.

Item no. 670182



#### On-off switch

Item no. 670163



#### Buzzer 3 V

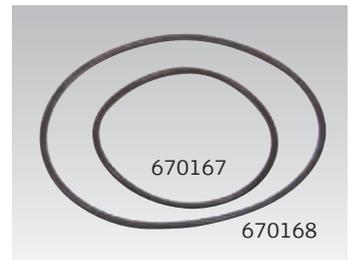
Item no. 670166



#### Drive belt $\varnothing$ 60 mm

Pack of 5.

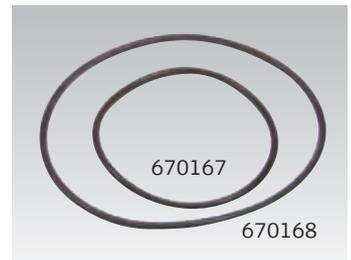
Item no. 670167



#### Drive belt $\varnothing$ 90 mm

Pack of 5.

Item no. 670168



#### Wheel pack with axles

The pack includes:

- 10 pcs 40 mm plastic wheels
  - 10 pcs 50 mm plastic wheels
  - 10 pcs 38 mm plywood wheels
  - 10 pcs 50 mm plywood wheels
  - 100 pcs 40 mm cardboard wheels
  - 100 pcs 50 mm cardboard wheels
  - 40 pcs 300 mm axles
- All wheels have 4 mm holes.

Item no. 670169

**Wheel pack,  
various colours**

Pack of 100 wheels,  
Ø 39 mm and 4 mm hole.

**Item no. 670170**



**Wooden splints**

Pack of 100 wooden splints.  
Ø 4 mm x 22 cm.

**Item no. 670180**



**Hole reducers 4 mm  
to 2 mm**

Pack of 20.

**Item no. 670171**



**Axle mounts**

Pack of 100. For 4 mm axles.

**Item no. 670162**



**Wire 6 x 10 m**

Tinned and plastic-insulated  
copper wire, 7 core, each  
0.20 mm in diameter.  
Outer diameter 1.2 mm.  
Pack of 6 rolls in different  
colours.

**Item no. 670173**



**Adhesive pads**

Pack of 500.

**Item no. 670181**



**Three-bladed  
propeller**

Pack of 10 x 120 mm plastic  
propellers. Fit 2 mm axles.

**Item no. 670178**



**Gear wheels,  
various colours**

The pack contains:  
20 x 4 gears with 10, 20, 30  
and 40 teeth and 20 x 75 mm  
toothed racks.

The gear wheels fit 4 mm axles.

**Item no. 670184**



**Four-bladed  
propeller**

1 x 58 mm plastic propeller.  
Fits 2 mm axles.

**Item no. 670172**



**Binding wire**

Galvanised steel wire.  
Ø 0.8 mm x 50 m. 500 g roll.

**Item no. 116100**



## BASIC ELECTRICAL EQUIPMENT

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## POWER SUPPLIES

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### Choosing the right power supply

The power supplies we sell most of are used to power low-voltage experiments (less than 25 V).

We have several models in this category, so which to choose?

The first thing to note is that a power supply lasts for many years. It is difficult to look 10 or 15 years into the future, but an extra investment now might save you both money and inconvenience if your needs change. That said, let's examine the different parameters to consider.

### The quality of the direct current (DC):

Rectified (pulsating DC voltage) – Fine, if you are only powering bulbs and motors.

Rectified and smoothed – As above, and for set-ups where voltage and current are measured – especially for relatively low-current applications. Not recommended with data acquisition equipment, for example.

Stabilised – Supplies "genuine" direct current. Can be used in all contexts – for electronics and data collection – and other situations, where ripple (residual pulsating DC) would interfere.

### The quality of the alternating current (AC):

The vast majority of power supplies for AC (not only Frederiksen's) use a variable transformer or a fixed tap on a transformer. A lot of the noise from the 230 V mains voltage will reach this output, and when applying a load to the DC section, unwanted bulges will typically be produced in the AC.

Our top-of-the-range models in the 3640xx series create the AC synthetically – the waveform is a smooth sine wave independent of noise on the grid or the DC load.

### Overload protection / current limiter

All our power supplies are designed to handle an overload or a direct short circuit without damage.

An overload protection or short circuit protection will completely disconnect the power supply when it is overloaded. After a short while, it can be turned back on.

A current limiter manages the task more elegantly, and reduces the voltage in order to prevent the maximum current being exceeded. Once the overload has been removed, the voltage is automatically readjusted. (See below for tips on the use of a variable current limiter.)

Frederiksen's 3640xx series is equipped with a unique AC limiter in addition: If you try to draw too much current, the voltage will be reduced – but the waveform will remain a sine wave.

### How to use the variable current limiter

The current limiter is known as the 'bulb saver' for good reason – but other (perhaps far more expensive) components can also be protected against overloading.

On models with a screwdriver-adjustable current limiter, you also avoid little busybodies changing the setting.

If you wish to avoid the current in a particular set-up exceeding a certain value, proceed as follows:

1. The voltage must be greater than 0 V, when adjusting the current
2. Short circuit the outlet using a lead
3. Adjust the current until the ammeter displays the desired value
4. Remove the short circuit

But the current limiter is not just a "smart fuse".

In experiments with electromagnetism, you are often interested in having a specific value for the current, while the voltage is irrelevant. If you simply use the voltage knob to adjust the current, this will often drift once the set-up warms up. But it may be rather hopeless to hit the correct current setting if resistance in the circuit is very low.

In this case, it is easier to adjust the current using the current limiter. So here the voltage regulation just needs to be "high enough" – the actual voltage will be held down by the current limiter.

P.S. Do yourself and us a favour: If one of your colleagues claims that the power supply is broken, check that the current limiter hasn't been turned right down before sending the device in for repair.



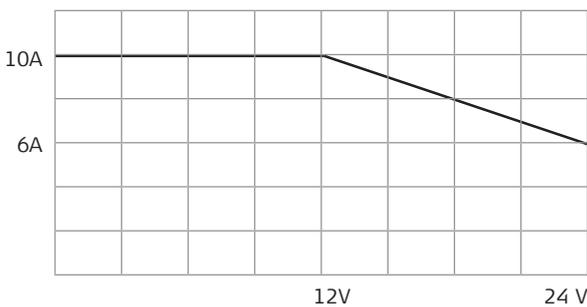
**Stabilised power supply 0-24 V AC/DC**

A very versatile power supply for all low-voltage experiments. Individual continuously adjustable voltages. Four displays show current and voltage for both AC and DC. Continuously adjustable current limiter for DC. Electronic current limiter for AC. Lightweight – easy to transport.

**Specifications:**

**DC:**

- Output voltage: continuously adjustable: 0 - 24 V
- Output current (0-12 volt): 0 - 10 A
- Output current (12-24 volt), falling linearly: 0 - 10/6 A



- Protection: Electronic
- Ripple and noise: < 25 mVpp
- Digital read-out: 1% ± 2 LSD

**AC:**

- Output voltage: continuously adjustable: 0 - 24 V
- Output current: 0 - 6 A
- Protection: Electronic
- Digital read-out: 2% ± 2 LSD
- Dimensions: 312 x 225 x 117 mm
- Weight: 2.5 kg

**Item no. 364000**



**Stabilised power supply 0-24 V AC/DC – screwdriver-adjustable current limiter**

The same as 364000, but the current limiter can only be adjusted using a screwdriver.

**Item no. 364010**



**Stabilised power supply 0-24 V AC/DC – screwdriver-adjustable current limiter – for recessed installation**

The same as 364010, but for recessed installation.

**Item no. 363022**



### Power supply 0-500 V

Used for powering electron beam tubes and other equipment requiring stabilised voltage of up to 500 V at relatively low current.

The device also supplies two auxiliary voltages: An adjustable negative voltage down to -50 V, connected in series with the 500 V supply, and a selectable AC voltage which is galvanically isolated from the other two.

Both voltages are continuously adjustable. Voltage and current can be read digitally on the display. A switch is used to select which of the two outputs to measure.

The AC voltage output can provide up to 3 A and is equipped with overload protection.

#### Specifications:

##### DC

Voltage: -50 – 0 – +500 V continuously adjustable

Current: max. 50 mA

Ripple: less than 0.1%

##### AC

Voltage: 2, 3, 4, 5, 6 or 7 V selectable

Current: max. 3 A

Dimensions: 312 x 225 x 117 mm

Weight: 4.55 kg

NB: Not for use by students.

**Item no. 365575**



### Power supply 0 – 6000 V DC

This power supply delivers stabilised DC, continuously adjustable between 0 and 6 kV. For safety, the current is limited by a built-in series resistance.

The short-circuit current is max. 2 mA. under load, the voltmeter shows the actual supplied voltage.

The power supply is also capable of delivering 6.3 V (max. 3 A) of alternating current for e.g. filament current ect.

The high voltage section floats relative to ground, allowing a voltage range of 0 to +6 kV or 0 to -6 kV relative to ground.

This power supply is ideal for experiments with electron beam tubes, electrostatics, Milikan's apparatus and others.

#### Specifications:

DC

Voltage: 0 - 6 kV, continuously adjustable, stabilised

Short-circuit current: 2 mA (max.)

Ripple and noise: < 1%

Read-out precision: 1% + 1 digit

AC

Voltage: 6.3 V

Current: 3 A (max.)

Dimensions: 312 x 225 x 117 mm

Weight: 4.2 kg

**Item no. 367060**



### Power supply 0-24 V AC/DC with display

Continuously adjustable voltages. The DC voltage is full-wave rectified and smoothed, but not stabilised. The display can be switched between the AC and DC output voltages.

The power supply features overload protection.

#### Specifications:

##### DC:

Voltage: 0 - 24 V, continuously adjustable

Current: Max. 5 A

Ripple and noise: Max. 5 V

##### AC:

Voltage: 0 - 24 V, continuously adjustable

Current: Max. 5 A

Dimensions: 256 x 225 x 117 mm

Weight: 6 kg

Item no. 361870



### Power supply 2-24 V AC/DC

The same as 361055, but the voltage increments are 2 V. Max. current 5 A.

Item no. 361065



### Power supply 12 V AC/DC 3 A

The power supply delivers stabilised DC, continuously adjustable from 0 to 12 V. Also supplies AC, selectable between 2, 4, 6 and 12 V. The AC voltage is not stabilised. Both outputs have overload protection. The DC channel is electronically protected and automatically reconnects while the AC channel has a circuit breaker which must be manually reconnected if it trips.

#### Specifications:

##### DC:

Output voltage: 0 - 12 V stabilised, continuously adjustment

Output current (max.): 3 A

Ripple and noise (max.): 100 mV

##### AC:

Output voltage: 2 - 4 - 6 - 12 V, selectable

Output current (max.): 3 A

Power consumption: 110 W (Max.)

Dimensions: 203 x 225 x 117 mm

Weight: 3 kg

Item no. 361600



### Power supply 1-12 V AC/DC

Voltage selectable in 1 V increments.

The DC voltage is full-wave rectified, but neither smoothed nor stabilised.

The power supply features overload protection.

#### Specifications:

##### DC:

Voltage: 1 - 12 V (unfiltered), selectable in steps of 1 V

Current: Max. 6 A

##### AC:

Voltage: 1 - 12 V (RMS), adjustable in steps of 1 V

Current: Max. 6 A

Dimensions: 203 x 225 x 117 mm

Weight: 2.8 kg

Item no. 361055



**Power supply 0-30 V, 20 A DC**

The power supply for the power hungry. Only supplies DC. The voltage is continuously variable between 0 and 30 V. The current limiter is continuously adjustable between 0 and 20 A. Digital display of current and voltage.

Dimensions: 310 x 265 x 135 mm

Weight: 17 kg

Item no. 362570



**Universal power adapter**

Universal DC power adapter with new, power-saving switch mode technology, which keeps the standby consumption down to 0.2 W. Meets new standards for reducing standby energy losses and hence CO<sub>2</sub> emissions.

The power saving is up to 90% in standby mode compared with older power adapters. In addition, power savings in operation are up to 30%.

Includes 7 adapter tips: USB female, 2.5 mm jack, 3.5 mm jack, 3.5 x 1.35 mm DC plug, 5.0 x 2.1 mm DC plug, 5.5 x 1.5 mm DC plug, 5.5 x 2.5 mm DC plug.

With LED power indicator. Short-circuit, overheating and overload protection.

**Technical specifications:**

AC input voltage: 100 - 240 V  
 DC output voltage: 3 - 4.5 - 5 - 6 - 7.5 - 9 - 12 V  
 Output: Max. 18 W  
 Standby consumption: 0.3 W  
 Output current: 1500 mA

Item no. 355035



**Power supply 15 V, 3 A DC**

Compact DC power supply with two separate digital displays for voltage and current. Equipped with safety sockets.

**Specifications:**

Voltage: 15 V smoothed and continuously adjustable

Current: 3 A max.

Dimensions: 27 x 15 x 9.5 cm

Weight: 2.9 kg

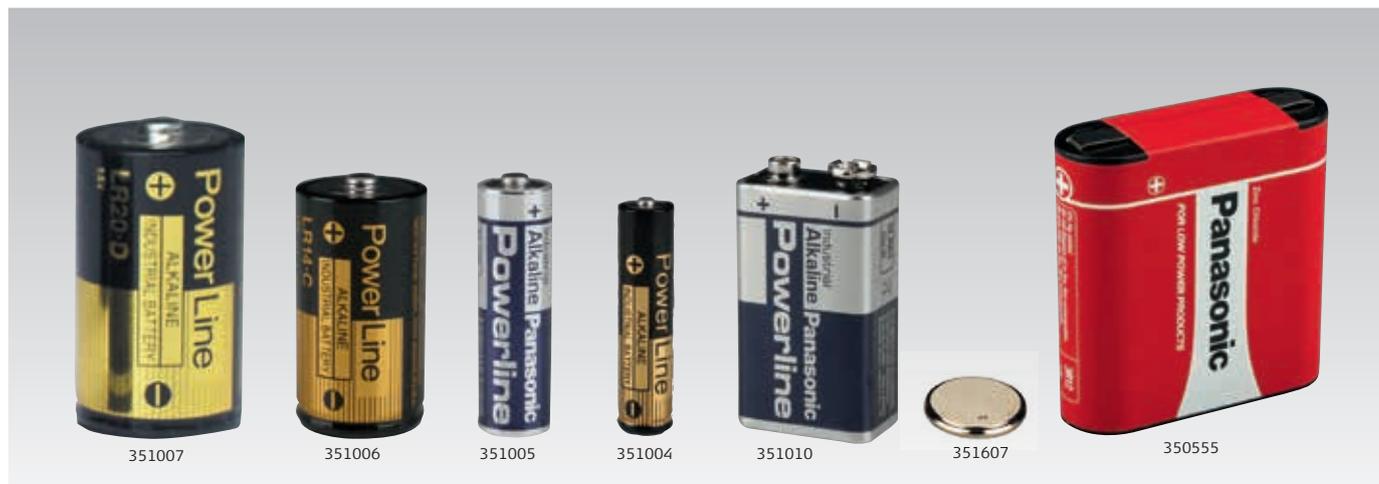
Item no. 362510



**Power adapters for specific devices**

Item no.	Technical specifications	Suitable for
355050	12 V / 1.5 A - 2.1 mm DC plug.	406050 221100 200260 513600
670286	12 V 2 A with safety plug	293500 293600

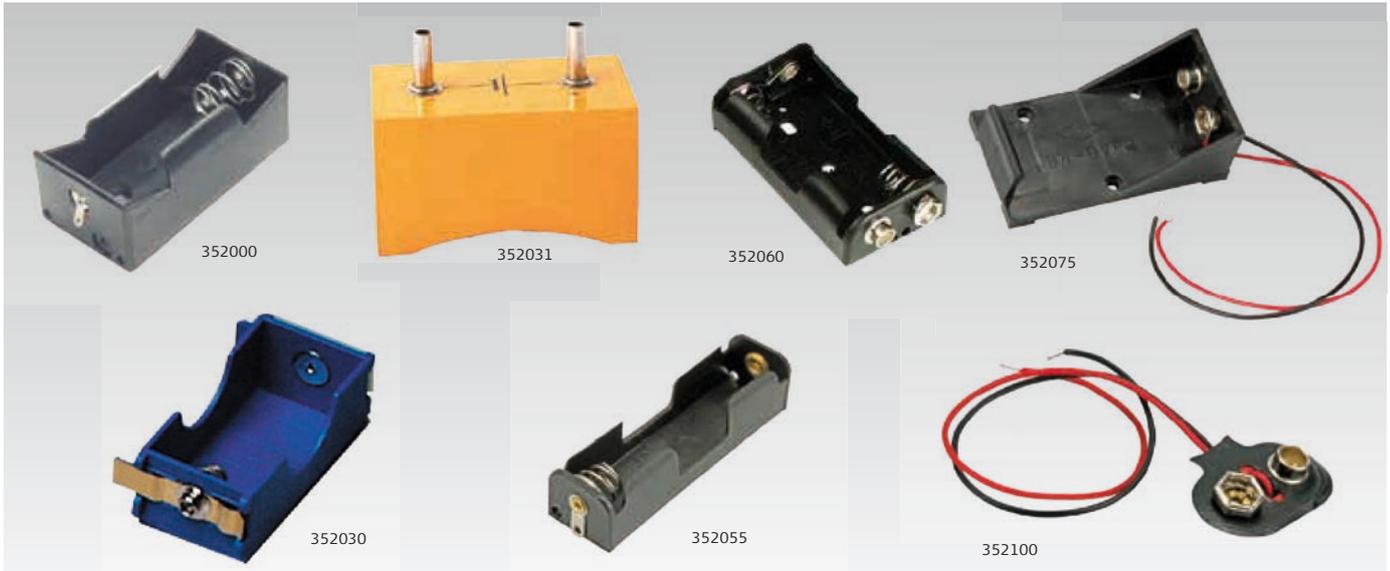
## BATTERIES AND ACCESSORIES



### Batteries

See applicable volume discounts at [www.frederiksen.eu](http://www.frederiksen.eu)

Item no.	Type	V	Code	Dim./mm	Sales qty
<b>Standard cylindrical 1.5 V batteries</b>					
351004	Alkaline	1.5	AAA	Ø 10 x 43	4 pcs
351005	Alkaline	1.5	AA	Ø 14 x 49	2 pcs
351006	Alkaline	1.5	C	Ø 25 x 49	4 pcs
351007	Alkaline	1.5	D	Ø 33 x 60	4 pcs
<b>Button cells</b>					<b>Comment</b>
351520	AgO	1.5	SR1130W	Ø 11.6 x 3.05	
351510	Alkaline	1.5	LR1130	Ø 11.5 x 3.1	stopwatch
351604	Alkaline	1.5	LR44	Ø 11.6 x 5.2	pH meter
351605	Li	3	CR2025	Ø 20 x 2.5	photo / PC
351606	Li	3	CR2032	Ø 20 x 3.2	
351607	Li	3	CR2430	Ø 24.5 x 3.0	
<b>Other batteries</b>					
350555	Manganese	4.5	3R12U	62 x 21 x 65	
350060	Manganese	6	4R25Y	65 x 66 x 113	with screw
350070	Manganese	9	PP9	51 x 64 x 78	Unilab ultrasound
351010	Alkaline	9	6LR61	26 x 17 x 48	
<b>Rechargeable batteries</b>					
352330	NiMh	1.2	AA	Ø 14 x 49	2100 mAh
352340	NiMh	1.2	AAA	Ø 10.5 x 50.5	800 mAh
352360	NiMh	8.4	P22H	26 x 17 x 48	170 mAh



### Battery holders

Item no.	Type	Connection
352000	For 1 x D / R20	Solder tabs
352030	For 1 x D / R20	Contact clips
352031	For 1 x D / R20	Safety plug
352055	For 1 x AA / LR6	Solder tabs
352060	For 2 x AA / LR6	Snap lock
352075	For 1 x 9 V E-block bat.	Leads
352100	For 1 x 9 V E-block bat.	Snap lock



### Battery tester

Tests 1.5 V and 9 V batteries.

**Item no. 352445**



### Battery charger, automatic

Battery charger for all our rechargeable batteries. This smart charger incorporates a microprocessor to control the charging and automatically disconnect when a full charge is reached. This helps preserve the batteries and makes using rechargeables a sound investment. Accommodates 4 type AAA, AA, C or D cells and 1 E-block 9 V.

**Item no. 352451**

## OSCILLOSCOPES



### Oscilloscope, 60MHz, 2 channels, PC-USB

The VDS2062 is a PC based dual channel oscilloscope. The device features a bandwidth of 60 MHz and a sampling rate of 500 MSa/s.

The VDS2062 is a full-fledged compact oscilloscope. It is controlled via PC also displaying the measurement signals. The oscilloscope is connected directly via USB.

#### Specifications:

Sample rate: 500 MSa/s

Memory: 10M samples

Sensitivity: 5 mV/div - 5 V/div

Time scale: 5ms/div - 100 s/div

**Item no. 400100**



### The right connection

Oscilloscope inputs are equipped with BNC sockets. Don't forget to purchase adapters or cables with safety connectors.

**Item no. 111005** Adapter BNC / double safety socket

**Item no. 110002** Shielded cable, 50 Ω, 115 cm, BNC / double safety plugs



### Oscilloscope, 60MHz, 4 channels, PC-USB

This oscilloscope is a PC based four channel oscilloscope. The device features a bandwidth of 60 MHz and a sampling rate of 500 MSa/s.

This is a full-fledged compact oscilloscope. It is controlled via PC also displaying the measurement signals. The oscilloscope is connected directly via USB.

#### Specifications:

Bandwidth: 60 MHz

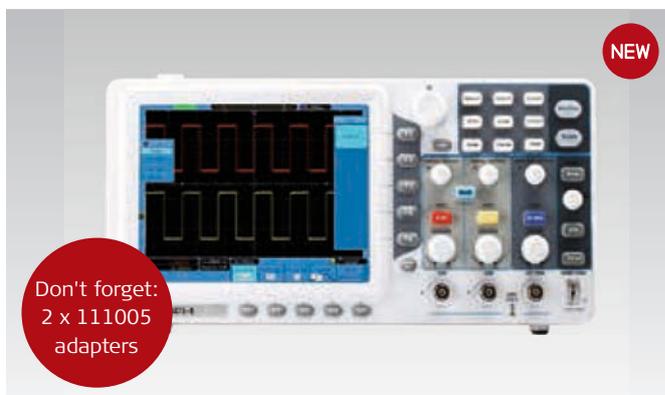
Sample rate: 500 MSa/s

Memory: 5M samples

Sensitivity: 5 mV/div - 5 V/div

Time scale: 5 ns/div - 100 s/div

**Item no. 400105**



### Oscilloscope, digital, 50 MHz

The new digital storage oscilloscope offers reliably measurement technology for a really good price. The colorful 8" (20.3 cm) TFT LCD panel with the resolution of 800 × 600 allows an excellent readability of the wave, especially in regards to high data volume or many waves covered reciprocally. The oscilloscope has a VGA output which allows connection directly to projectors in the classroom. The oscilloscope offers 60 MHz bandwidth, a sample rate of 250 MSa/s in dual channel and a memory depth of 10 MSa per channel.

Delivery including 2 probes, a USB cable, PC software, a power adapter and a user manual.

#### Specifications:

Bandwidth: 60 MHz

Realtime sampling: 500 MS/s

Memory: 1M samples

Sensitivity: 2 mV/div - 5 V/div

Time scale: 1 ns/div - 10 s/div

**Item no. 400150**



## Demonstration multimeter

This multimeter has been developed specifically for demonstration purposes while teaching, and measures the following parameters: Voltage, current, resistance, frequency, temperature, pressure and pH.

The displayed measurement is selected using the rotary switch centrally positioned below the display.

On the front, the demonstration multimeter is equipped with a 4-digit display, with 45 mm high LEDs. There is a smaller display on the rear of the instrument for the teacher's use.

Connection for measurement of voltage, current, resistance and frequency is via standard 4 mm safety sockets on the front panel.

Temperature measurement uses type K thermocouples for which there is a special socket.

pH measurement uses a standard pH electrode with a BNC plug.

For pressure measurement, special sensors are used which connect via a DIN socket.

Data can be transferred via the serial interface and processed in the Datalyse program.

### Specifications:

Measurement	Measurement range	Precision	Input impedance
Voltage DC	0 – 500 V	0.5% + 1 digit	10 MΩ
Voltage AC	20 mV – 500 V	10 Hz – 1 kHz: 1% + 1 digit	10 MΩ
		1 kHz – 2 kHz: 2% + 2 digits	
		2 kHz – 5 kHz: 5 % + 2 digits	
		5 Hz – 10 kHz: 10 % + 2 digits	
Current DC	0 – 10 A	0.5% + 1 digit	10 Ω; 0.1 Ω; 0.01 Ω
Current AC	20 μA – 10 A	10 Hz – 10 kHz 1% + 2 digits	
Resistance	0 – 10 MΩ	1% + 1 digit	
Frequency*)	0 – 100 kHz	0.5% + 1 digit	10 MΩ
Temperature	-200 °C – 1370 °C	0.1% + 1 digit	
Pressure	0 – 7000 hPa	0.1% + 1 digit	
pH	0 – 14	0.1% + 1 digit	>10 GΩ

\*) Frequency measurement up to 10 kHz requires at least 1 V, from 10 kHz to 100 kHz requires at least 10 V.

**Item no. 386770**

## Accessories for demonstration multimeter

Temperature probes: All type K sensors. See page 11.

Pressure sensors: The demonstration multimeter can automatically differentiate between these two types for individual calibration. Calibration data is on the rear of each sensor and only needs to be input once. Only these two types can be used.

**pH electrodes:** All standard electrodes with BNC plugs. We recommend:

**Item no. 541520 pH-electrode**



## Digital multimeters



	<b>670061</b>	<b>386225</b>	<b>386135</b>	<b>386215</b>	<b>386231</b>
V DC	0.2/2/20/200/1000	2/20/200/600	0.4/4/40/400/500	0.32/3.2/32/320/600	0.06/0.6/6/60/600/1000
Precision	0.5% + 3 digits	1.2% + 1 digit	0.8% + 1 digit	1.2% + 1 digit	0.5% + 1 digit
V AC	200/750	200/500	4/40/400/500	3.2/32/320/600	0.06/0.6/6/60/600/750
Over voltage Std.	Cat II	Cat II	Cat.I 600Vcat.II 300V	Cat.III 600V	Cat. III 1000 VCat. IV 600 V
mA, AC/DC	0.2/2/20/200	-	0.4/4/40/400	0.32/3.2/32/320	0.6/6/60/600
A AC/DC	5	2A (not AC)	4/10	10	6/10
Fuses	5 A	2A	500 mA	500 mA, 10 A	1 kV, 600 mA; 1 kV, 10A
$\Omega$	200/2 k/20 k/ 200 k/2000 k	200/2 k/20 k/ 200 k/2000 k	400/4 k/40 k/400 k/4 M/40 M	320/3.2 k/32 k/320 k/3.2 M/32 M	600/6 k/60 k/600 k/ 6 M/60 M
F	-	-	-	-	40 n/400 n/4 $\mu$ /40 $\mu$ /400 $\mu$ /4000 $\mu$
Hz	-	-	-	-	10 - 10 M
Other	Does not accept stand-stand safety cables	-	-	-	Temperature and USB interface

### Overvoltage standards

Roughly speaking, Cat. I, II, III and IV express how close to the power line an instrument is approved for.

Cat.I is ordinary electronics and other equipment, where energetic transient voltages do not occur. Cat.II covers equipment connected to a power outlet and wiring that is more than 10 m from a Cat.III source. Cat.III covers, for example, distribution boards, machinery, main circuit breakers, industrial installations and high-current installations. Cat.IV is all outdoor wires (which are exposed to the direct or induced effects of lightning strikes).



### Multimeter

Digital model for easy measurements. Measures DC V, AC V, DC A, ohms, transistor test, diode test etc. Uses 1 x 9 V battery (e.g. 351010). Battery not included. Supplied complete with test leads and user instructions.

Note: Does not accept safety cables!!!

**Item no. 670061**



### Multimeter, DMM 135A

Budget edition, 3 3/4-digit auto ranging multimeter. A robust device for less demanding tasks. Diode test and continuity test. Low battery indicator. Power supply: 2 AAA batteries (included)

**Item no. 386135**



**Multimeter, model 120**

Easy-to-use multimeter. With only two connection terminals, the risk of incorrect operation is minimised. Measures DC current and voltage, AC voltage and resistance. Also includes diode test, transistor test and battery test functions.

**Item no. 386225**



**Multimeter, DMM-8062**

3 3/4-digit auto ranging multimeter. A modern instrument that also measures capacitance, frequency and temperature and numerous electronic tests using the supplied multi-function socket. There is also an option to connect the multimeter to a PC via USB or use the instrument as a demo instrument for a Smart Board (or similar) or perform data collection for processing in Excel. Software included. Battery-saving auto power off after approx. 15 min.

**Item no. 386231**



**Multimeter, model 125**

3 1/2-digit auto ranging multimeter. A good all-round instrument for school use. Analogue bar graph and digital instrument that measures voltage, current and resistance. Battery-saving auto power off after approx. 10 mins and low battery indicator. Beeps in the event of incorrect connection, limiting the risk of damage.

**Item no. 386215**



**Test leads for multimeter**

1 set of test leads, one black and one red, with safety plugs and probe tips.

**Item no. 382600**

## Analogue student instruments

Robust, user-friendly instruments that are easy for students to read. They are all electronically protected against overloads and will tolerate short-term incorrect operation and excess voltages. Equipped with 4 mm safety sockets.

### Voltmeter

Measures both AC and DC  
Precision: +/- 2% of full scale  
Impedance: 10 k $\Omega$ /V  
Electronically protected.  
Measurement ranges: 0 - 3 V; 0 - 15 V; 0 - 30 V AC/DC  
Dimensions: 158 x 108 x 56 mm

Item no. 381560



### Ammeter

Measures both AC and DC.  
Precision: +/- 2% of full scale  
Electronically protected in all measurement ranges up to 15 A (short term up to 30A).  
Measurement ranges: 0 - 0.05 A; 0 - 0.5 A; 0 - 5 A AC/DC.  
Dimensions: 158 x 108 x 56 mm

Item no. 381570



### Galvanometer

Measures small DC currents.  
Centre-zero scale.  
Precision: +/- 2% of full scale.  
Measurement ranges: +/- 5 mA, +/- 500  $\mu$ A, +/- 50  $\mu$ A.  
Dimensions: 158 x 108 x 56 mm

Item no. 381580



### Voltmeter, analogue

Voltmeter with large, clear, 45° inclined scale and 2 measurement ranges: -5 to +15 V and -1 to +3 V. The instrument is equipped with safety sockets for 4 mm safety connectors.

Item no. 381160



### Ammeter, analogue

Ammeter with large, clear, 45° inclined scale and 2 measurement ranges: 0 to 5 A and 0 to 1 A. The instrument is equipped with safety sockets for 4 mm safety connectors.

Item no. 381170



### Galvanometer, analogue

Galvanometer or microammeter for measuring very small currents. Suitable for showing induction in a coil. Measures -500 to +500 microamperes. The instrument is equipped with safety sockets for 4 mm safety plugs.

Item no. 381175





## Edison Robot

Edison is a sturdy robot created for education and innovation.

The robot can be controlled in several different ways and therefore it can be used by everyone from the first science/technology education in primary school up to High School work with programming, and everyone can be challenged at their level and learn about robotics, programming and technology. The Edison robot has multiple built-in sensors and react to both sound, light, distance and infrared signals.

Edison is LEGO®-compatible, easy to program from PC or tablet with the free software Edware. It has built-in applications that can be started by scanning certain barcodes.

Edison can be used as a remote-controlled car with a standard TV remote control. The buttons on the remote can be reprogrammed to the new feature. Edison can be programmed to perform precisely the task that you want in the program Edware on a computer or tablet (iPad, Android).

**Item no. 660200**

## EdMat

The team behind the Edison robot has made a very useful activity mat to use with the robot. The mat is an A1 sized mat available in several languages. The activity mat is free for download from [meet Edison.com](http://meet Edison.com). However, we offer the possibility of printing the mat on high quality vinyl. If you are interested please contact us for more info.



## Edison - spare parts pack

Contains all of Edison's removable parts:

- 1 x New EdComm cable (Increase programming compatibility across more devices)
- 1 x Battery door (including springs)
- 1 x Clear skid
- 2 x Wheels
- 2 x Tyres
- 4 x Gear shafts
- 4 x Clutch/crown gears
- 4 x Worm gears
- 6 x Allen key/hex head screws
- 1 x Allen key/hex wrench
- 1 x Bag of silicone grease

**Item no. 660210**



### Wattmeter

Robust and user-friendly instrument that measures both AC and DC power. Tolerates short-time overloads. Equipped with safety sockets.

**Specifications:**

- Measurement range: 0 – 200 W (max. 30 V and max. 10 A)
- Resolution: 0.1 W
- Precision: 5% of full scale
- Power supply: 4 x AA batteries or mains adapter 355010
- Dimensions: 158 x 108 x 56 mm

**Item no. 406550**

### Energy meter for 220 volt AC

Connect between power outlet and utility and then you can read W / kW - kWh - H and V. With the energy meter, the energy consumption of the individual utilities can be determined precisely, just as the maximum values for W / kW can be set and an alarm triggered in case of exceedance. Measurements are displayed to three decimal places - minimum measurement to two decimal places.

**Item no. 407545**



### Energy meter, digital

The energy meter enables you to measure the energy consumption of electrical devices. The top of the display shows voltage, current, maximum current, power and maximum power. Energy (kWh), total cost or cost per kWh can be shown in the display to one decimal place. The bottom of the display shows total time for the connected device. Fitted with Schuko connectors.



**Item no. 670059**

## LABORATORY LEADS



### Safety cables, silicone, 1000 V, 25 A, -60 °C – 180 °C

Extra soft leads. Very comfortable to use.

Length	Colour/item no.			
25 cm	Black: 105710	Red: 105711	Yellow: 105712	Blue: 105713
50 cm	Black: 105720	Red: 105721	Yellow: 105722	Blue: 105723
100 cm	Black: 105740	Red: 105741	Yellow: 105742	Blue: 105743
200 cm	Black: 105750	Red: 105751	Yellow: 105752	Blue: 105753



### Safety cables, PVC, 250 V, 10 A, -20 °C – 80 °C

Not quite as soft as the silicone cables, but also a bit cheaper.

Length	Colour/item no.			
25 cm	Black: 105410	Red: 105411	Yellow: 105412	Blue: 105413
50 cm	Black: 105420	Red: 105421	Yellow: 105422	Blue: 105423
100 cm	Black: 105440	Red: 105441	Yellow: 105442	Blue: 105443



### Safety adapters for fitting 4 mm banana sockets

Type	Colour/item no.			
1000 V	Black: 105790	Red: 105791	Yellow: 105796	Blue: 105794
400 V	Black: 105792	Red: 105793	Yellow: 105797	Blue: 105795

## BASIC ELECTRICAL EQUIPMENT

### Tools for fitting safety adapters

Item no. 105799 Hex key 1.5 mm

Item no. 105798 Hex key driver 1.5 mm



### Insulated alligator clips, safety type

Item no. 109020 Black

Item no. 109021 Red



### Uninsulated alligator clips- fit safety plugs

Item no. 109000 pack of 100



### Safety plugs for cables

Colour/item no.:

Black: Item no. 107710 Red: Item no. 107711

Yellow: Item no. 107712 Blue: .....

Item no. 107713



### Cables with 2 mm plugs, silicone, 30 V AC/ 60V DC, 10 A, up to 180 °C

The mini plugs do not fit a mains socket and are therefore an alternative to safety connectors.



Length	Colour/item no.	
25 cm	Black: 105110	Red: 105111
50 cm	Black: 105120	Red: 105121
100 cm	Black: 105140	Red: 105141

### Insulated alligator clips for 2 mm plugs

Item no. 109510 Black

Item no. 109511 Red



## CABLE HOLDERS



### Cable holder for wall mounting

Consists of a 35 cm long aluminium rail with 18 plastic holders. The plastic holders can be individually adjusted and adapted to different types of lead. Holds at least 60 leads. Robust construction. Easy to install using 2 screws.

Item no. 113075

### Cable holder with tray on wheeled base

Solid construction comprising two 35 cm rails, each with 18 adjustable holders. Holds at least 120 leads. The tray's interior dimensions are 36 x 26 cm. The height of the cable holder can be adjusted from 1 to 1.8 m.

Item no. 113085



### Cable holder in steel

For wall mounting. The holder has 13 slots and can accommodate approx. 60 leads. Note that our Safety cables, PVC item nos. 105410-105443, must be wedged into place in this holder.

Item no. 103090



Cables by the metre, please see page 96.

## CABLES AND ADAPTERS

Name	Male (plug)	Female (socket)
Safety plug		
2 mm banana		
BNC		
UHF		
3.5 mm Jack		
6 mm Jack		
RCA phono		
DIN loud-speaker plug		
3-pin DIN		
Thermocouple type K		
Serial, 9-pin sub D		
Serial, 25-pin sub D		
Serial, Pasco SW 500		
USB A		
USB B		
USB mini-B		

Item no.	Connector 1	Connector 2	Length	Comment
110002	BNC, male	Two safety plugs, 115 cm male		
110025	BNC, male	BNC, male	100 cm	50 Ω coax. e.g. for 518000
110090	2 mm banana	Safety plug	100 cm	1 set with one black and one red cable
111600	BNC, male	RCA phono, female	adapter	With 110078 makes BNC for 3.5 mm jack
110078	3.5 mm Jack (stereo)	Two RCA phono male	120 cm	
111005	BNC, male	Two safety sockets, female	adapter	
110075	3.5 mm Jack, male	Two safety connectors, male/female	100 cm	
108010	Safety plug, female	Safety plug, female	adapter	
105785	2 mm banana, female	4 mm banana, male	adapter	Permanently fitted in socket



**Oscilloscope probe, 20 MHz**

Shielded cable with BNC plug. Fitted with x1 and x10 voltage divider, ground terminal and removable spring clip.

**Item no. 110310**



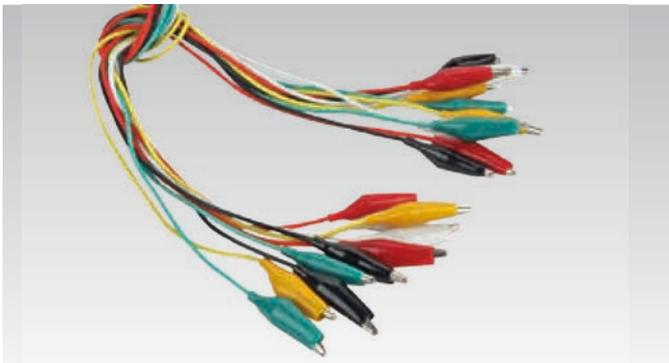
**Adapters for GM tube**

Item no.	Connector, GM tube	Connector, Counter
512580	DIN, Frederiksen	BNC
512575	BNC	6 mm Jack

**Misc. cables and adapters for counters**

USB communication adapter for 513600 GM counter, 1.8 m, USB A - 3.5 mm Jack

**Item no. 512565**



**Mini leads**

Mini leads with insulated alligator clips - pack of 10 in assorted colours. Length: 50 cm.

**Item no. 106220**



**USB cables**

**Item no. 398600 USB cable A / B (large)**

**Item no. 398605 USB cable A / mini-B**

**Item no. 398615 2.0 USB cable A / B (Micro)**

### Soft plastic-insulated cable. Ø 0.14 mm, 200 m roll

Item no.	Colour
641600	Black
641601	Red
641602	Yellow
641603	Blue

### Soft plastic-insulated cable. Ø 0.25 mm, 25 m roll

Item no.	Colour
641710	black
641711	red
641712	yellow
641713	blue

### Soft plastic-insulated cable. Ø 0.25 mm, 200 m roll

Item no.	Colour
641740	black
641741	red
641742	yellow
641743	blue
641744	green
641746	orange
641750	10 colours

### Plastic-insulated, solid hook-up wire. Ø 0.6 mm, 100 m roll

Item no.	Colour
641940	Black
641941	Red
641942	Yellow
641943	Blue
641944	Green



### Metal wire on 100 g rolls:

Item no.	Type	Diameter	m/roll	Ω/m
114010	Copper, insulated	0.25 mm	215	0.35
114020	Copper, insulated	0.50 mm	55	0.088
114030	Copper, insulated	1.00 mm	13.5	0.022
113510	Copper, uninsulated	0.25 mm	230	0.35
113520	Copper, uninsulated	0.50 mm	58	0.088
113530	Copper, uninsulated	1.00 mm	14	0.022
113540	Copper, uninsulated	2.00 mm	15 m	
114510	Constantan	0.25 mm	236	10.0
114520	Constantan	0.50 mm	62	2.5
114530	Constantan	1.00 mm	17	0.624
115010	CuNi23	0.25 mm	236	8.2
115510	Kanthal	0.25 mm	302	27.2
115520	Kanthal	0.50 mm	71	6.81
115530	Kanthal	1.00 mm	18	1.69

### Various metal wires

Item no.	Type	Diameter	Unit
116000	Iron	0.5 mm	roll
641810	Copper, insulated	0.30 mm	500 g
641510	Copper, tinned	1.39 mm	500 g
117510	Platinum	0.25 mm	cm
117620	Silver	0.50 mm	m
117630	Silver	1.00 mm	m
117810	Tungsten	0.25 mm	m

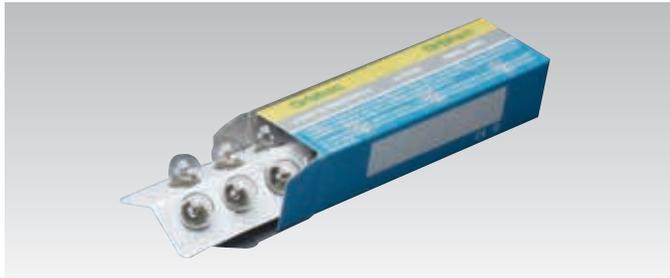
### Various wires

116500	Extra strong thread	Strong sewing thread	roll
116600	Cord, braided		50 m
116800	Fishing line	Ø 0.4 mm	100 m

### Various cables

Item no.	Type
642010	Loudspeaker cable 2 x 0.4 mm <sup>2</sup>

## BULBS ETC.



### Low voltage for E10 socket

Item no.	Voltage	Current	Colour
425002	1.35 V	0.06 A	white
425005	1.5 V	0.09 A	white
425010	2.5 V	0.3 A	white
425015	3.5 V	0.2 A	white
425060	3.5 V	0.2 A	red
425070	3.5 V	0.2 A	yellow
425080	3.5 V	0.2 A	green
425020	4 V	0.3 A	white
425025	6 V	0.05 A	white
425030	6 V	0.1 A	white
425035	6 V	0.5 A	white
425040	6 V	1 A	white
425042	10 V	0.05 A	white
425045	12 V	0.25 A	white
425100	3-12 V	LED	white
425110	10-24 V	LED	white

### Low voltage for bayonet socket

Item no.	Voltage	Output
426530	12V	38 W
426540	12V	45 W

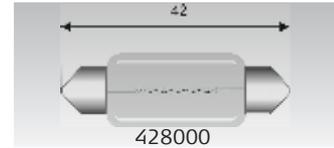


### Low voltage, halogen for bi-pin socket

Item no.	Voltage	Output
426555*	12 V	25 W
427010	12 V	50 W



\* Bulb for light box 293500 (purchased after Aug. 2000)



### Low voltage, various sockets

Item no.	Voltage	Output	Socket
428000*	12 V	15 W	festoon

\* used in 280030 Student Reuter lamp and 324000 Wave length of light apparatus

### Neon lamps

Item no.	Ignitionvolt- Socket age	Size
428520*	90 V festoon (large)	Ø 13 x 100 mm

\* for polarity testing



### 230 V, E27 socket

Item no.	Output	Type	Socket
426030	60 W	matt	E27
639165	80 W	Reflector lamp, red	E27
639162	80 W	Reflector lamp, blue	E27
639160	80 W	Reflector lamp, green	E27

### Miscellaneous

Item no.	Specs	Socket	Suitable for
425520	6 V, 5A	E14	old Reuter lamps and 320700 Apparatus for study of light energy
426210	230V, 120W halogen 78 mm tube		280110 Halogen lamp
426220	230 V, 350 W halogen 118 mm tube		280120 Halogen lamp

## FUSES

S = slow blow

F = fast acting

SF = super-fast acting



### Miniature fuses Ø 5 x 20 mm, 250 V

Sold in packets of 10

Item no.	Type	Size	Suitable for
408512	F	5A	670061 Multimeter
408533	F	1 A	Stereo microscope 077110 + 11
408542	F	500 mA	Microscope 076765.
408551	F	250 mA	Resonance tube 248010
408554	F	200 mA	
409009	S	6.3 A	Power supply 363001 and 364001
409012	S	5 A	Air blower 197060
409013	S	4 A	Power supplies 361051, 361060, 361065, 361860, 361861, 361870, 362062, 362065
409015	S	3.15 A	Power supplies 363000, 363010, 363022, 364000, 364010
409018	S	2.5 A	
409021	S	2 A	Control transformer 284050, Multimeter, Demo 386770
409027	S	1 A	Function generator 250250, Neo microscope 076780-90, Primomic series 076725-27 and 076860 (halogen/LED) stereo microscope 40 B/C 077040 - 41
409036	S	315 mA	Counter 200250, Multimeter, Demo 386770
409041	S	125 mA	Spectral tube holder with power supply 285550, Laser 288500 -10 and -20, Photo-detector 489550



### Special fuses for multimeters

Unit prices

**Item no. 409640** S 10 A, fits 386215

**Item no. 409645** 10A, fits 386230

**Item no. 409660** S 2 A, fits 386225

**Item no. 409641** 500 mA. fits 386215

**Item no. 409650** 10 A. fits 386231

**Item no. 409651** 600 mA. fits 386231



### Holder for fuse wire

For use in a circuit, to demonstrate the operation of a fuse. Use with fuse wire 410000, which is pressed into the fuse holder's clamps.

**Item no. 410500**



### Fuse wire

Silver wire that fuses at 3 A.

Use with fuse wire holder 410500. Roll of 50 m.

**Item no. 410000**

### Miscellaneous materials

**Item no. 641320** Terminal block, strip of 12

**Item no. 650520** Brass nails, bright, approx. 980 pcs

**Item no. 650510** Nail board 10 x 15 cm

**Item no. 641210** Solder tabs 3.2 mm, pack of 100

**Item no. 641220** Solder tabs 4.2 mm, pack of 100

**Item no. 647515** Solder 500 g, lead-free

**Item no. 647517** Solder, 4 m in dispenser, lead-free

**Item no. 647520** Leaded Solder. 0.46mm. 250g

**Item no. 647550** Tip Activator, Soldering tip pre-tinner, 15g, Lead-free

**Item no. 088095** Electrical hazard warning sign, self-adhesive

**Item no. 649010** Edding 400 permanent marker

## ELECTRICAL CIRCUITS

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## LAMP HOLDERS



### Lamp holder with 2 sockets, E10

Holder for pygmy bulbs, with safety sockets.  
Dimensions: 72 x 143 mm

Item no. 412000



### Lamp holder with 4 sockets, E10

The same as 412000 but with four safety sockets (connected in pairs).  
Dimensions: 72 x 143 mm

Item no. 412010



### Lamp holder, E10

Holder for miniature bulbs on yellow base. Can be used with safety plugs, mini leads and banana plugs.

Item no. 412015



### Lamp holder, E27

Holder mounted on plastic base, with safety sockets.  
Dimensions: 72 x 112 mm

Item no. 413000

### Lamp holder, E27

Holder mounted on 100 mm long Ø 10 mm steel rod.  
Fitted with 230 V mains lead.  
Base not included.

Item no. 413010



### Mini lamp holders

Mini lamp holders, ideal for use with mini leads (106220).

Item no. 752010 Lamp holder E10 with bracket

Item no. 752000 Lamp holder E10 plastic mount

Item no. 639225 Lamp holder E10 with solder tabs



### Solder tabs

Screwing these onto lamp holder 752000 makes it easier to attach alligator clips.

Item no.	Type
641210	3.2 mm
641220	4.2 mm

## ELECTRICAL CIRCUITS

### Motor, unmounted 2 - 6 V

2-6 V DC toy motor.  
Motor:  $\varnothing$  24 x 27 mm  
Axle:  $\varnothing$  2 x 6.5 mm

Item no. 472000



### Pulley for motor 472000

Pulley with  $\varnothing$  2 mm centre hole  
for the axle of  
motor 472000.

Pulley diameter: 16 mm

Item no. 472001



### Spring clip for motor 472000

Spring clip with hole for attach-  
ing to a base.

Item no. 472002



### Propellers for motor 472000

Black plastic propellers,  
pack of 5.

Item no. 471905



### Motor, unmounted 1.5 - 15 V

1.5 - 15 V DC motor. Good  
quality motor with reasonable  
amount of torque.

Motor:  $\varnothing$  37 x 61 mm  
Axle:  $\varnothing$  3.2 x 8.8 mm

Item no. 472005



### Pulley for motor 472005

Pulley with  $\varnothing$  3.2 mm centre hole  
to fit the axle of motor 472005.  
Pulley diameter: 16 mm

Item no. 472007



### Spring clip for motor 472005

Spring clip with hole for attach-  
ing to a base.

Item no. 472008



### Motor, mounted 2 - 6 V

2-6 V DC toy motor. Mounted on  
a base with 2 sockets for 4 mm  
safety connectors. Pulley includ-  
ed.

Base size: 70 x 100 mm

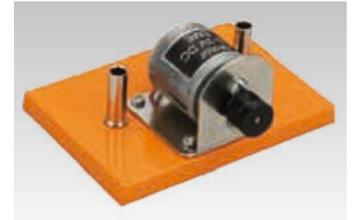
Item no. 472010



### Motor, mounted 1.5 - 3 V

Motor mounted on yellow base.  
Can be used with safety plugs,  
mini leads and banana plugs.

Item no. 472015



### Connected motors

Two identical 6 V electric motors  
are used to demonstrate the  
energy conversion of electrical  
energy. One motor will turn the  
other, which will act as a gener-  
ator.

Mounted on a base, with safety sockets.

Item no. 472400



### Spring clip, universal

Attaches motors and other  
components of diameter 19 -  
25 mm to a base. With adhe-  
sive pads and screw hole. Pack  
of 10.

Item no. 670179



### Hand dynamo, set of 2

Generator fitted in a transpar-  
ent plastic housing. By means  
of a crank and a gearbox, the  
dynamo can yield a power  
output of up to 7.5 W.

The unit is supplied with an  
E10 socket for small bulbs and leads with mini alligator clips for con-  
nection to electrolysis experiments, measuring instruments, electrical  
circuits, etc. Supplied as a set of two, with ideas for experiments.

Item no. 471610



### Hand generator from Dr FuelCell

This hand generator is the same  
as the one supplied in the Dr  
FuelCell sets from Heliocentris.  
Max. voltage 2.1 V.

Item no. 471650



### Telegraph key

Telegraph key/momentary switch mounted on a plastic base. Equipped with 2 safety sockets. Dimensions: 72 x 143 mm

Item no. 414000



### Knife switch, two-way

Knife switch mounted on a plastic base and connected to 3 safety sockets. Dimensions: 72 x 143 mm

Item no. 414500



### Knife switch mini, simple

Ideal for use with mini leads 106220 or alligator clips.

Item no. 414520



### Knife switch mini, two-way

Ideal for use with mini leads 106220 or alligator clips.

Item no. 414530



### Push switch

Switch mounted on yellow base. Can be used with safety plugs, mini leads and banana plugs.

Item no. 670058



### Push-button switch on base

Bells switch mounted on a plastic base. Equipped with 2 safety sockets.

Dimensions: 72 x 143 mm

Item no. 415000



### Mounted buzzer

Buzzer mounted on yellow base. Sounds when current is applied. Can be used with safety plugs, mini leads and banana plugs.

Item no. 670055



### Rectifier

Silicon diode mounted on base, with safety sockets. Max. 6 A / 600 V AC.

Dimensions: 72 x 112 mm

Item no. 434000



### Bridge rectifier

Silicon bridge rectifier mounted on a base, with 4 safety sockets. Max. 1.2 A / 60 V AC. Dimensions: 72 x 112 mm.

Item no. 434500



### Bridge rectifier with LEDs

Four arrow-shaped LEDs connected to safety sockets. The LEDs are equipped with resistors. Used with a function generator such as 250250 to reduce the frequency in order to follow the circuit's process. Max. 15 mA / 25 V AC. Dimensions: 90 x 90 mm.

Item no. 434600



### Current direction indicator, 30 V

This current direction indicator has two bright LEDs fitted in a box with safety sockets. If the device is connected to a DC voltage, one of the LEDs will light, indicating the current direction.

If the device is connected to AC, both LEDs will come on. If the device is moved back and forth, the eye can detect that the current runs in both directions with a time shift. Supplied with a Ø 10 x 93 mm steel rod. Dimensions: 120 x 120 x 27 mm.

Item no. 434720



### Breadboard electronics set, 6 groups

The breadboard replaces the old "nail board" and is much neater since you just stick the components into the breadboard and connections are made automatically. Connect your circuit to a battery and test if it works. There is no soldering and components can be reused. Easy and cheap to expand. Many variants of breadboards are available! Ours are of professional quality and are used in the electronics industry and elsewhere.

The set comprises:

Large plastic box for storing all the parts

6 assortment boxes with breadboard and the components required to complete the included exercises.

7 student guides (the 7th one is for the teacher) containing 11 different exercises with detailed descriptions. Inventory plan for components, leads and batteries.

Item no. 655000



## Extra leads and breadboards for 655000 Breadboard electronics set

Item no.	Colour	Specifications
106012	Yellow	Ø 0.8 mm x 10cm
106013	Blue	Ø 0.8 mm x 10cm
106020	Black	Ø 0.8 mm x 10cm
106021	Red	Ø 0.8 mm x 10cm
110210	black	0.8 mm to 4 mm female-female
110211	Red	0.8 mm to 4 mm female-female

### Breadboard, 555 holes

For solder-free construction of small electronic designs, prototyping etc. The components are held and connected by spring clips. This is a high-quality breadboard that meets professional requirements. For school use, it is excellent for both small and medium projects. The board comprises 5 lengthwise connectors each with 25 holes, for supply voltages etc. The two broad "strips" comprise 2 rows of 43 transverse connectors of 5 holes each. The board is supplied without components.

This is the board used in 655000 Breadboard set.

Item no. 653010



### Selection of diodes and resistors for electronics

Components included in 655000 Breadboard electronics set are marked with \*.

#### Diodes:

Item no.	Type	Colour
622110	5 mm, 20 mA *	red
622120	5 mm, 20 mA	yellow
622130	5 mm, 20 mA	green
622010	3 mm, 20 mA	red

### Various toggle and slide switches

Item no.	Type	Specifications
638210	Toggle switch	1 pole, 250 V / 2 A
638220	Toggle switch	2 pole, 250 V / 2 A
638281	Toggle switch	on-off-on, single pole, 6 A
638312	Switch	slide, 2 pole
638320	Switch	slide, single pole
670163	Toggle switch	single pole

#### Resistors:

Item no.	Type
603130	0.6 W 1% 1 kΩ *
603170	0.6 W 1% 4.7 kΩ *
603190	0.6 W 1% 10 kΩ *
603250	0.6 W 1% 100 kΩ *

### Colour code chart

Colour code chart for decoding the colour codes of resistors.

Item no. 605009

### Various non-linear resistors for electronics

Item no. 609105 Thermistor (NTC) 1.5 kΩ

Item no. 609420 A light-dependent resistor (LDR) 6 kΩ – 1 MΩ, 50 mW

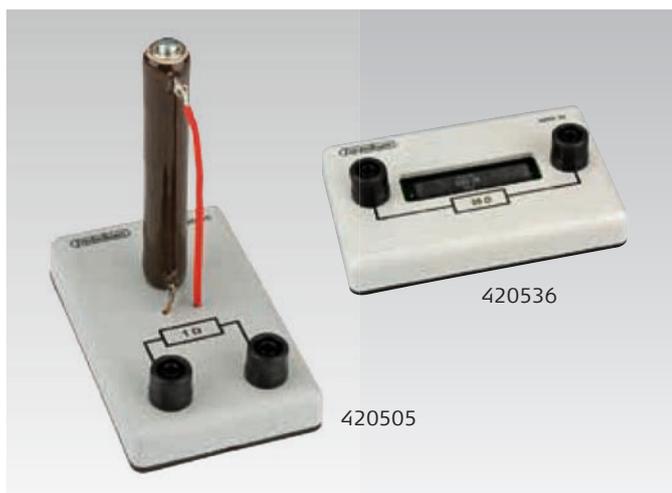
### Misc. electronics components

Components included in 655000 Breadboard electronics set are marked with \*.

Item no.	Type	Specifications
606260	Potentiometer	0.25 W, 10 kΩ with axle
606290	Potentiometer	0.25 W, 100 kΩ
605550	Potentiometer *	0.50 W, 10 kΩ Cermet with dial knob
616802	Capacitor *	10 μF
616806	Capacitor *	100 μF
9455390	Capacitor *	1000 μF
638050	Switch *	5 mm pin spacing
637485	Relay *	2 pole, 9 V
637618	Buzzer *	6 V, 25 mA, 360 Hz
670166	Buzzer *	3 V
624710	Transistor *	BC 547B
609430	Thermistor *	10 kΩ

#### Didn't find what you wanted?

We carry a range of standard electronic components, available at [www.frederiksen.eu](http://www.frederiksen.eu).



### Resistor on base

Resistor mounted on a base equipped with safety sockets.  
Supplied in 2 different versions: Resistor wound on ceramic tube max. 50 W, or resistor embedded in ceramic material, max. 10 W. See photos.

Base dimensions: 72 x 112 mm.

All the 10 W types are precision resistors (1%).

Item no.	Resistance	Max. power
420505	1 $\Omega$	50 W
420525	5 $\Omega$	50 W
420530	10 $\Omega$	50 W
420536	50 $\Omega$	10 W
420541	100 $\Omega$	10 W
420546	150 $\Omega$	10 W
420548	470 $\Omega$	10 W
420551	1 k $\Omega$	10 W
420556	2.2 k $\Omega$	10 W
420561	4.7 k $\Omega$	10 W
420566	10 k $\Omega$	10 W



### Decade resistor, 0 to 1 M $\Omega$

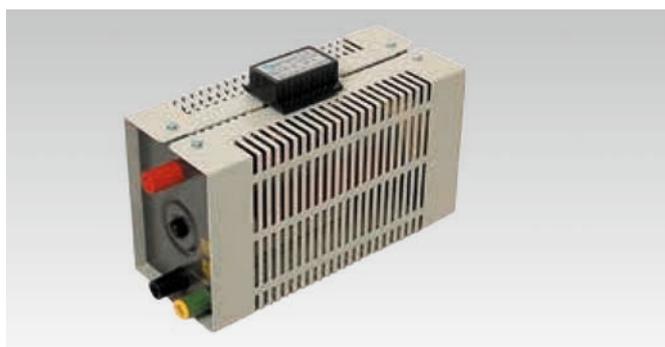
Sturdy decade resistor with 7 decades.

Ranges: 0 to 999,999.9  $\Omega$  in 0.1  $\Omega$  steps.

Precision: x 0.1  $\Omega \pm (5\% + 0.04 \Omega)$   
x 1  $\Omega$  and 10  $\Omega \pm (2\% + 0.04 \Omega)$   
x 100  $\Omega$  to x 100  $\Omega \pm (1\% + 0.04 \Omega)$

Dimensions: 280 x 85 x 175 mm

Item no. 423610



### Variable resistor

The variable resistor is fitted with 3 safety sockets and can function both as a variable resistor and as a voltage divider.

The variable resistors can withstand a short-time overload (up to 4 mins) of 100%.

Item no. 422050 0 - 10  $\Omega$  / 4 A

Item no. 422060 0 - 33  $\Omega$  / 3.1 A

Item no. 422070 0 - 100  $\Omega$  / 1.8 A

Item no. 422080 0 - 330  $\Omega$  / 1 A



### Resistors for determining temperature coefficient

Wire wound resistor on Plexiglas tube, fitted with sockets for safety plugs. The resistance wire is immersed in a non-conductive liquid to keep it at a defined temperature. Dimensions:  $\varnothing$  20 x 180 mm.

The resistance values below are measured at 20  $^{\circ}\text{C}$ .

Item no. 424010 Copper, approx. 1.8  $\Omega$

Item no. 424020 Constantan, approx. 46.7  $\Omega$

Item no. 424030 Nickel, approx. 8.7  $\Omega$



### Resistors, 2 x 500 $\Omega$ on base

2 resistors of 500  $\Omega$  fitted with sockets for safety plugs.

Used for demonstrating the necessity of transforming the voltage up in order to transfer energy through long high-voltage cables.

Base dimensions: 72 x 112 mm

Item no. 420900

## ELECTRICAL CIRCUITS



### Material samples

Set of 8 rods. Can be used to investigate the electrical conductivity of different materials.

Materials: Copper, aluminium, brass, iron, lead, rubber, nylon and glass.

Dimensions:  $\varnothing$  5 x 102 mm

Item no. 269000



### Electrolytic capacitor on base

Electrolytic capacitor mounted on a base, equipped with safety sockets.

Item no. 430070 15.000  $\mu$ F, 25 V

### Various capacitors for electronics

We carry a large range of electrolytic and film capacitors. Please visit [www.frederiksen.eu](http://www.frederiksen.eu) for item numbers.



### Resistor holder

Two terminal blocks mounted on a base, equipped with safety sockets. Used for mounting resistors.

Dimensions: 72 x 143 mm

Item no. 416000



### LCR circuit

Used for experiments with resonant circuits and filters. The components are selected to illustrate the different characteristics as clearly as possible. For example, the components can be connected to make LCR low-pass filters, which are overdamped, underdamped, critically damped or have the flattest possible characteristics. The supplied manual includes a section on measuring techniques and eight complete experiment guides. The equipment consists of - Resistors: 24.9 k $\Omega$  / 1.0 k $\Omega$  / 1.0 k $\Omega$  (1%) - Inductors (coils): 4.7 mH / 1.8 mH (5%) - Capacitors: 2.2 nF / 1.0 nF (1%). The components are fitted with sockets for leads with safety plugs.

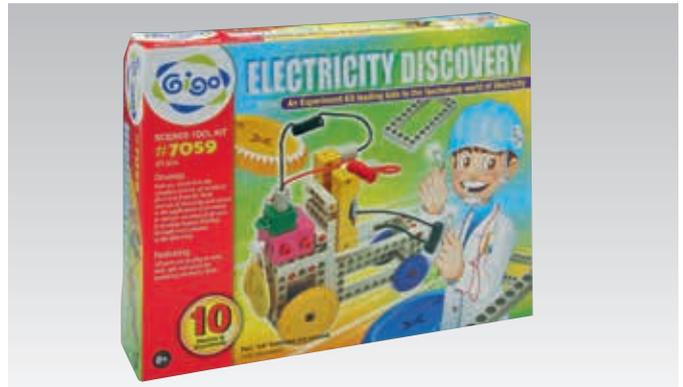
Item no. 420600



### Electricity case

The electricity-themed CVK case is a great, space-saving solution for introductory experiments with electricity. The case houses batteries, bulbs, switches, leads, alligator clips, materials for testing conductivity, thermometers, etc. Equipment for 15 groups. Instructions included.

**Item no. 670084**



### Construction set, electric cars and machines

Build a variety of cars and machines. Picture manual with ideas for 10 models/experiments. The set includes a motor, gears, cables, bulbs, switches etc. Learn how electric circuits work. Contains 90 parts. Manual included. Needs 2 x 1.5V AA batteries (item no. 351005)

**Item no. 210870**



### Flashing LEDs

Mini flashing lights with multiple applications (e.g. model making) or to demonstrate basic electronics principles. Fun, easy-to-build set with 2 flashing LEDs that flash alternately.

Technical details:

Power supply: 9 V DC / 8 mA (e.g. 1 x 9 V E-block battery)

Dimensions: 30 x 35 x 15 mm

**Item no. 668102**



### Electronics set, large

799 experiments with electricity and electronics. The modules fit easily and elegantly together with press studs. Contains lamp holders, various resistors, LEDs, buzzer, switches, loudspeaker, capacitors, transistors, microphone, motors, battery holders (AA), battery, ammeter and various specific ICs. An easy-to-read booklet containing 799 experiments is included. Can be combined with the now-discontinued 210935 Electronics set.

**Item no. 210950**



### Traffic light

Miniature traffic light. Realistic functionality with adjustable interval.

Technical details:

With 12 LEDs.

Low power consumption: 15 mA.

Power supply: 1 x 9 V E-block battery.

With on/off switch.

Dimensions: 50 x 35 x 115 mm

**Item no. 668131**



### Mini lightshow

Fun and safe single-channel sound-controlled light show with 4 LEDs.

Built-in microphone and adjustable sensitivity.

Technical details:

Power supply: 9 V DC / 0.5 mA min. / 12 mA max. (e.g. 1 x 9 V E-block battery).

Dimensions: 40 x 55 x 35 mm

**Item no. 668103**



### Crawling microbug

Colourful, insect-like, micro robot. Moves towards the light. Ideal for using in teaching electronics, since its simple, but efficient circuit can be used to illustrate many fundamental principles.

Properties:

- Two mini electric motors make the robot move.
- Adjustable light-sensitivity suits any lighting conditions, and allows the desired movement to be achieved.
- LEDs continuously show where the robot is heading.
- 2 different walks.
- Stops in total darkness.

Technical details:

Power supply: 2 x 1.5 V AAA batteries

Dimensions: 110 x 90 mm

**Item no. 668129**



### Soldering

**Item no. 708025** Soldering iron set, 778010 iron + 708410 stand

**Item no. 708010** Soldering iron, Antex 230 V, 25 W

**Item no. 708710** Soldering iron, Antex 230 V, 60 W

**Item no. 647517** Solder, 4 m in dispenser, lead-free

**Item no. 647520** Leaded Solder. 0.46 mm. 250 g

**Item no. 647550** Tip Activator, Soldering tip tinner, 15 g, Lead-free

**Item no. 708031** Soldering tip 3 mm for 708010 lead-free solder

**Item no. 708410** Universal stand, Antex

**Item no. 708112** Sponge, Antex for stand 708410

**Item no. 708013** Heating element 230 V, Antex

**Item no. 751600** Phosphor bronze wire, 65 cm, pack of 25 lengths

## TERMINAL POSTS, ELECTRODES ETC.

### Terminal post, uninsulated

Ø 10 mm terminal post with insulated terminal screw. With socket for safety leads. Overall length: 110 mm. Supplied in pairs.

**Item no. 435000**



### Terminal post, insulated

Equipped with Ø 30 mm Plexi-glas insulator. The connection section has Ø 4 and Ø 5 mm connection holes, a terminal screw and a socket for safety plugs.

Terminated with a Ø 10 x 57 mm steel rod.

Overall length: 174 mm

**Item no. 435010**



### Terminal post, insulated

Insulated terminal post with Ø 10 mm steel rod. Fitted with insulated terminal screw. Compatible with safety plugs. Supplied in pairs.

**Item no. 435030**



### Plate electrodes with notch, angled

These plate electrodes are designed for fitting to terminal posts 435000.

Item no.	Material	Diameter
450000	Copper	1 mm
450005	Aluminium	2 mm
450010	Zinc	2 mm
450020	Lead	2 mm
450030	Iron	1 mm



### Terminal post with 2 poles

Insulated terminal post with two clamping screws with sockets for safety plugs.

Fitted with a Ø 10 x 100 mm support post.

40 mm distance between terminal screws..

**Item no. 435020**

## ELECTRICAL CIRCUITS



### Electrode holder for round electrodes

Holder for electrodes up to  $\varnothing$  7.5 mm. The holder fits terminal post no. 435000. The electrode is held in place by a terminal screw with a socket for safety plugs.

Dimensions: 65 x 25 x 12 mm

Item no. 451510



### Electrode holder, double, for round electrodes

Holder for electrodes up to  $\varnothing$  7.5 mm. Equipped with a  $\varnothing$  10 x 150 mm stainless steel rod.

The electrodes are held in place by terminal screws, with sockets for safety plugs.

Item no. 451520



### Universal electrode holder, double

Can be used with both round electrodes 4510xx and plate electrodes 4498xx.

The holder can rest on the edge of a glass jar or beaker, or be fitted in a stand using item 002600 Support for electrode holder.

The electrodes are held in place by terminal screws with sockets for safety plugs.

Item no. 449710

Item no. 002600 Support for electrode holder

### Electrode connector

Electrode connector for electrodes up to  $\varnothing$  7.5 mm. Made from acid-proof plastic. Holder with contact screw that fits safety leads.

Dimensions:  $\varnothing$  25 x 12 mm

Item no. 451300



### Round electrodes

Dimensions  $\varnothing$  6 x 150 mm. Fit in standard rubber stoppers with holes.

Item no.	Metal
451000	Copper
451010	Nickel
451020	Aluminium
451030	Tin
451040	Iron
451060	Zinc
451070	Lead
451050	Carbon, approx. 200 mm long, pack of 10

### Plate electrodes

Dimensions: 50 x 87 mm.

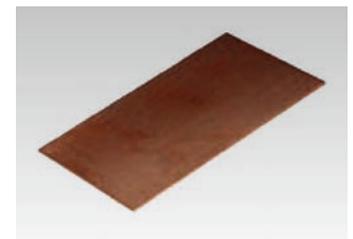
Item no. 449800 Copper

Item no. 449805 Aluminium

Item no. 449810 Zinc

Item no. 449820 Lead

Item no. 449830 Iron



### Special electrodes

Item no. 450095 Silver electrode 8 x 0.5 x 100 mm

Item no. 451700 Copper nails 3 x 65 mm, pack of 10



### U-tube with salt bridge

Used for electrolysis with different electrolytes for the two electrodes. Can also be used for fuel cell experiments. Normally used in conjunction with rubber stopper with hole 043520, electrode connector 451300 and round electrodes 4510xx.

The U-tube has hose connectors.

Dimensions:

Interior diameter of U-tube: Ø 20 mm.

Centre distance between the two uprights: approx. 62 mm.

Overall height of the U-tube: 160 mm.

Exterior diameter of hose connectors: approx. Ø 8 mm.

Electrodes not included.

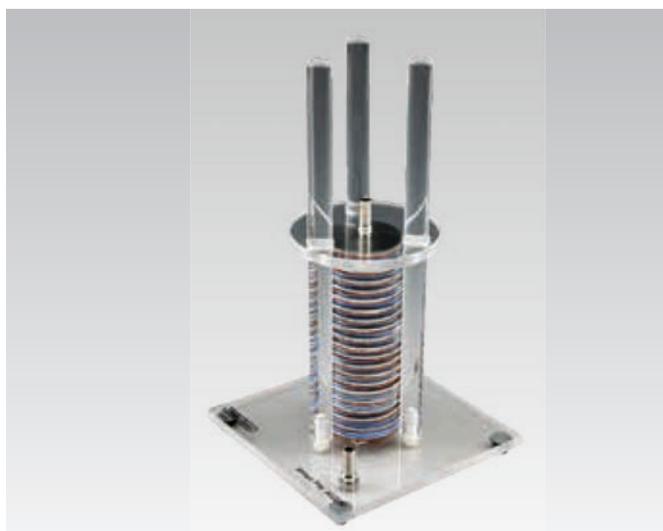
**Item no. 452000**



### Clay cylinder for Daniell and Leclanché cells

Dimensions: Ø 60 mm, height 150 mm.

**Item no. 452501**



### Voltaic pile

The voltaic pile was the first galvanic battery. Invented by Alessandro Volta in 1800, it facilitated research into electrical currents. This model closely resembles the original design, but using more modern materials. Plexiglas replaces the original wooden parts.

**Item no. 352200**



### Daniell cell

The cell consists of a glass cylinder, Ø 95 x 155 mm with a volume of approx. 1 L., a porous clay cylinder (452501), a cylindrical zinc electrode and a square copper electrode. Compatible with safety plugs. The open circuit voltage is approx. 1.1 V.

The cell is supplied without electrolyte. Use a 10% solution of copper sulphate  $\text{CuSO}_4$  and sulphuric acid  $\text{H}_2\text{SO}_4$  or zinc sulphate  $\text{ZnSO}_4$ .

**Item no. 452500**



**Item no. 352201** Zinc discs for voltaic pile 352200, pack of 10

**Item no. 352202** Copper discs for voltaic pile 352200, pack of 10

**Item no. 352203** Porous discs for voltaic pile 352200, pack of 10



**Voltameter, student version**

Made from acrylic, with embedded platinum electrodes. The supplied mini test tubes (012110) are used to collect oxygen and hydrogen. Equipped with safety sockets. Use dilute sulphuric acid as the electrolyte.

Interior dimensions: Ø 61 x 56 mm (160 mL).

Exterior dimensions: Ø 87 x 76 mm.

**Item no. 453000**



**Mini test tube**

Exterior Ø: 12 mm

Height: 75 mm

**Item no. 012110**



**Lid for voltameter**

The lid has 2 plastic tubes which are placed over the platinum electrodes of 453000 Voltameter.

The plastic tubes have hose connectors to feed the hydrogen and oxygen into, for example, a fuel cell.

Supplied with 60 cm of silicone tubing.

**Item no. 453005**

## ELECTRICAL SUNDRIES



### Supplies

- Item no. **650510** Nail board 10 x 15 cm
- Item no. **650520** Brass nails, bright, approx. 980 pcs
- Item no. **752051** Threaded cylinder E10, 100 pcs
- Item no. **752052** Pertinax washers, 100 pcs
- Item no. **682330** Machine screws, M3 L=10 mm, 100 pcs
- Item no. **683130** Nuts M3, 100 pcs
- Item no. **641210** Solder tabs 3.2 mm, 100 pcs
- Item no. **752000** E10 lamp holder plastic mount
- Item no. **752010** E10 lamp holder with bracket
- Item no. **754000** Post for coils
- Item no. **471700** Bicycle dynamo
- Item no. **471710** Motor unmounted, 2-6 V DC
- Item no. **755000** Push button, Bakelite
- Item no. **106220** Mini leads, 10 pcs
- Item no. **641600** Soft cable,  $\varnothing$  0,14 mm / 200 m, black
- Item no. **641601** Soft cable,  $\varnothing$  0,14 mm / 200 m, red
- Item no. **641603** Soft cable  $\varnothing$  0.14 mm / 200 m, blue
- Item no. **641602** Soft cable  $\varnothing$  0.14 mm / 200 m, yellow
- Item no. **641510** Hook-up wire, tinned,  $\varnothing$  1.39 / 500 g
- Item no. **115510** Kanthal wire 0.25 mm 100 g / 300 m
- Item no. **751600** Phosphor bronze wire 65 cm, 25 pcs
- Item no. **753500** Bi-metallic strip 0.3 x 5 x 2000 mm
- Item no. **038000** Valve rubber 5 m
- Item no. **591200** Self-adhesive tape
- Item no. **051700** Plastic glass 2 cL clear, 50 pcs
- Item no. **641750** Soft cable, 10 different colours

### Resistors 0.4 W, packs of 100

- Item no. **602990** 4.7  $\Omega$
- Item no. **603010** 10  $\Omega$
- Item no. **603040** 33  $\Omega$
- Item no. **603100** 330  $\Omega$
- Item no. **603150** 2.2 k $\Omega$
- Item no. **603170** 4.7 k $\Omega$
- Item no. **603190** 10 k $\Omega$
- Item no. **603210** 22 k $\Omega$

### Bulbs, packs of 10

- Item no. **425040** 6 V 1 A
- Item no. **425025** 6 V 0.05 A
- Item no. **425030** 6 V 0.1 A
- Item no. **425035** 6 V 0.5 A



### Apparatus

- Item no. **462510** Coil, student, 200 windings
- Item no. **462520** Coil, student, 400 windings
- Item no. **462530** Coil, student, 1600 windings
- Item no. **463000** U/I core with screw for student coils
- Item no. **381560** Volt meter with safety sockets
- Item no. **381570** Ammeter with safety sockets
- Item no. **406550** Watt meter, digital



### Tools, etc.

- Item no. **700105** Screwdriver 2 mm
- Item no. **700131** Screwdriver 4 mm
- Item no. **701850** Screwdriver and bit set
- Item no. **702011** Side cutter, mini
- Item no. **704530** Hammer, 200 g
- Item no. **704710** Junior hacksaw
- Item no. **708010** Soldering iron, Antex 230 V, 25 W
- Item no. **708410** Universal stand
- Item no. **670054** Electronics tool set, 11 parts
- Item no. **703115** Wire stripper
- Item no. **703125** Wire stripper, self-adjusting
- Item no. **704220** Utility knife, large, pack of 10
- Item no. **704221** Blade for large utility knife, pack of 10

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## ELECTRICAL FIELDS

### Van de Graaff generator

Generates very high DC voltages, but is safe to use due to low output current.

The generator features a conducting sphere with a diameter of 220 mm. The sphere is fitted with a  $\varnothing$  4 mm socket for connecting other equipment via a lead.

The top of the sphere can be dismantled to reveal the design of the device. Static electricity is produced by a rubber belt (item no. 370001) and 2 plastic rollers. The bottom roller is powered by a drive belt (item no. 370002) from a stepless variable-speed 230 V motor or a hand crank.

There is an earthing socket on the motor housing for a ground connection or for connecting to a separate conducting sphere.

#### Specifications:

Sphere diameter: 220 mm.

Capacitance relative to ground: approx. 12 pF

Charging current: up to 6  $\mu$ A

Spark length: 80 – 100 mm.

Overall height: 560 mm.

Width and depth: 195 mm.

Weight: 4 kg.

Supplied with dust cover and manual.

**Item no. 370060**

### Conductor sphere

Used as a target for the sparks from the Van de Graaff generator. The sphere's mounting post has a socket that connects to the generator's earthing socket.

Sphere diameter: 100 mm.

The sphere is provided with a  $\varnothing$  10 mm stainless steel rod.

Accessories required: 000600

Stand Base.

**Item no. 370500**



### Student experiments with the Van de Graaff generator

- Students can be charged up with the Van de Graaff generator but must, under no circumstances, be given an electric shock.
- The students must be given precise instructions about the procedure, and informed that participation is voluntary.
- The student must be insulated from the floor, table and other objects.
- The Van de Graaff generator must initially be discharged.
- When the experiment is finished, the Van de Graaff generator must be stopped. Once it is fully stopped, the student must be discharged as follows:
- The teacher and student each take an end of a 1 m long wooden ruler or similarly poor electrical conductor.
- The teacher moves his hand slowly towards the student's hand, and once the distance between the hands is 5 cm, they stop, and the teacher observes the student's hair.
- When the hair is "normal", the student is discharged and can step down onto the floor.



### Accessories for Van de Graaff

Set comprising a swatch of hair on a rod, neon lamp, Faraday cup, pointed electrode, rotor, pith ball in a string and insulated cylinder with pith balls.

**Item no. 670065**



### Electric whirl

The whirl is placed on top of the Van de Graaff generator's dome. It is placed on the supplied needle. The powerful field at the tips ionises the air, repelling ions with the same charge as the whirl, which therefore rotates away from the tips.

**Item no. 443000**



### Insulated stool

For use in experiments with static electricity, to insulate a person, for example.

Made from 20 mm laminated board with four Ø 30 x 35 mm insulators for legs. Dimensions: 305 x 305 x 55 mm

**Item no. 443510**

### Discharge tube for determining polarity

Neon-filled gas discharge tube for demonstrating electric charge and polarity.

Orange glow = negative electrode. Large model – easy to see due to the clear separation between the two electrodes.

**Item no. 428520**



## Electrometer

This instrument measures very small current and charge, and enables a range of fascinating experiments to be performed. It is sensitive enough that a small metal ball as an antenna can register the waving of a piece of charged PVC tube at the other end of the classroom. But it is still quite robust; tolerates 2000 times overload of the current range and 140 times of the charge range. For static electricity, it is the charge measurement capability that is of particular interest. Electrostatic induction is convincingly, and quantitatively, demonstrated, and the capacitance of, for instance, a plate capacitor is easy to determine when its charge can be directly measured.

The apparatus has an analogue output for connecting demonstration instruments, a digital multimeter or data acquisition equipment. Powered by a 9 V battery (supplied). Battery life: approx. 25 hours.

### Specifications:

#### Current

Input measurement range: -500 pA ... + 500 pA

Shunt resistance: 1 G $\Omega$  +/- 1%

Maximum permitted voltage: -1000 V ... + 1000 V

#### Charging

Input measurement range: -500 nC ... + 500 nC

Shunt capacitor: 1  $\mu$ F +/- 5% 250 V

Maximum permitted voltage: -70 V ... + 70 V

#### Output

Nominal output range: -500 mV ... + 500 mV

Max. deviation, I: +/- 2% of full output

Max. deviation, Q: +/- 5% of full output

**Item no. 441030**



## Ionisation chamber for electrometer

Use with 441030 and a power supply (alternatively a battery) to demonstrate the ability of ionised air to conduct current. The ionisation can derive from an alpha source or a flame.

**Item no. 441035**



## Faraday's ice pail

Used with electrometer 441030 or electroscopes 441000 for demonstrating electrostatic induction.

With  $\varnothing$  4 mm plug.  $\varnothing$  68 mm.

**Item no. 442500**

## Ball on insulated rod

Used to transfer an electrical charge.

Ball:  $\varnothing$  38 mm. Rod:  $\varnothing$  10 x 130 mm. Weight: 14 g.

**Item no. 441500**

## Conductor sphere

For a variety of experiments in electrostatics. With  $\varnothing$  4 mm plug.  $\varnothing$  68 mm.

**Item no. 442800**





### Plate capacitor 15 cm, circular

Circular plate capacitor made from aluminium sheet with insulated handle. Equipped with a socket for safety plugs. Plate diameter: 150 mm, plate area: 177 cm<sup>2</sup>. Set of 2.

Item no. 431510

### Spacer for plate capacitor

Bag containing 25 small PVC spacers 7 x 7 x 2 mm. Stackable.

Item no. 431680

### Dielectric for plate capacitor

Set of six 225 x 225 x 2 mm PVC sheets.

Item no. 431600

### Plate capacitor 22 cm, square

Square plate capacitor made from aluminium plate with bent-over edge, with a notch for mounting. Use, for instance, 435030 terminal post, set (not included).

Plate size: 220 x 220 mm; area: 484 cm<sup>2</sup>. Set of 2.

Item no. 431530



### Plate capacitors

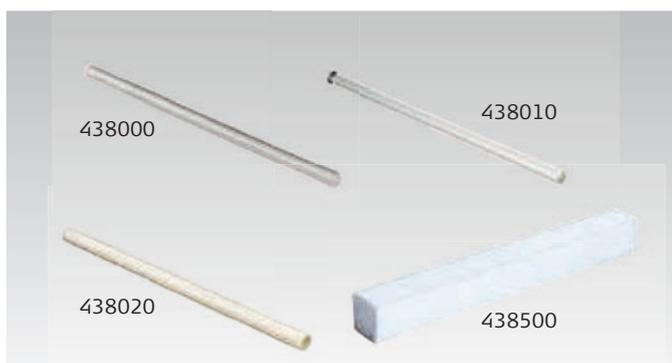
The circular plate capacitors are mounted horizontally with one plate in a stand. The other plate is placed on top with either spacers (3 stacks) or a dielectric between. This ensures the plates are parallel, with a well-defined separation.

## STATIC ELECTRICITY



### Rubbing cloths approx. 20 x 20 cm

439000	Felt
439010	Real silk
439021	Rabbit fur
439030	PVC (woven)



### Rubbing rods and tubes

438000	Plexiglas	Ø 12 x 250 mm
438010	Glass	Ø 10 x 225 mm
438020	PVC tube	Ø 16 x 300 mm
438500	Polystyrene	30 x 30 x 250 mm

### Brass rod with insulated handle

For showing that metals can also be statically charged.

Brass rod Ø 8 x 250 mm with a Ø 12 x 100 mm insulated handle.

**Item no. 438030**



### Metallised ping pong ball

Used to transfer and investigate electrical charges. With a thin nylon suspension thread.

Diameter: 38 mm. Weight: 2 g.

**Item no. 440500**



### Swivel stand

Used as a moveable holder for charged rods to investigate the polarity of static electricity.

Diameter of base: Ø 42 mm. Height: 95 mm.

**Item no. 439500**



### "Pith balls"

Ø 12 mm balls of expanded polystyrene (styrofoam) for investigating electrostatic charge.

Supplied in a box of 12.

**Item no. 440000**

### Stand for "pith balls"

With a hook for suspending "pith balls". Made from nickel-plated brass with a plastic base.

Height: 220 mm. Base plate: 110 x 70 mm.

**Item no. 440700**



**Electroscope**

For demonstrating electrostatic charges. When the electroscope has a charge applied to it, the pointer turns, and indicates the size of the charge. The device features a Ø 150 mm protective ring that can be grounded. Supplied with a Ø 15 mm charge collector with Ø 4 mm plug (item no. 441004).

**Item no. 441000**



**Zinc plate**

Used with electroscope 441000 for demonstrating the photoelectric effect. If the zinc plate is illuminated with UV light from a device such as UV-C lamp item no. 287105 with Lamp holder item no. 287100., the electroscope will be discharged.

**Item no. 441003**

**The tribo electric series**

Different materials have different capacities for becoming statically charged. The list here is an extract from the series, beginning with materials that are easily positively charged and ending with those that become negatively charged. To achieve the greatest charge, materials from each end of the series must be combined.

Rabbit fur	+++
Glass	
Nylon	
Wool	+
Silk	
(neutral)	
Amber	
Plexiglas	
Brass	÷
Polyester	
Polystyrene	
PVC	
Teflon	÷ ÷ ÷

**Photoelectric effect**

Surprisingly enough, Einstein won the Nobel Prize not for the theory of relativity but for the photoelectric effect.

This phenomenon demonstrates that light is quantised: It consists of "light particles" – photons – whose energy has a specific size determined by the wave length.

This means that a photon with the right amount of energy can detach an electron from a surface, but this is not possible for a light source of a longer wave length.

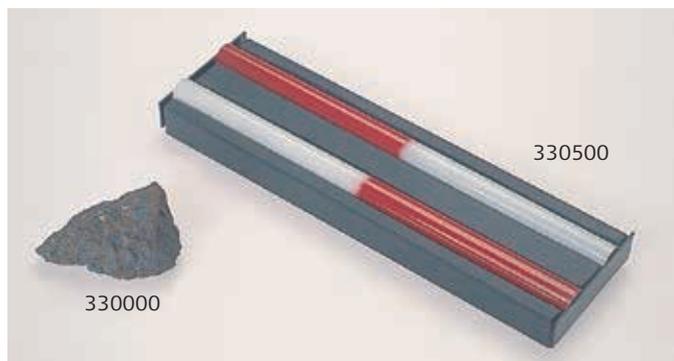
First, the surface of 441003 zinc plate is sanded with sandpaper to remove any oxidation. Once placed in Electroscope (441000), it is negatively charged using a power supply or 439021 rabbit fur and 438020 PVC pipe.

Now the zinc plate can be illuminated, first with an incandescent bulb, and nothing happens.

Next, the plate is lit with a mercury lamp UV-C lamp item no. 287105 with Lamp holder item no. 287100, and now the pointer reverts to a vertical position.

UV radiation consists of photons with enough energy to detach the electrons from the zinc's surface, whereas light in the visible range is unable to do this, regardless of its intensity.

## PERMANENT MAGNETS



### Lodestone

Magnets can be found in nature in the form of magnetite, or lodestone. This is an iron ore that has been magnetised by Earth's magnetic field.

**Item no. 330000**

### Bar magnets, cylindrical

Set of two AlNiCo bar magnets with keepers and coloured poles.  
Dimensions: Ø 11 x 170 mm

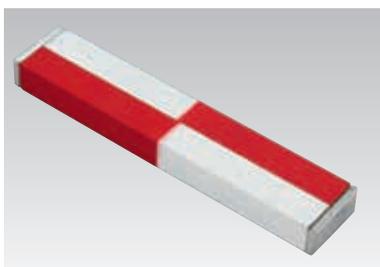
**Item no. 330500**

### Bar magnets, square section

Set of two AlNiCo bar magnets with coloured poles.

Dimensions:  
10 x 10 x 100 mm

**Item no. 330510**

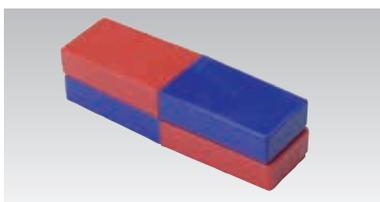


### Bar magnets, moulded in plastic

Set of two.

Dimensions:  
80 x 22 x 10 mm

**Item no. 330850**



### Bar magnets, small cylindrical

Set of two plain alnico bar magnets.

Dimensions: Ø 5 x 50 mm

**Item no. 330530**



### Board magnets

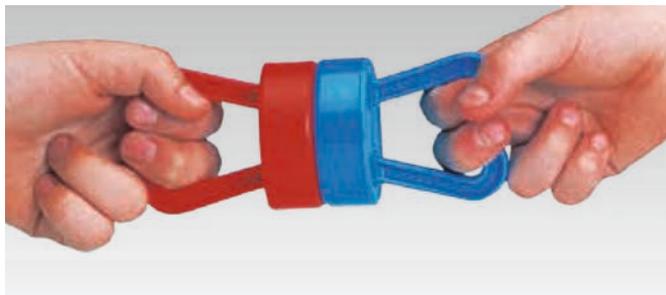
10 magnets with plastic covers. Suitable for notice boards etc.

Dimensions: Ø 29 x 8 mm

**Item no. 331900**



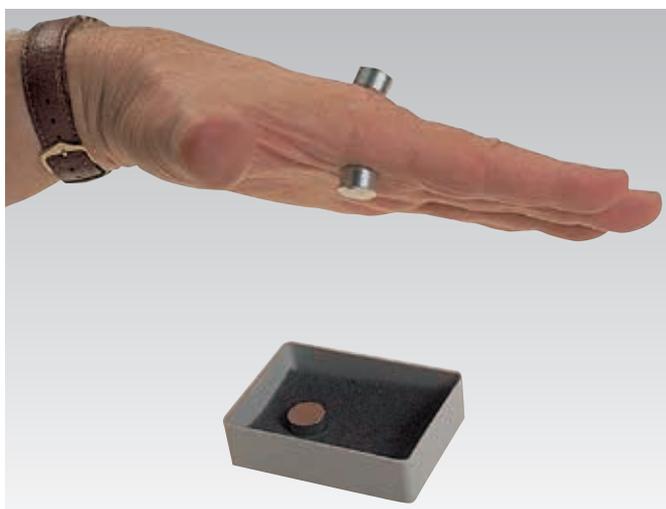
## NEODYMIUM MAGNETS



### Magnets, super

Experience the huge pull of these super magnets. They are designed to allow students to safely use neodymium magnets themselves. Supplied as a set of 2. The red one has the north pole facing out, the blue one the south pole.

**Item no. 331516**



### Neodymium magnets

These magnets are so powerful that they can even demonstrate the properties of extremely weakly magnetic materials. Box of two. Available in 3 sizes:

Item no.	Size
331800	Ø 6 x 8 mm
331810	Ø 10 x 8 mm
331820	Ø 14 x 8 mm

### Neodymium magnets

Set of 10 round neodymium magnets.

Dimensions: Ø 12 x 4 mm

**Item no. 670088**





**Magnet, floating compass**

Consists of a powerful neodymium magnet encased in a transparent container that floats. Place the container in water, and the magnet will turn to face north. The points of the compass are marked on the container. The magnet is 8 cm long and 3 cm in diameter at its middle. The container is approx. 4 cm high and 11.5 cm in diameter.

Item no. 792046

**Cylindrical magnet with bearing**

Powerful magnet with coloured poles, Ø 30 mm and thickness 6 mm. Mounted in a bearing on a stainless steel rod, Ø 10 mm. Can be used with coils to demonstrate alternating current.

Item no. 332010



**Cylindrical magnet on a bar**

Similar to 332010 but permanently mounted on the rod.

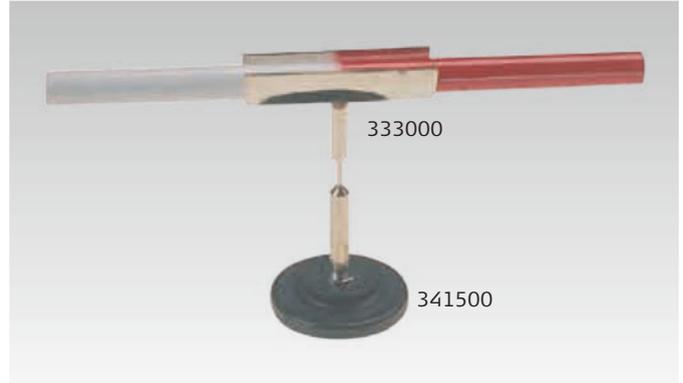
Item no. 332000



**Neodymium ring magnets**

Set of 25 ring-shaped neodymium magnets. Put them on a pencil and make them hover. Exterior diameter 17 mm, interior 10 mm.

Item no. 670087



**Swivel stand for bar magnet**

To hold a bar magnet, and demonstrate repulsion and attraction. Made from nickel-plated brass. For magnets up to 11 mm in diameter. Requires base no. 341500.

Item no. 333000



**Horseshoe magnet, large**

Large, powerful AlNiCo magnet with coloured poles. Supplied with a keeper. Dimensions: 30 x 82 x 135 mm. Distance between the poles: 59 mm.

Item no. 331500

**Horseshoe magnet, small**

The same as 331500, but with external dimensions of 15 x 60 x 90 mm. Distance between the poles: 48.7 mm.

Item no. 331510

**Warnings concerning strong magnets**

If magnets are swallowed, always consult a doctor. There is a risk of them snapping together in the digestive tract, which could be life-threatening. Small children should not use small neodymium magnets unsupervised. Powerful magnets can damage credit cards.

## Magnet set

The set includes a wide selection of different magnets and materials for experiments with magnets and magnetic forces.

The set includes the following:

- 1 set of steel magnets 7 x 16.5 x 100.
- 1 steel horseshoe magnet with keeper.
- 1 set of plastic encased ferrite magnets 80 mm long.
- 2 ferrite magnets 50 x 19 x 5 mm.
- 5 ring-shaped ferrite magnets Ø 24 mm.
- 5 ring-shaped ferrite magnets Ø 12 mm.
- 1 pair AlNiCo magnets 6 x 6 x 38 mm.
- 3 AlNiCo magnets Ø 12, Ø 19 and Ø 24 mm.
- 1 AlNiCo horseshoe magnet 25 mm.
- 1 set of AlNiCo magnets Ø 8 mm x 24 mm.
- 1 set of AlNiCo magnets 10 x 15 x 50 mm.
- 4 coloured magnetic sheets 50 x 50 mm made from magnetic rubber.
- 1 container of iron filings for demonstrating magnetic field lines.
- 4 plotting compasses Ø 16 mm.
- 8 discs of identified materials.

The set is supplied in a plastic case 50 x 230 x 335 mm.

**Item no. 331600**



## Hovering magnets

Item no.	Colour
330100	Multi-coloured
330110	Two-coloured



## Cars and ring magnets

Set consisting of 2 cars and 4 ring magnets. An effective demonstration of the first principles of magnetism. The ring magnets are marked with north and south poles, and each pole is a different colour. Car size: 100 x 50 x 60 mm. Ring magnet size: Ø 36 x 8 mm.

**Item no. 331515**



## Magnetic balls

Plastic-coated magnetic balls, Ø 17 mm. Mixed colours.

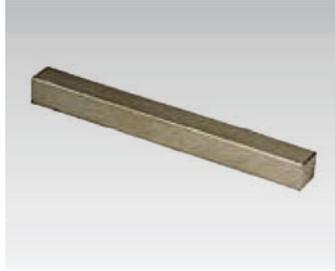
**Item no. 331514**

## MATERIALS FOR MAGNETISM

### Soft iron bar

The same size as bar magnet 330510. (10 x 10 x 100 mm).

Item no. 334500



### Soft iron bars, painted

The same size as bar magnet 330510. With poles painted like a magnet. Set of 2.

Item no. 334510



### Steel knitting needles

Made from magnetisable steel. Dimensions:  $\varnothing$  2 x 210 mm. Pack of 10.

Item no. 335500



### Hacksaw blades, standard

Made from magnetisable, hardened steel. Length: 300 mm. Pack of 10.

Item no. 336000



### Hacksaw blades, small

Metal blades for magnetising experiments. Length: 150 mm. Pack of 10.

Item no. 336010



### Iron nuts

Used for suspending magnets for experiments. Pack of 10.

Item no. 336500



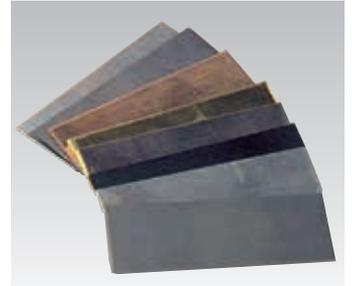
### Various nails

Item no.	Type	Quantity
338000	Blue steel nails	200 g
338500	Iron nails 25 mm.	500 g
338510	Iron nails 55 mm.	2 kg
338530	Iron nails 100 mm.	2.5 kg
338540	Iron nails 130 mm.	50 pcs.

### Plates for experiments in magnetism

Set of 8. Made from brass, copper, iron, plastic, aluminium, nickel, lead and zinc. Supplied in a plastic box. Plate dimensions: 65 x 25 x 1 mm. Can also be used for experiments on the electrochemical series.

Item no. 339000



### Magnets and compasses – CVK case

This case contains teaching materials for experiments concerning two closely related topics:

**Magnets:** The students investigate the properties of magnets. By playing with the small magnetic cars or the hovering magnets, they are encouraged to make discoveries and to try to formulate their observations. Half of the bar magnets have unmarked poles, which enables the students to determine their polarity for themselves.

**Compass:** Experiments with magnets hanging on a stand or floating on a polystyrene base encourage the students to observe and discover how the magnets, like a compass needle, always point north-south. The students can build their own compass with a compass rose, pin, compass housing and a compass needle. They can use this new knowledge to discover the points of the compass and find themselves on a map etc.

The case contains equipment for 15 groups.

Item no. 598700



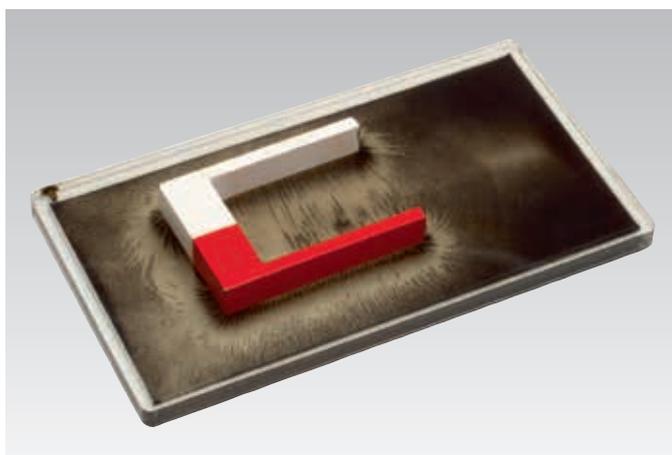


### Magnetic field demonstration set

For demonstrating 2D and 3D magnetic fields. The set comprises a magnetic field box and a magnetic field plate, both filled with a viscous liquid, iron filings, along with two bar magnets and a horseshoe magnet. A bar magnet can be placed in the middle of the box to show the magnetic field in 3 dimensions. Similarly, a magnet placed on the plate will cause the iron filings to align with the magnetic field lines.

Dimensions: box: 76 x 76 x 76 mm, plate: 91 x 157 x 9 mm

Item no. 339610

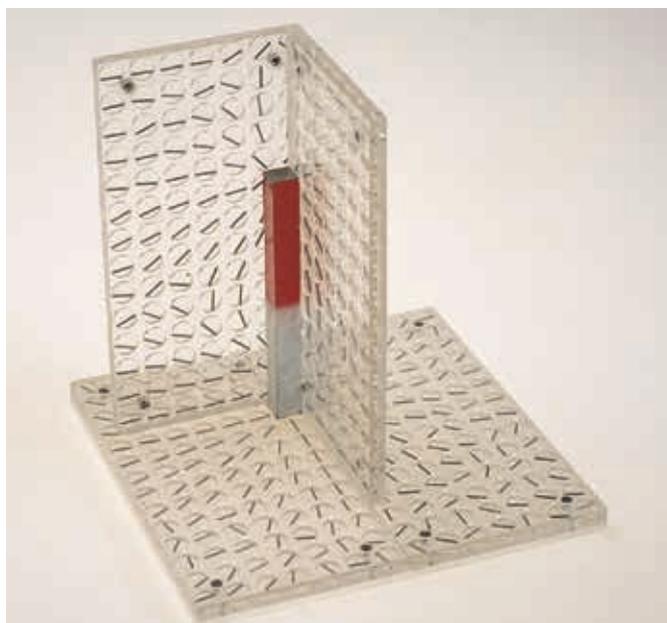


### Magnetic field plate with iron filings

Iron filings in a viscous liquid. Magnets not included.

Dimensions: 223 x 122 x 11 mm

Item no. 339620



### Magnetic field plates

Plates containing small magnetic bars (7 x 14 bars). For demonstrating magnetic field lines without using iron filings. By positioning the plates at an angle to each other, magnetic field lines in 3 dimensions can be visualised.

The set consists of 4 plates measuring 154 x 77 x 6.5 mm, an alnico bar magnet  $\varnothing$  5 x 50 mm and a  $\varnothing$  50 mm cardboard disc with magnet holder for demonstrating Earth's magnetic field.

Item no. 339520

## ELECTRIC AND MAGNETIC FIELDS



### Iron filings

Used to display magnetic field lines. Shaker containing 250 g.

**Item no. 337500**



### Compass needle

Magnetic steel needle with nickel-plated brass bearing. Requires base no. 341500. Length: 110 mm.

**Item no. 341000**

### Stand for compass needle

Non-magnetic metal stand with steel tip on a stable base. Dimensions:  $\varnothing$  41 x 85 mm.

**Item no. 341500**



### Magnaprobe

A Magnaprobe is used to investigate magnetic fields between the same and different poles, the direction of magnetic fields around a conductor or coil, the sizes of magnetic fields produced by an electric current etc. Very sensitive. Consists of a 2 cm gimbaled magnet with coloured poles. Length: 122 mm.

**Item no. 343500**



### Declination needle

Declination needle with coloured poles and agate bearing. Supplied with stand no. 341500. Length: 205 mm.

**Item no. 342000**



## Teslameter

A simple, user-friendly instrument designed to measure strong magnetic fields, e.g. from AlNiCo magnets, coils or electromagnetic experiments. The instrument is also suitable for use with 516500 Beta spectrometer apparatus.

The teslameter consists of a probe with a Hall element and an instrument for digital read-out of the measured magnetic field. The instrument is connected to the mains by the supplied power adapter. It switches automatically between two measurement ranges.

### Measurement ranges:

0.01 - 2T, resolution: 1 mT

1 - 200 mT, resolution: 0.1 mT

Precision: 5%.

### Dimensions:

Probe (without holder): 80 x 8 x 2 mm

Instrument: 172 x 108 x 65 mm.

Supplied with probe 406055 (can be purchased separately).

**Item no. 406050**



### Lenz's Law kit, student model

The kit consists of a  $\varnothing$  34 x 180 mm copper tube and two ring-shaped neodymium magnets.

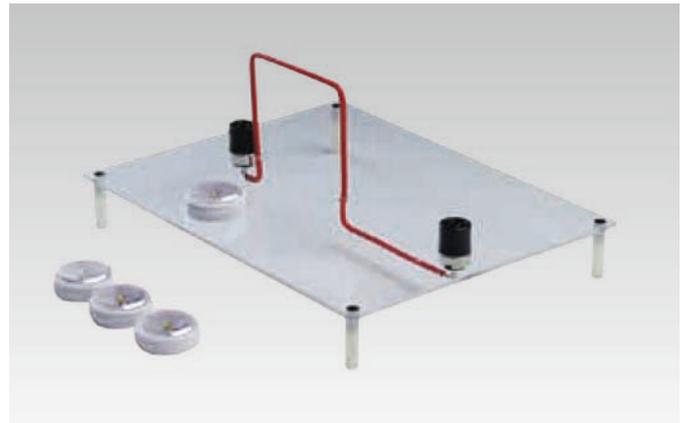
When a powerful magnet falls through the copper tube, this happens surprisingly slowly. A moving magnetic field (the magnet) induces an eddy current in the copper tube that in turn creates a magnetic field in the opposing direction to the magnet's field.

Item no. 460215

### Lenz's Law kit, U-profile

Lenz's Law is demonstrated in this apparatus by allowing a magnet to roll down a nearly vertical aluminium U-profile. The movement can be followed all the way down. The U-profile has a hook for suspending a force sensor or a dynamometer. Two cylindrical neodymium magnets and two stainless steel dummies are included.

Item no. 460220



### Magnetic field model

For demonstrating the magnetic field around a conductor. The field lines can be visualised using iron filings (337500) or mini compasses (340010). Connects to 8 A DC via safety sockets.

Item no.	Type	Size
455000	Vertical wire	155 x 200 mm.
455010	1 winding	155 x 200 mm
455020	10 windings	155 x 200 mm



### Diamagnetic floating graphite

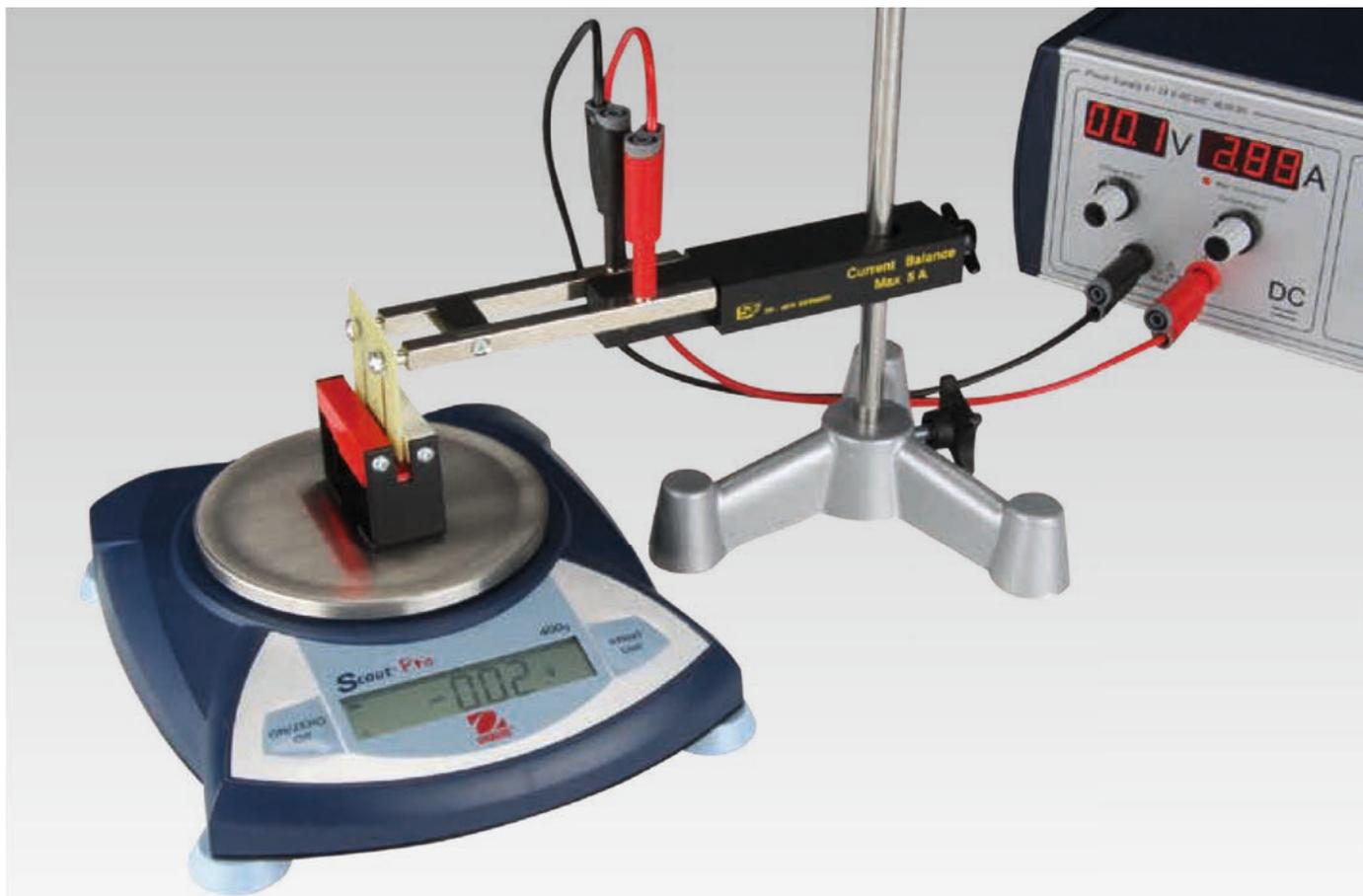
Pyrolytic carbon is the material with the highest diamagnetic susceptibility at room temperature. Set of four small neodymium magnets and two small pieces of pyrolytic carbon.

Item no. 346000

Diamagnetism is a phenomenon that occurs in all materials when exposed to an external magnetic field.

A field magnetised in the *opposite direction* is produced in the material, which has a repelling effect. In diamagnetic materials, the relative permeability is less than 1.

Many materials, however, are paramagnetic (such as ferrofluid) or ferromagnetic (such as steel): A field is created in the material, which is *in the same direction* as the external field – the relative permeability is greater than 1. These types of magnetism are often much greater than the material's diamagnetism, which may therefore be unobservable. But in certain materials, diamagnetism manages to dominate.



### Current balance

For measuring the force between a current-carrying conductor and a magnetic field. The equipment consists of a system of 6 permanent magnets, a holder for the conductors and six conductors of lengths 8, 6, 4, 3, 2 and 1 cm. The holder tilts for quick swapping of the conductors. Measurement requires a balance with a 0.01 g resolution (e.g. 102950) and a power supply such as 364000. Current through the conductors: 0-5 A DC. Supplied without a balance, power supply or stand hardware.

Item no. 456500

### Current balance, angle-dependent

For measuring the force between a current-carrying conductor and a magnetic field relative to the angle between the current direction and the magnetic field. For use with current balance 456500.

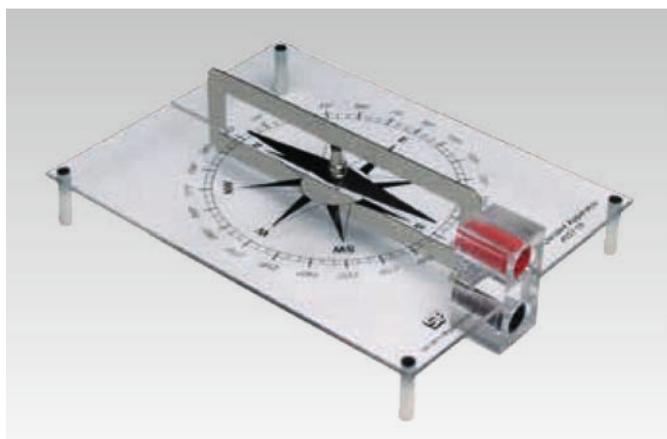
The equipment features a magnet system that produces a largely homogenous field between the pole pieces, which rapidly diminishes outside. The current-carrying conductor is designed as a revolving wire coil with a graduated scale. The scale's zero point can be set to match the force's zero state. Supplied without a balance, power supply or stand hardware.

Item no. 456510

### Oersted's apparatus

For demonstrating the effect of a current-carrying wire on a magnetic needle. The magnetic needle and conductor are mounted on a transparent, acrylic plate printed with a compass rose. A DC current of up to approx. 3 A is applied through safety terminals. Length of magnetic needle: 105 mm.

Item no. 455710





### Pohl swing

For demonstrating the force on a conductor in a magnetic field.  
Dimensions: 270 x 100 x 160 mm.

Item no. 455500

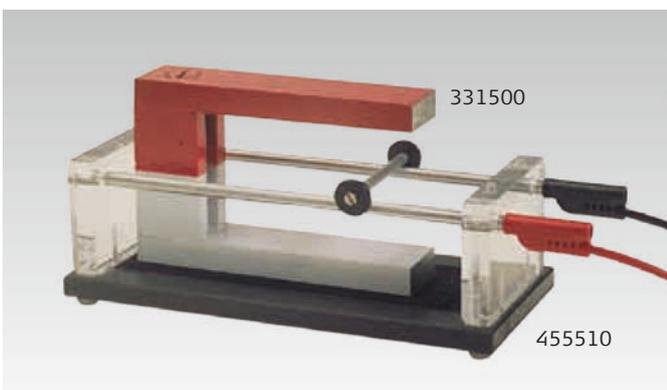


### Induction coil, hanging

Used with round magnet with bearing item no. 332010 to demonstrate induced voltages. Because the coil windings can be pulled apart, the rotatable magnet can be positioned within the coil and made to rotate using, for example, 202500 Motor/generator with winding shaft.

Wire thickness: 2 mm

Item no. 455600



### Laplace force demonstration

For demonstrating the force on a conductor in a magnetic field. The apparatus consists of a pair of rails with  $\varnothing$  4 mm terminals. The conductor consists of a bar with plastic discs which is placed across the rails.

An alnico horseshoe magnet no. 331500 (not included) is used as a magnet.

When the conductor is placed on the rails and current (max. 10 A) applied, the conductor will be affected by a force making it roll perpendicular to the magnetic field and the current direction, i.e. along the rails.

Item no. 455510



### Coil with variable winding pitch

For investigating a coil's field strength relative to its winding pitch. The field strength can be measured by 406050 Teslameter.

The coil has 30 windings and a diameter of 100 mm, and its length can vary between approx. 80 and 490 mm. Equipped with safety sockets. The coil will withstand 10 A (20 A short-time)

Item no. 466000

## TRANSFORMER SETS AND ACCESSORIES FOR DEMONSTRATIONS

### Coils for demonstration transformer

Compatible with U-I core 459700. Wound on plastic bobbin with square opening. The front plate shows the connection options, number of windings, ohmic resistance and max. current intensity. All the sockets are of the safety type. The coils are fitted with extra insulation in compliance with applicable rules.

Item no.	Type	Tap	Current	Resistance
459610	5 windings	Spot welding tongs	Approx. 360 A	-
459620	72 windings	6/12/24/24/6/72	10 A	0.23 Ω
459640	600 windings	200/400/600	2.5 A	3.5 Ω
459645	600 windings	Mains connection	2.5 A	3.5 Ω
459650	1200 windings	400/800/1200	1.5 A	15 Ω
459655	24000 windings	High voltage	0.02 A	11 KΩ





### U-I core for demonstration coils

Laminated U and I-core with clamping bracket (item no. 449725), which ensures low power dissipation.

Height: 170 mm. Width: 150 mm. Cross section: 40 x 40 mm. Weight: 6 kg.

Item no. 459700



### Pole pieces for U-core

Two solid, nickel-plated, soft iron pole pieces for fitting to U-core 459700

Dimensions (for each pole piece): 75 x 40 x 40 mm. Weight: 1.9 kg.

Item no. 459720

### Welding pieces

Can be spot-welded using welding tongs 459610.

Item no. 460510

### Crucible

Copper crucible for demonstrating induction heating. Fitted with a wooden handle. Water can be used as the medium and it will boil.

Item no. 459660



### Thomson's jumping ring

For demonstrating magnetic repulsion caused by the induction current in a closed ring. It is placed as a secondary coil in an I-core. The set consists of a closed and an open aluminium ring.

Item no. 460000



### Arc discharge rods

Demonstrate how high-voltage arc discharges rise due to heat. For safety, the arc discharge rods are fitted into an insulated, protective plastic tube with safety sockets. One of the rods is horizontally adjustable in order to initiate the electric arc.

Dimensions: Tube: Ø 90 x 500 mm. Base plate: 200 x 200 mm

Item no. 461510

## TRANSFORMER SETS AND ACCESSORIES FOR STUDENT PRACTICALS



### Coils for student transformer

Made from coloured plastic with safety sockets. The coils are fitted with a transparent polyester film with an effective dielectric strength of more than 4500 V to prevent electric shocks. Hole size: 20.5 x 20.5 mm.

Item no.	Colour	Windings	Current	Resistance
462510	blue	200	2 A	0.7 $\Omega$
462520	yellow	400	1 A	2.3 $\Omega$
462517	grey	200/400	1 A	2.3 $\Omega$
462522	grey	600	0.75 A	4.3 $\Omega$
462527	grey	300/600	0.75 A	4.3 $\Omega$
462525	grey	800	0.5 A	9.5 $\Omega$
462530	red	1600	0.25 A	33.3 $\Omega$
462540	grey	3200	0.125 A	146 $\Omega$

### U/I core

Laminated U/I core with thumb screw (item no. 463001). Compatible with coils nos 462510-40. Dimensions: 20 x 20 x 83 mm.

**Item no. 463000**



### I-core, solid

Solid armature for demonstrating the increased loss of power when using solid rather than laminated cores. The solid core becomes hotter in use than the laminated one. Dimensions: 20 x 20 x 83 mm.

**Item no. 463020**



### I-core, laminated

Laminated I-core. Dimensions: 20 x 20 x 83 mm.

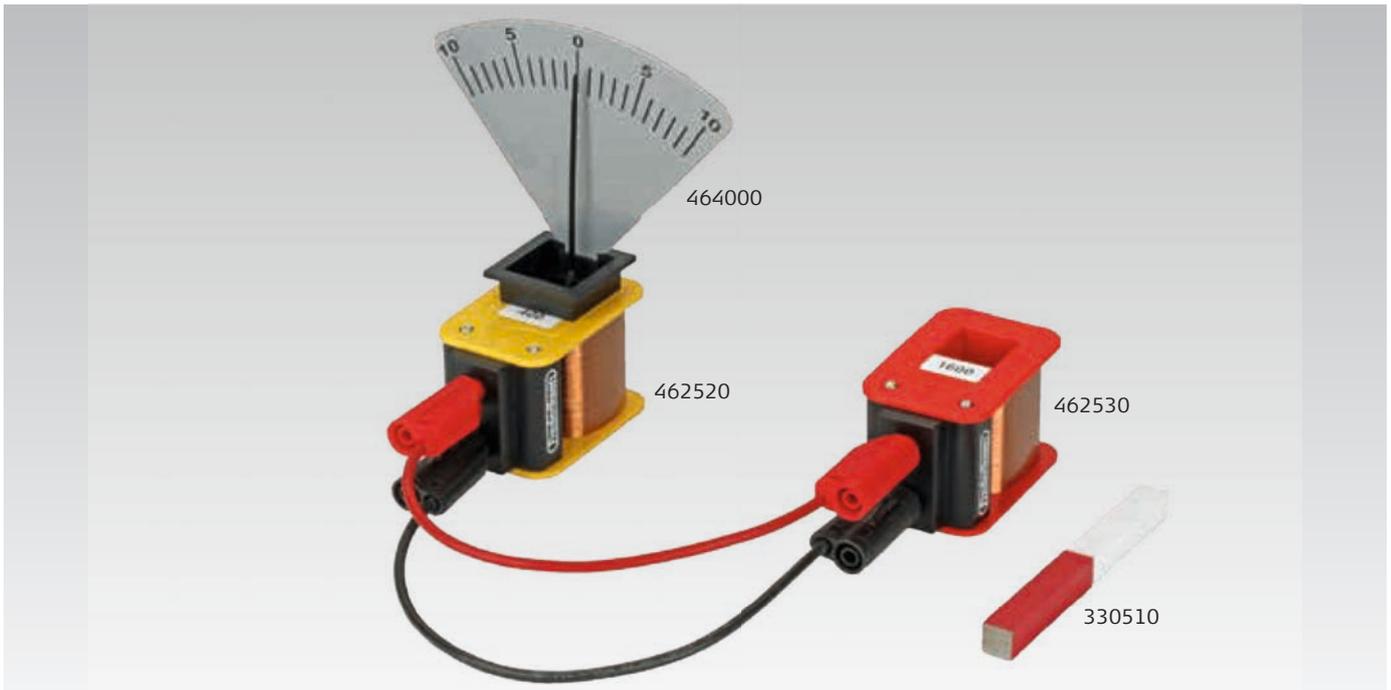
**Item no. 463010**

### E-core, laminated

For demonstrating a 3-phase transformer. Compatible with coils 462510-40. Set with upper and lower core on a base. Cross-section: 20 x 20 mm. Base plate: 120 x 70 mm. Height: 140 mm. Weight: 1.6 kg.

**Item no. 463500**

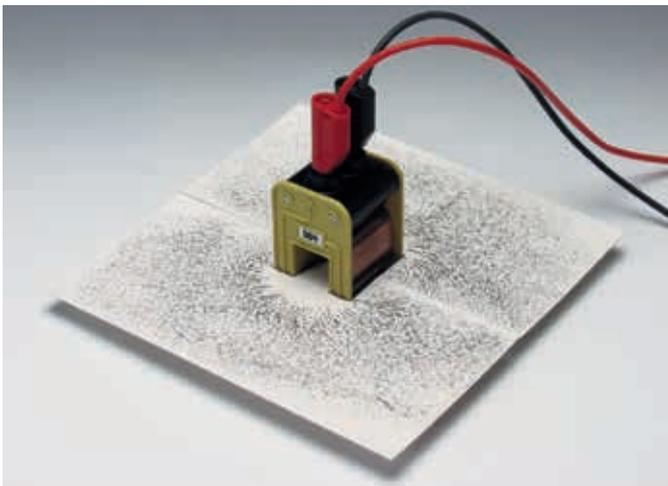




### Spring and contact pin

For use when making relays and interrupters. The spring and contact pins are fitted with tungsten contacts and fixing notches. Contact pin length: 110 mm Spring length: 120 mm

Item no. 456000



### Cardboard square for coil

Cardboard square with cut-outs for coil no. 462510. For demonstrating the magnetic field around a coil using iron filings.

Item no. 455200

### Galvanometer insert

For building a simple galvanometer. The insert consists of a permanent magnet with a pointer. The device is fitted with a 0-centre scale. Compatible with coils nos 462510-40.

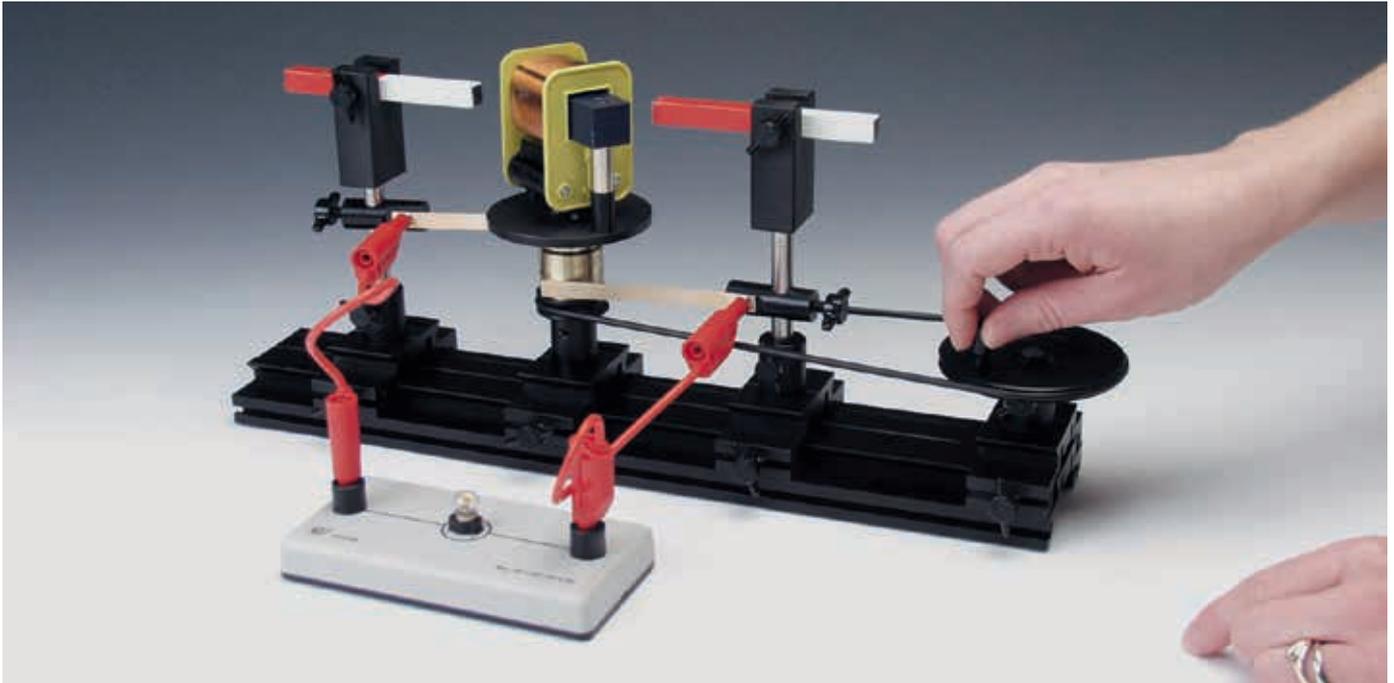
Item no. 464000



### Horseshoe electromagnet

To demonstrate the correlation between electricity and magnetism. Only magnetised when current is applied. Height: 10 cm. Requires 4 V DC connected via terminal blocks.

Item no. 331700



### Motor/generator set, single-phase

Sturdy assembly for clearly demonstrating single-phase AC and DC generators and DC motors.

The set consists of:

- 470800 Coil holder with commutator x 1.
- 462525 Coil, student, 800 windings x 1.
- 463010 I-core, laminated, student x 1.
- 470820 Commutator contact spring x 2.
- 294635 Profiled rail without saddles x 1.
- 294610 Saddle with Ø 10 mm hole x 4.
- 470810 Magnet mount for motor/generator x 2.
- 330510 Bar magnets 100 x 10 x 10 mm x 1.
- 470830 Manual drive pulley x 1.
- 203700 Drive belts, set of 4 different x 1

Instructions.

A power supply and leads are also needed (not included).

**Item no. 476000**



### Coil holder with commutator and collector

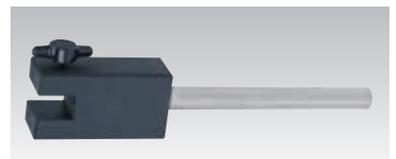
Coil holder for constructing a rotor for motor/generator. For use with coil 462520 and I-core 463010. The commutator is designed so that its top and bottom act as a collector with a constant connection to the coil, while the central section reverses the current every half turn. The coil holder is fitted with a pulley and a Ø 10 mm rotary shaft that fits into a 294610 saddle.

Dimensions: Overall: Ø 76 x 142 mm, commutator/collector: Ø 30 mm, pulley: Ø 28 mm.

**Item no. 470800**

### Magnet mount for motor/generator

Used for mounting the stator magnets in the motor/generator set. Fitted with a Ø 10 x 95 mm stainless steel pin. Made from plastic with a recess for 10 x 10 mm bar magnets no. 330510 (or Ø 10 mm cylindrical magnets).



**Item no. 470810**

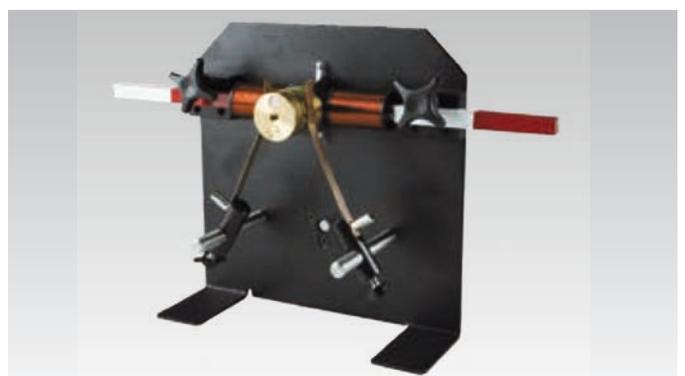
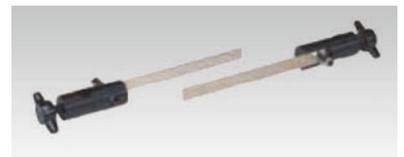
### Commutator/collector contact spring

Contact spring made from phosphor bronze.

To mount on the bar of magnet holder no. 470810 using a thumb screw. Fits safety plugs.

Overall length: Spring dimensions: 8 x 0.5 x 100 mm.

**Item no. 470820**



### Motor-generator model

This model is ready to use. As a generator, it can produce both AC and DC (but the waveform is not a sine wave).

**Item no. 470600**



### Motor/generator set, three-phase

With all the parts required for a 3-phase AC generator, you will have a set-up that works every time. Can also be used for demonstrating rotating fields and asynchronous motors.

The three black safety sockets are connected internally. If an oscilloscope is being used, it only needs to be connected to one of them. For data logging, a voltage sensor is connected to each coil.

The complete set includes:

473500 Coil holder x 1.

462520 Coil, 400 windings x 3.

463010 I-core, laminated x 3.

294635 Profiled rail without saddles x 1.

294610 Saddle x 2.

332010 Round magnet with bearing x 1.

202500 Motor/generator x 1.

203700 Drive belts, pack of 4 x 1.

Accessories required: power supply and leads and oscilloscope or data logging equipment.

**Item no. 476050**

### Coil holder, three-phase

Consists of a triangular, acrylic plate with support pin for I-cores with coils and a bearing with a thumb screw for a  $\varnothing$  10 mm post. Equipped with safety sockets. Used with round magnet with bearing item no. 332010, I-core item no. 463010 and coils nos 462510-40. Side length of acrylic plate: 200 mm. Height: 80 mm.

**Item no. 473500**

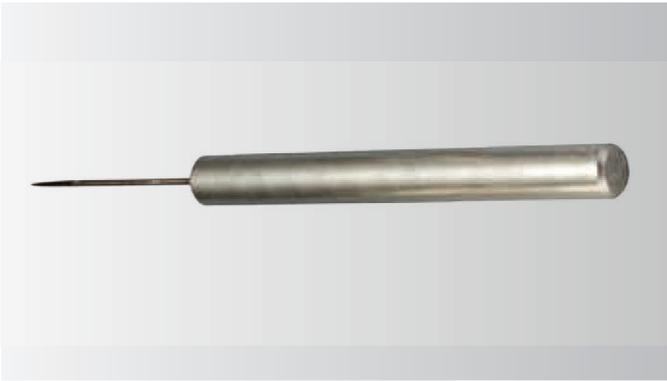




### Spring contacts

For use with commutator item no. 470500. Attach to terminal posts item no. 435000. Set of 2. Length: 170 mm

**Item no. 470510**



### Needle on a post

Used for experiments with rotating fields in connection with no. 473500 and nos 475010 or 475020.

Post: Ø 10 x 90 mm. Length: 135 mm.

**Item no. 475510**



### Commutator for student coils

Used for experiments with DC motors and generators. The commutator consists of two semi-circular brass pieces mounted on a cylindrical plastic drum. Equipped with two 4 mm sockets for coils nos 462510-40. Commutator: Ø 30 mm. Overall height: 80 mm

**Item no. 470500**

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## LIGHT SOURCES



### Spectral lamp holder with screw fitting

The spectral lamp holder is designed for use with spectral lamps with E27 screw fittings. The spectral lamps must not be connected to the mains but to Control transformer 284050. The spectral lamp holder incorporates a cooling fan to keep the surface temperature below 60 °C. Dimensions: 295 x 78 x 78 mm.

Item no. 283065



### Spectral lamps with screw fittings

This range of bright spectral lamps offers a selection of elements at very competitive prices.

N.B.: The lamps have an E27 fitting (like a standard screw fitting), but must not be connected directly to the mains. The lamps must be fitted in spectral lamp housing 283065 and powered via Control Transformer 284050.

Item no.	Element
283650	Na
283655	Cd
283660	Hg
283665	Zn
283670	Ne
283675	He



### Spectral lamp holder

Lamp holder with 9-pin socket for Osram spectral lamps. It is fitted with a built-in cooling fan to keep the holder's surface temperature below 60 °C. The centre of the light aperture is placed 147 mm above table height. Light aperture: Ø 25 mm. The rear plate of the lamp holder has a threaded socket for a Ø 10 mm support post. The lamp holder is fitted with a lead with a special 3-pin plug for use in Control transformer 284050. Dimensions: 228 x 77 x 77 mm.

Item no. 283050



### Spectral lamps, Osram

Powerful light source for producing spectral lines. Lamps with 9-pin Pico sockets for fitting in spectral lamp holder 283050. To be powered via Control Transformer 284050.

Dimensions: Ø 20 x 100 mm

Item no.	Element
283500	Na
283610	Hg
283520	Cd
283530	He
283540	Ne
283550	Zn



**Control transformer**

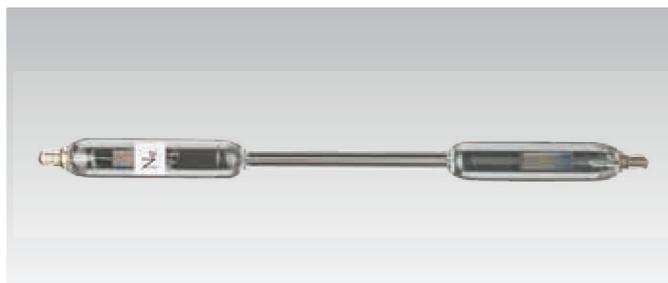
Used as a power supply for spectral lamps in connection with spectral lamp housing 283050 or 283065, and mercury lamp 286000 fitted in holder 287000.

Connects to 230 V AC. Fitted with a special 3-pin socket.

Maximum output current: 1 A.

Dimensions: 185 x 118 x 225 mm

**Item no. 284050**



**Spectral tubes**

For demonstrating the characteristic spectra of different materials.

Ignition voltage up to 6 kV, max. current 2 mA DC.

Dimensions: Length approx. 220 mm, capillary tube Ø 6 x 80 mm.

Item no.	Type
285000	Ne
285010	Hg
285020	H <sub>2</sub>
285025	H <sub>2</sub> Balmer
285030	He
285040	Ar
285050	O <sub>2</sub> (IR)
285060	Kr
285070	N <sub>2</sub>
285110	H <sub>2</sub> O
285120	CO <sub>2</sub>
285130	Xe
285150	Iodine
285180	Na and He



**Spectral tube holder with power supply**

New holder for use with the familiar thin spectral tubes, which makes their use both easier and considerably safer. The spectral tubes are mounted in insulated holders, equipped with a contact electrode. The lower holder is spring-loaded and can be moved up and down for ease of installing the spectral tube. Suitable for spectral tubes with a length of between 224 and 299 mm and a diameter of max. 15.5 mm. The holder's built-in power supply delivers an ignition voltage of up to 6 kV. Operating voltage is considerably lower and is adjusted using the variable current limiter.

The current can be adjusted between 2 and 8 mA using a button on the rear. Connects to the mains. Dimensions: 90 x 90 x 330 mm.

**Item no. 285570**



### Compact spectroscope

A practical and sturdy instrument with a nice, bright rendering of the spectrum, centred in the field of view. It uses a grating of 600 lines per mm. Allows observation of both emissions and absorption spectra. No wavelength scale.

Dimensions: Ø 25 x 105 mm

Item no. 321015

### Compact spectroscope, pocket size

Item no. 321015

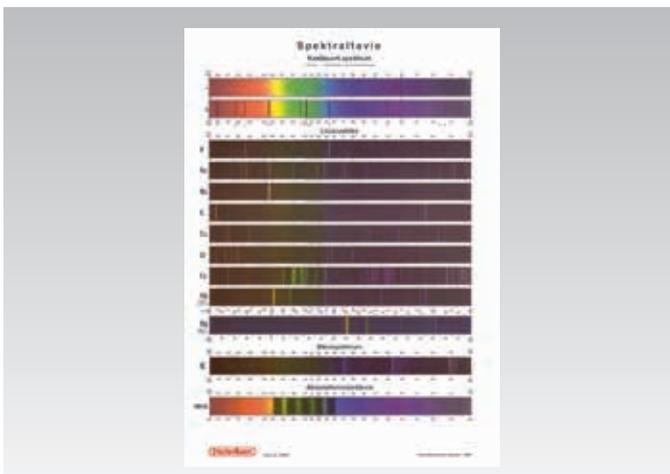


### Hand-held spectrometer

A budget hand-held spectrometer with a wavelength scale and printed spectral lines for a range of materials.

For student use, when the aim is simply to determine the approximate wavelength for the spectral lines being observed.

Item no. 321030



### Spectral table, A4

The table shows continuous spectra, linear spectra, band spectra and an absorption spectrum. Wavelengths are given in nanometres. A4 format. Danish text.

Item no. 322010



### Chemicals for spectral analysis

Used to demonstrate the flame colours of different chemicals by burning a little of them in a bunsen burner flame. The set consists of 12 chemicals: calcium carbonate, calcium chloride, calcium hydrogen phosphate, calcium sulphate, potassium carbonate, potassium chloride, potassium nitrate, copper(II) sulphate, lithium sulphate, sodium carbonate, sodium chloride and sodium sulphate.

Item no. 322500



### Electroscope and zinc plate for electroscopes

For demonstrating the photoelectric effect. The zinc plate is negatively charged. On illumination with red light, which has low photon energy, no change is observed, but on illumination with ultraviolet light, discharge of the zinc plate on the electroscopes is observed.

Accessories required:

UV-C lamp item no. 287105 used with lamp holder item no. 287100.

Item no. 441000 Electroscopes

Item no. 441003 Zinc plate for electroscopes

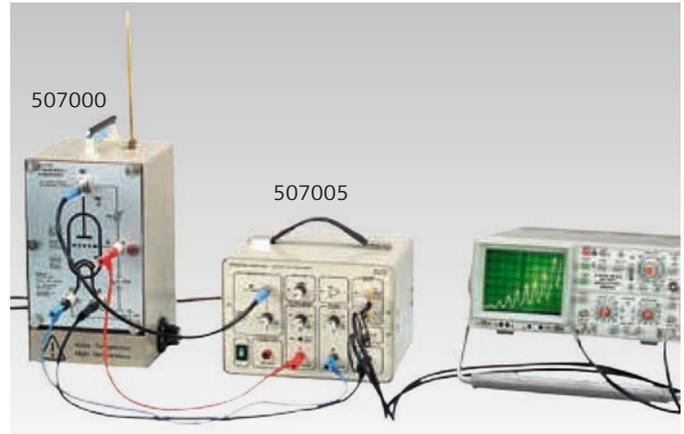


### Planck's constant with LEDs

This apparatus still uses the photoelectric effect to determine Planck's constant, but the light source consists of five replaceable LEDs. The LEDs are marked with their wavelength and are mounted in a black plastic housing which ensures easy optical connection to the photocell, without risk of ambient light disturbing the measurements. This model yields very precise results.

The apparatus includes a measurement amplifier and is supplied with a mains adapter.

Item no. 506020



### Franck-Hertz apparatus, mercury

For determining the first excited energy level of mercury.

Consists of a mercury-filled vacuum tube with embedded electrodes. The vapour pressure of the mercury in the tube is determined by the temperature in the thermostat-controlled oven. Connects to an accelerating voltage of 0 - 50 V, a filament voltage of 6.3 V and a braking voltage of 1.5 V. By measuring a series of the accelerating voltage and the associated values of the current through the tube, the first excited energy level of mercury can be determined.

Required accessory is a 507005 Measurement amplifier.

Item no. 507000

### Measurement amplifier

Measurement amplifier and power supply with ramp generator for 507000.

Item no. 507005



### Planck's constant - diode characteristics

This apparatus is designed for determining Planck's constant based on the knee voltage of a range of LEDs, and associated frequency of the light emitted by the diodes. This version does not use a photocell. The diodes are a UV, an IR and three which emit visible light. They have been carefully chosen to have a very narrow and well-defined bandwidth. The equipment is simple to use and doesn't require special light sources or costly filters. The results are reproducible to within 10% of the table value for Planck's constant.

Power is supplied by a built-in 9 V battery (included), or a 9 V mains adapter may also be used.

Item no. 506000

## X-RAYS



### Tel-X-Ometer

X-ray tube and experimental region with transparent, radiation-safe cover.

The tube has a copper anode, and the anode voltage can switch between 20 and 30 kV. The current can be adjusted.

A goniometer arm with nonius and slide holder, in which a GM tube is typically mounted. The arm can rotate  $11^\circ$  -  $130^\circ$  on either side, and be fixed in the  $0^\circ$  position. The sample holder in the centre of the device can follow the arm's angle at a ratio of 1:2 for experiments with Bragg reflection, but can also be rotated independently.

The supplied 50-page manual has technical information and descriptions of a wealth of experiments relating to Laue diffraction, Bragg reflection, Bremsstrahlung spectrum, absorption, reflections, Moseley's Law, dosimetry and crystallography. (These experiments require various accessories; see below.)

The instrument is equipped with a timer and several interlock switches, to prevent unintended radiation. It meets the specific requirements of the Danish National Institute of Radiation Hygiene and is approved for use in upper secondary schools.

**Item no. 509000**

### GM tube for Tel-X-Ometer

Geiger-Müller tube that fits the Tel-X-Ometer's slide holder. The tube has a BNC plug and is compatible with our counters with BNC sockets.

**Item no. 509025**



### Basis Accessory Kit, Tel-x-ometer

Comprises 26 components, including collimators, luminescent screen, large individual crystals (NaCl, LiF), absorption foils (Ni, Cu, Co, Zn), rotary holder with 8 metal foils for diffraction, film cassettes and Debye-Scherrer powder camera. Using this set, you can verify Bragg's Law, perform x-ray spectroscopy, verify Moseley's Law and demonstrate Laue diffraction. In all, more than 30 experiments can be performed using this set. From the most fundamental properties of X-radiation to highly advanced measurements.

**Item no. 509010**

### Other accessories for Tel-X-Ometer:

**Item no. 509011 NaCl crystal**

**Item no. 509040 Ionisation chamber**

## ELECTRON TUBES

### e/m tube

Used to determine the relationship between the electron's charge and its mass ( $e/m$ ). The vacuum tube is fitted with a built-in measurement scale for determining the diameter of the circle produced by the electron beam when it is deflected in a magnetic field. The tube is mounted on a base, equipped with safety sockets.

Anode voltage: 300 to 300 V; focusing voltage: 0 to -50 V; filament voltage: 4 to 10 V.

Item no. 507500



### Helmholtz coils for e/m tubes

Consists of 2 separate coils each of 120 windings in parallel planes 15 cm apart. Coil diameter: 295 mm. Max. current: 5 A.

Item no. 465000



### Thomson e/m tube, Teltron 2525, type S

Used to investigate the motion of electrons in the magnetic field. The tube is equipped with a luminescent screen that delineates the path of the electrons. A magnetic field can be applied externally using a set of Helmholtz coils (not included) allowing the tube to be used for determining  $e/m$ . With the built-in condenser plates, the electrons can be affected by an electrical field. In combination, the two fields will produce a velocity filter for the electrons.

Anode voltage up to 5 kV, deflection voltage up to 350 V, filament voltage max. 7.5 V. Requires holder 508560 (not shown).

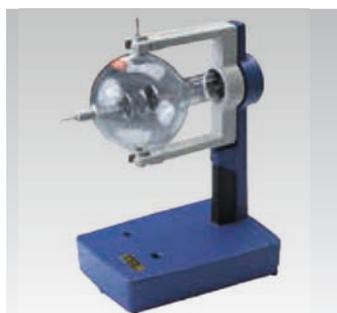
Item no. 508505



### Stand for Teltron tube, type D, Teltron 501

Stable, secure stand with space for attaching Helmholtz coils. The tube can be rotated around the longitudinal axis.

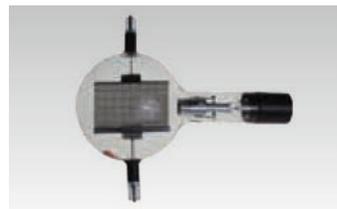
Item no. 508060



### Thomson e/m tube (deflection tube), Teltron 525 (D)

This demonstration tube is equivalent to 508505 (TEL 2525), but its condenser plates are completely outside the luminescent screen. The electrical deflection therefore occurs over a wider area, and the parabola is more clearly visible. Conversely, it requires a somewhat larger deflection voltage – the same supply as for the anode voltage may be used if variation is unnecessary. A set of Helmholtz coils (not included) allows magnetic deflection to be demonstrated as well. Anode voltage up to 5 kV, deflection voltage up to 5 kV, filament voltage 6.3 V

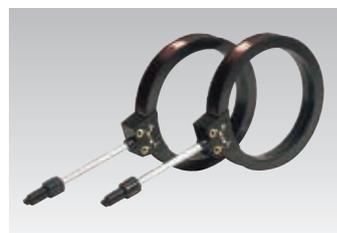
Item no. 508005



### Helmholtz coils, Teltron 502 (D)

A set of Helmholtz coils for generating a uniform magnetic field. No. of windings: 320 Max. current 1.0 A, but can withstand 1.5 A for up to 10 mins and 2 A for up to 3 mins.

Item no. 508050



### Electron diffraction tube, Teltron 555 (D)

Along with the photoelectric effect, electron diffraction illustrates one of quantum mechanics' most revolutionary results: the wave-particle duality.

The wave nature of the electron is detected from the electron beam passing through a polycrystalline graphite foil which deflects the wave packets. Based on knowledge of the lattice constants of graphite, the Broglie wavelength of the electrons can be determined, and its energy variation studied. Anode voltage up to 5 kV, focusing voltage 0 – 50 V, filament voltage max. 7.5 V.

Item no. 508035



NeedsomeTeltronequipmentthatyoudidnotfindhere? Pleasedonothesitatetocontactus.Wecanprovidemuch more than you can find here on this page.

## OCEAN OPTICS RED TIDE SPECTROMETER

The Red Tide series from Ocean Optics comprises high-quality digital spectrometers. The system is modular and many combinations are possible. Communication with the PC is by USB.

The core of the range is the Red Tide USB-650 spectrometer. The measurement range for the instrument itself is 350-1000 nm, over a 650 pixel sensor. The sensor's resolution is therefore 1 nm. The instrument's optical resolution is approx. 2 nm.

The spectrometer can be combined with an optical fibre for emission spectroscopy or a cuvette holder with integrated lamp to create a photospectrometer for absorption spectroscopy.

The effective measurement range depends on the supplementary equipment used (fibre, cuvette holder).

OceanView is Ocean Optic's software for measuring using the spectrometer, including controlling the lamp in the cuvette holder (in ChemPack and PCpack). The program allows the recording of emission and absorption spectra, colouring of the visible spectrum and more. In some of the combinations below, PC software is included.



### Ocean Optics ChemPack

Set consisting of Ocean Optics Red Tide USB-650 spectrometer, 321802 cuvette holder and 321806 OceanView software. Measurement range: 370-985 nm.

**Item no. 321810**

### Ocean Optics PCpack

Set consisting of Ocean Optics Red Tide USB-650 spectrometer, 321802 cuvette holder, 321855 fibre optic cable, and 321806 OceanView software.

**Item no. 321814**

### Fibre optic cable Vis-NIR

Fibre optic cable terminated with standard SMA 905 connectors at both ends.

Length: 2 m; wavelength range: 400-2500 nm.

**Item no. 321855**

### Fibre optic cable UV-Vis

Fibre optic cable terminated with standard SMA 905 connectors at both ends.

Length: 2 m; wavelength range: 300-1100 nm.

**Item no. 321850**

### Ocean Optics Cuvette holder

Cuvette holder and lamp holder for Red Tide USB-650.

**Item no. 321802**

### OceanView software

PC-based software for the Ocean Optics spectrometers. A single licence for use on two different PCs.

**Item no. 321806**



### Ocean Optics PhysPack

Set consisting of Ocean Optics Red Tide USB-650 spectrometer, 321855 fibre optic cable, and 321806 OceanView software.

Measurement range (with optical fibre): 400 – 1000 nm.

**Item no. 321812**



### Spectrometer

For determining the wavelength of visible light through diffraction in an optical grating, or refraction in a prism. Classical spectrometer with goniometer. The instrument's angular scale can be read to a precision of 0.1 degrees. Supplied with holders for both prisms and gratings, as well as an adjustable prism table. Students will find it easy to operate and read off the spectrometer and to position the adjustable elements to best effect. The collimator and telescope are equipped with  $\varnothing$  32 mm achromatic lenses with a focal length of 178 mm. The collimator has an adjustable aperture. The telescope has an eyepiece with a reticle.

**Item no. 321530**



### Smoke chamber for Brownian motion

For demonstrating Brownian motion in smoke with a (stereo) microscope. A Reuter lamp or similar can be used as a light source. The apparatus is fitted with a convex lens which condenses the light in the chamber. Smoke is drawn into the chamber using a rubber bulb. Dimensions: 100 x 24 x 25 mm

**Item no. 515000**



### Smoke chamber for Brownian motion with laser

The same as 515000, but for use with laser light. The apparatus incorporates two plane parallel windows which allow the laser light to pass through the chamber. Dimensions: 100 x 24 x 25 mm.

**Item no. 515010**

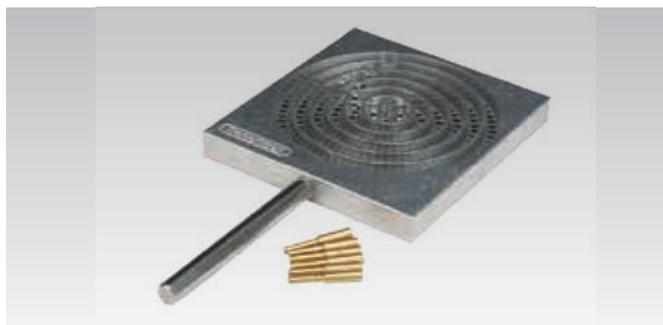


### "Proton" and "Neutron"

For illustrating the stabilising effect of neutrons on the atomic nucleus. The "protons" are made from disc magnets, while the "neutrons" are made from iron discs. The "protons", being magnetic, will repel each other, when placed on a flat surface. The "neutron" stabilising effect is illustrated by placing "neutrons" between "protons" thereby eliminating the repulsive force. The "protons" have red stickers and the "neutrons" blue stickers. Each student group requires 5 "protons" and 12 "neutrons".

**Item no. 516100 "Protons", each**

**Item no. 516110 "Neutrons", each**



### Chain reaction apparatus

For demonstrating a chain reaction using matches. Supplied with 6 brass pins for damping the chain reaction.

**Item no. 516000 Chain reaction apparatus**

**Item no. 516001 Extra pins, pack of 6**

### Dice

For simulating radioactive decay. 100 pcs.

**Item no. 595200**



### Continuous cloud chamber

Continuously operating cloud chamber for displaying particle tracks. With the aid of approx. 50 g dry ice and 1-2 mL of denatured alcohol, particle tracks can be observed for up to 30 minutes. Equipped with a 12 V special bulb and spring for mounting alpha-particle-absorbing metal foil. Supplied with approx. 50 mL denatured alcohol. Diameter: 120 mm; height: 90 mm.

Supplied without radioactive source no. 510510, see page 149.

**Item no. 512000**



### Dry ice maker, 30 g

Device for producing dry ice. Connect the Snowpack to a CO<sub>2</sub> cylinder with a syphon tube (item no. 072570). Follow the supplied instructions and in 1 minute a dry ice pellet of Ø 50 x 22 mm will be produced.

**Item no. 073080**



**Bright Atom model, student**

Bright Atom is an award-winning model of the atom. Students use their hands to feel and create their own atoms, isotopes and ions, and understand the concepts in an easy and fun way! The Bright Atom student set is simple to use and a dependable teaching resource.

Both surfaces can be used to create atoms and isotopes since the electron shells are marked, and everything can be stored away in one place, namely inside the model.

One can make two atoms collide and move the valence electron manually to give students a visual display of the collision.

The Bright Atom student set contains: 2 surfaces on which to build atoms and 30 protons, 30 neutrons, and 30 electrons.

**Item no. 528000**



**Bright Atom model, teacher**

The Bright Atom teacher model is an excellent teaching resource for introducing abstract concepts relating to atomic structure, isotopes and ions.

Since the Bright Atom teacher model is magnetic, it can be placed directly on a smartboard.

The model includes: 2 nuclei, 8 electron shells, 20 protons, 20 neutrons and 20 electrons.

**Item no. 528001**



**Bright Atom model, set**

Bright Atom set comprising 8 student sets, item no. 528000 and 1 teacher model, item no. 528001.

**Item no. 528005**



**Plasma ball, large**

Consists of a glass ball containing a noble gas under very low pressure. The built-in Tesla transformer produces 120 kV at a very low current. This generates continuous discharges which resemble myriad tongues of lightning, which react to touch. The magnetic field around the ball is very low and is not a health risk.

One amusing experiment is to hold a fluorescent tube or compact fluorescent lamp near the ball. This will light up and cause amazement! The plasma ball is ideal as an introduction to atomic physics.

**Item no. 670138**



**Plasma ball, small for USB**

The same type of plasma ball as 670138, but a small model with a USB connection.

**Item no. 306720**

## RADIOACTIVE SOURCES

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### Risø source, complete set

Radioactive sources mounted in approved holders with plastic shafts, threaded for mounting in a support. Set comprising Alpha, Beta and Gamma sources, and storage container for the sources.

**Item no. 510000**

### Risø source – Alpha source

Radioactive alpha source mounted in an approved holder with a plexiglas shaft, threaded for mounting in a support. Sample: Americium-241, activity: 37 kBq, half life: 432.6 years.

**Item no. 510010**

### Risø source – Beta source

Radioactive beta source mounted in an approved holder with a plexiglas shaft, threaded for mounting in a support. Sample: Strontium-90 in equilibrium with yttrium-90, activity: 37 kBq, half life: 28.8 years.

**Item no. 510020**

### Risø Educational Source – Gamma source

Radioactive gamma source mounted in an approved holder with a plexiglas shaft, threaded for mounting in a support. Sample: Caesium-137, activity: 370 kBq, half life: 30.1 years.

**Item no. 510030**

### Storage container for Risø Educational Sources

Plexiglas container for three Risø sources.

**Item no. 510040**



### Americium source for use with continuous cloud chamber

Radioactive alpha source mounted in approved holder with a black plastic shaft, threaded for installing in cloud chamber 512000.  
 Sample: Americium-241, activity: 3.7 kBq, half life: 432.6 years.

Item no. 510505

### Holder for americium source (5105.05)

Item no. 510510



### Co-60 source (Risø)

Radioactive alpha source mounted in approved holder with a plastic shaft, threaded for mounting in a support.  
 Sample: Cobalt-60, activity: 260 kBq, half life: 5.27 years.



Item no. 510035



### Radioactive rocks

The set comprises 6 different minerals (uraninite, thorianite, euxenite, allanite, pyrochlore and rødberg (red rock from the Fens Formation in Norway)) containing uranium, thorium, yttrium and/or cerium in various combinations and quantities. The minerals produce from a weak to a strong reading on a GM sensor or counter and are excellent alternatives to artificial sources. Also excellent for using with a scintillation detector (518500) and a multichannel analyser (518000), see page 154.

Item no. 670255

### Potassium chloride

Naturally occurring potassium contains 0.0117% of the radioactive isotope K-40. Pour one or two tablespoons into a zip bag and flatten it out. Use a high sensitivity GM tube without a protective cap. You can expect a count of about three times the background radiation.

Item no. 848700-2 (250 g)

## What radiation do the sources emit?

The alpha, beta and gamma sources have been chosen to best illustrate the three types of radiation – but nothing is perfect, so it is good to be aware of the details.

### The Alpha source

Am-241 alpha-decays to countless different excited states in Np-237, which then decay by gamma radiation. The most important gamma energies are 13.9 keV (42%), 26.3 keV (2.4%) and 59.5 keV (36%), where the percentage is relative to the number of alpha emissions.

In other words, some low-energy gamma radiation is emitted from the alpha source, but since a Geiger counter is very insensitive to gamma radiation, it will still be the alpha radiation that dominates the observations.

The Np-237 daughter nucleus is radioactive, but at a low level. A Risø source of Am-241 must be more than 80 years old before there is one Np-237 emission per second.

### The Beta source

Sr-90 fully beta-decays to the ground state of Y-90, which then beta-decays to Zr-90.

99.98% of these emissions are to the ground state, but in 0.017% of cases they reach an excited level, which then decays by emission of gamma radiation with an energy of 1761 keV.

Zr-90 is stable.

### The Gamma source

Cs-137 beta-decays to Ba-137. 94% of the decay is to an excited level, which then decays by gamma radiation with an energy of 662 keV.

The source is designed so that most of the beta radiation is stopped within the source.

Ba-137 is stable.

### The Co-60 source (gamma)

Co-60 beta-decays effectively purely to an excited level in Ni-60, which then decays in two stages to the ground state through emission of gamma radiation with energies of 1173 keV and 1333 keV.

But 0.12% of the beta decays are to the middle energy level, meaning we are "cheated" of the first gamma quantum in the cascade.

The source is designed so that most of the beta radiation is stopped within the source.

Ni-60 is stable.



### Isotope generator

For experiments in determining half lives.

The isotope generator contains Cs-137, which mainly beta-decays to Ba-137m, which then decays by gamma decay to Ba-137. The half life of Ba-137m is approx. 2.6 minutes.

Using the accompanying extraction fluid, a small amount of Ba-137m can be extracted (along with a large amount of inactive Ba-137), while the mother nuclide Cs-137 remains in the generator.

After half an hour, the activity of the extracted sample is low enough to be poured down the drain. The half life of Cs-137 is approx. 30 years. The isotope generator's activity is 380 kBq. Ba-137m can be extracted from the isotope generator up to 1,000 times.

N.B.: Use only the original extraction liquid. Use of other extraction liquids will void the warranty.

**Item no. 511200**



### Isotope generator

Budget alternative from Spectrum Techniques for extracting radioactive samples for experiments in determining half lives. Contains Cs-137, which mainly beta-decays to Ba-137m, which then decays by gamma emission to Ba-137. The half life of Ba-137 is approx. 2.6 minutes. Approx. 1,000 experimental doses of Ba-137 can be generated. Decays by gamma emission. After 30 mins, the activity of the extracted sample is approx. 4 Bq and it can be flushed away. Supplied with 250 mL of eluting solution, plastic syringe and 10 aluminium dishes.

**Item no. 670136**

### Extraction liquid for isotope generator 670136

Bottle containing 250 mL

**Item no. 511210**



### Extraction liquid for isotope generator 511200

Bottle containing 250 ml

**Item no. 511205**

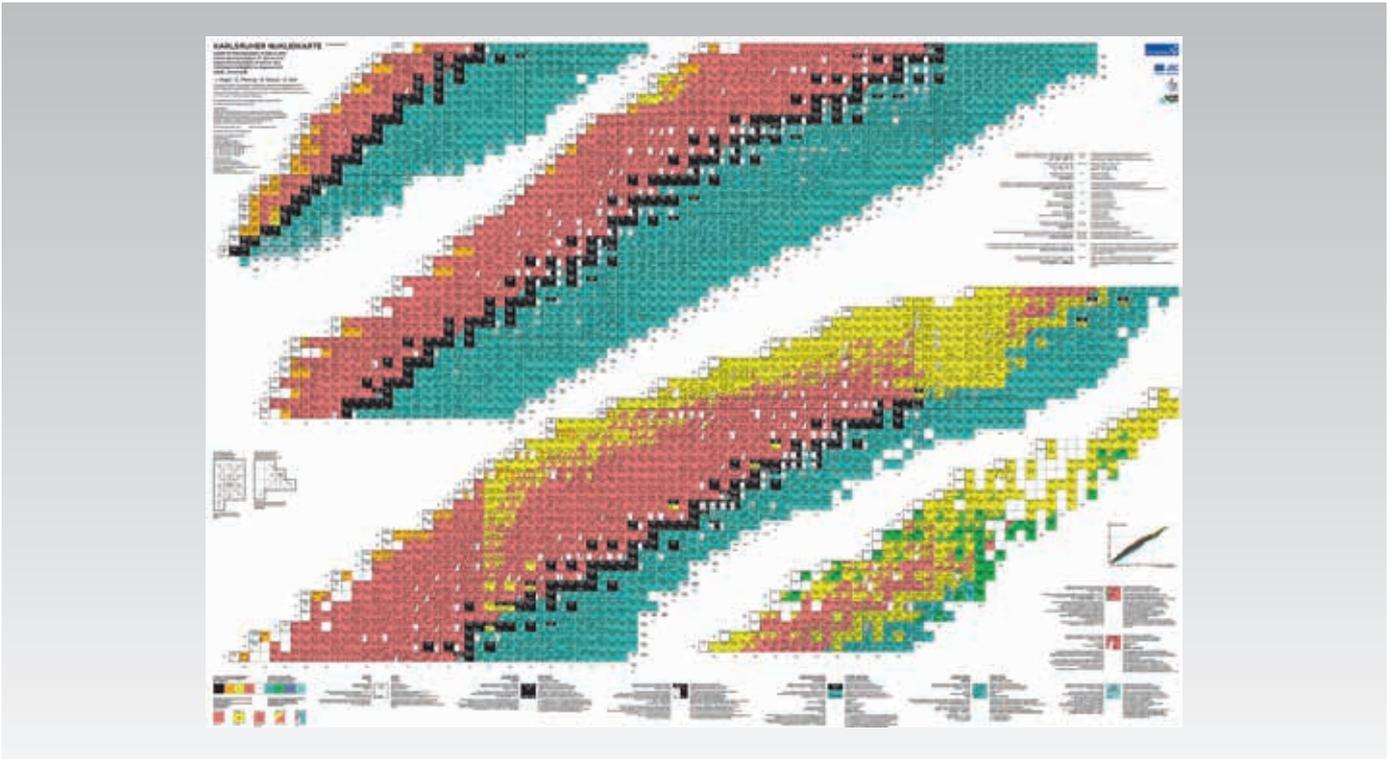


### Steel cabinet with combination lock

Steel cabinet for storing radioactive sources. The cabinet has space for a mini generator and Risø sources. Supplied with a yellow warning sign and a spare key.

Dimensions: 38 x 30 x 30 cm

**Item no. 511710**

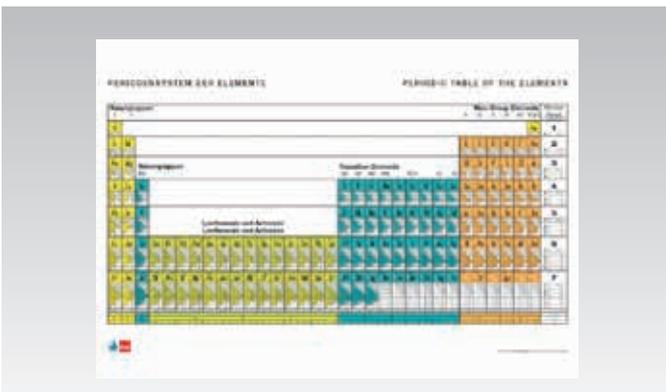


### Isotope chart, roll-up

The well-known Karlsruhe Nuclide Chart, fully updated (8th edition from 2012), showing decay types, half lives etc. A small explanatory booklet is included, in six languages (English, German, Spanish, French, Russian and Chinese).

The individual fields measure 14 x 14 mm. The chart measures approx. 95 x 139 cm. The chart can be mounted on a rail system or using wall fittings. Rolls up automatically.

**Item no. 529520**



### Periodic table, roll up

This periodic table shows elements 1 - 112 with atomic symbol, atomic number and atomic mass. Also shows the electron count in shells and orbits. Printed on plastic-coated cloth. Text: English/German.

The chart measures 100 x 164 cm. It can be mounted on a rail system or with wall fittings. Rolls up automatically.

**Item no. 529010**

## Geiger-Müller tubes

All our GM tubes are sensitive to alpha, beta and gamma radiation. They are supplied with a protective cap for the delicate mica window (which is removed when measuring alpha radiation, for example).

### We use three connector types for GM tubes: BNC, Jack and DIN:

A BNC connector is used for tubes without built-in electronics. These are compatible with, for example, our GM counter 513600 (513530, 513535).

The tubes with a Jack connector have a built-in high-voltage supply and amplifier. This type is compatible with GM counter 513600 and Electronic counter 200250 and for data logging.

The tubes with DIN connectors don't have electronics. These are only for use with older apparatus.

### We offer two sizes of GM tube:

The normal size (9.1 mm window) is excellent for most of the traditional school radioactivity experiments. These tubes have a Ø 10 mm steel mounting post.

The extra sensitive tubes (28.6 mm window) are suitable for measurements of radon daughters, naturally radioactive minerals, cosmic radiation and other applications where a greater area of sensitivity, greater solid angle or more sensitive volume are desirable. These tubes are supplied with a forked holder with a mounting post.



Item no. 512515 GM tube on post, BNC connector

Item no. 512525 GM tube, extra sensitive, BNC connector

Item no. 512518 GM tube, with no cable, BNC connector



Item no. 513575 GM sensor, Jack connector

Item no. 512510 GM tube on post, DIN connector

### Data for the tubes

	Normal tube	Extra sensitive
Gas	Ne + Halogen	
Cathode	446 Stainless steel	
Temperature range / °C	-40 to +75	
Effective length / mm	38.1	36.8
Effective diameter / mm	9.1	28.6
Window thickness / mg/cm <sup>2</sup>	1.5 to 2.0	2.0 to 3.0

## Extra holder for GM tube, extra sensitive

Compatible with 512525 and 513565.

Item no. 512532



## Adapter for GM tube, BNC to Jack

From 512515 or 512525 GM tube with BNC socket to Electronic counter 200250, Coincidence box 513800 or Digital adapter PS-2159.

Item no. 512575

## Adapter for SF GM tube with DIN connector

Adapter for connecting SF-type GM tubes with a DIN connector to counters with BNC connectors.

Item no. 512580



## Spark detector

Newly developed spark detector for visualising alpha particles.

- The alpha radiation can be both seen and heard
  - Clear demonstration of the alpha particles' ionisation of the air
  - Registers alpha radiation from radioactive minerals
  - Facilitates new, exciting experiments in the laboratory
- When alpha particles ionise the air in the spark detector's aperture, sparks can be both seen and heard. The transparent lid allows observation from several different directions.

The spark detector needs to be connected to a high-voltage supply such as 367060. Normal operating voltage is between 2 and 5 kV.

The spark detector can be placed directly on a table or mounted in ordinary stand hardware using the supplied mounting post.

Supplied with instructions and experiment ideas.

Item no. 512110

## Set of electrodes for the Spark detector

Item no. 512111

**Gamma-Scout with alarm**

Geiger counter with alarm. Suitable for continuous measuring and recording of radioactivity at the metering location (permanent monitor). Registers alpha, beta and gamma radiation. Measurement range: 0.01  $\mu\text{Sv/h}$  to 1,000  $\mu\text{Sv/h}$ .

Item no. 189650



**GM counter. Hand-held with built-in tube**

The hand-held Geiger counter is a flexible device, specially developed for schools and other educational institutions.

Use the built-in GM tube with protective cap for gamma radiation measurements; remove the cap when working with alpha and beta radiation. The Geiger counter uses a single 9 V battery.

- Registers alpha, beta and gamma radiation
- 8 fixed measurement periods (1, 10, 20, 30, 40, 50, 60 and 100 s)
- Shows dose rate ( $\mu\text{Sv/h}$ ), relative to Cs-137
- The GM voltage can be adjusted between 400 and 700 V, while the count rate is displayed
- Displays max., min., and average for  $\mu\text{Sv/h}$  and CPS

Item no. 513545



**GM counter**

Geiger counter – with the focus on ease of operation.

Measurement periods: 1, 10, 60, 100 and 300 seconds. The counter can perform both single measurements and repeated series. In the latter case, the last complete count in a full measurement period is displayed, while the new measurement counts up in a secondary display.

The device is silent when turned on, but two independent sound signals can be selected. We have reintroduced the "genuine Geiger counter sound", a click for each impulse registered from the tube. It is also possible to select a small beep at the end of each measurement period.

The counter can be used with GM tubes with BNC or Jack connectors. The GM voltage can be adjusted in the range 300 to 700 V, while the count is displayed.

A USB communication cable (512565) can be obtained as an accessory to allow the data to be logged using the Datalyse software.

A cable with a Jack connector (512560), is also available if one wants to send 5 V impulses to data logging equipment or similar.

The device is supplied with 6 x 1.5 V AA batteries. These offer a battery life of several days. Alternatively, mains adapter 355050 can be used. The counter turns itself off automatically after one hour of activity.

Item no. 513600

**USB communication adapter for 513600**

Item no. 512565

**Cable, modular connector for Jack**

Item no. 512560



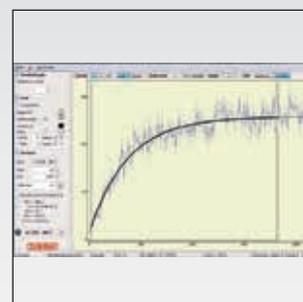
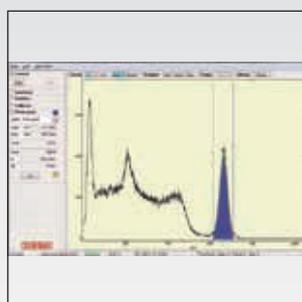
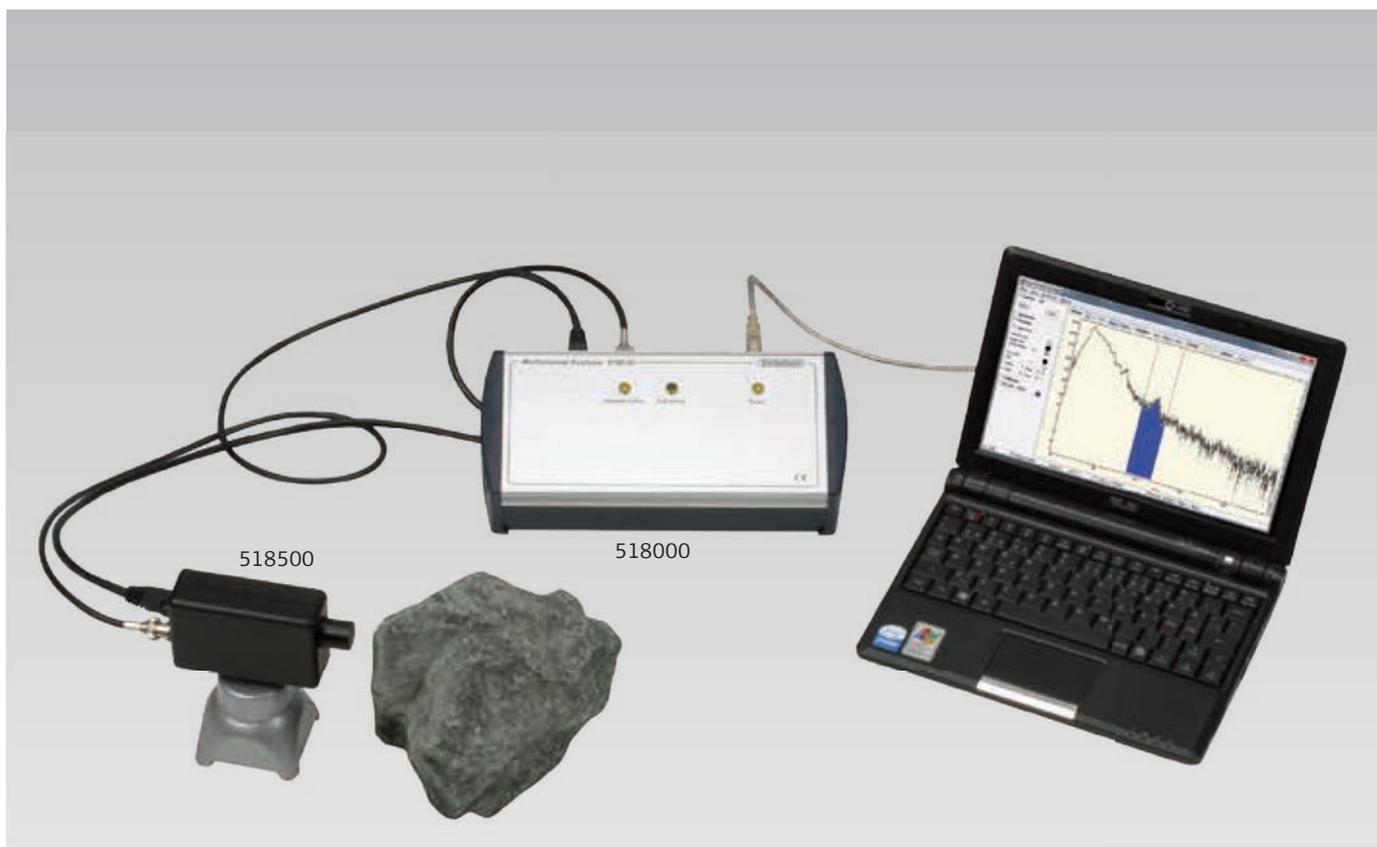
**Electronic counter**

Universal counter with clear display. Suitable for group experiments. GM sensors with Jack connectors (513565 and 513570) can be connected directly. Count signals from other Geiger counters and GM amplifiers can be connected.

Count periods: 1, 10, 60 or 100 s and manual. For all fixed count periods, continuous or individual measurement can be selected.

This is a universal counter with a wide range of applications – not just for radioactivity.

Item no. 200250



## Multichannel analyser

A multichannel analyser (MCA) sorts incoming pulses from an energy-sensitive detector into a large number of channels according to size. When the counts in the channels are plotted as a function of the channel number, the result is an energy spectrum.

The Frederiksen MCA features 1024 channels, variable analogue and digital gain, a variable integration time and built-in logic to reject "pile up" (a pulse starting on top of the previous one).

The Frederiksen MCA and accompanying software have been specially developed to work with the 518500 Scintillation detector, but an "AUX" input can be used with the anode signal from a traditional photomultiplier tube.

The MCA does not use an external power supply, but has an external USB connection.

New, user-friendly software is included.

When the MCA is connected to a computer, and the program is running, data acquisition can be initiated at the press of a button. All the settings from the previous run are remembered but can, of course, be amended for other applications. Default settings for CsI(Tl) and NaI(Tl) scintillation detectors can be retrieved at the press of a button.

In the spectrum, one or more energy ranges can be defined where the counts can be summed, or the data can be fitted to a Gaussian function. Decay of the counts into a Gaussian peak (or simply into a channel range) can be fitted to an exponential decay function.

(Purchasers of our MCA are recommended to subscribe to our mailing list for software and manual updates. Contact [hs@frederiksen.eu](mailto:hs@frederiksen.eu)).

**Item no. 518000**

### Scintillation detector for 518000

This detector is the ideal companion for the 518000 multichannel analyser. It is powered directly by the MCA unit.

The caesium iodide scintillation crystal used measures 6 x 6 x 15 mm, which provides an exceptional angular resolution, e.g. for Compton scattering experiments. This crystal size will obviously be less sensitive than the huge NaI crystals commonly used with photomultiplier tubes, but with our standard gamma source from Risø Educational Sources, a total count rate of 1,800 per second can still be achieved.

Energy resolution (full width at half maximum) is approx. 7% at 662 keV (Cs-137) and 5% at 1333 keV (Co-60). The detector's bias voltage is software-controlled (through the MCA) in order to keep the gain independent of temperature.

**Item no. 518500**



### Compton scattering, kit

The Compton effect illustrates the particle nature of gamma radiation. When a gamma quantum bounces off an electron, its energy loss depends on the scattering angle.

This kit comprises two pairs of shell-shaped targets and a central holder with adjustment screws and lead absorber.

These rotationally symmetrical aluminium targets give a high count rate for the two fixed scattering angles of approx. 60° and 90°. With our gamma spectrometer and a standard Cs-137 source, viable difference spectra for both angles can be obtained within an hour. A lead absorber blocks the direct radiation from the source to the detector. Correction for background radiation (including scattered radiation from the table top etc.) is handled by the 518000 software.

The principle behind this device is the old geometric truth that the size of a peripheral angle is defined by the arc it spans. We can thus obtain the same scattering angle over a very large solid angle.

In addition to the Cs-137 Risø source (item no. 510030), the following are required:

514102 Rail for mounting bench

294610 Saddle with Ø 10 mm hole (2 of)

514180 Source holder for mounting bench, simple

518500 Scintillation detector

518000 Multichannel analyser

**Item no. 519000**

## EQUIPMENT FOR EXPERIMENTS WITH RADIOACTIVITY



### Mounting bench

Complete mounting bench for Risø sources and GM tubes, which provides a stable platform for experiments with radioactivity. The mounting bench is suitable for investigating the range of different types of radiation in air and the absorption of radioactive emissions in lead and aluminium. The holder for the Risø sources can be rotated and is provided with a graduated scale of +/- 110 degrees at a resolution of 1 degree.

Comprises a 40 cm long bench with mm scale, GM tube holder and Risø source holder. The source holder has a  $\varnothing$  6 mm metal rod for suspending absorber plates.

An absorber set is included, comprising: Lead plates: 5 x 2 mm and 10 x 1 mm (the lead plates are painted to avoid contamination). Aluminium plates: 2 x 3 mm, 6 x 2 mm and 4 x 0.5 mm.

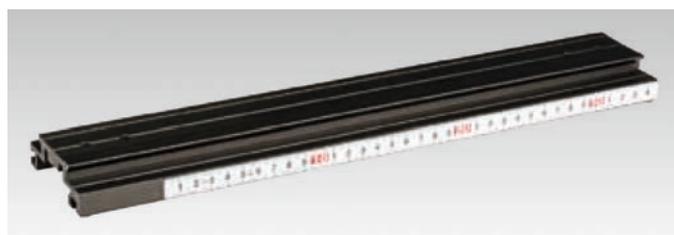
Item no. 514100



### Holder for extra sensitive GM tube

Saddle with holder for use on mounting bench. The holder fits GM tubes 512525 and 513565 (and discontinued models 512520 and 513560).

Item no. 514101



### Rail for mounting bench, 40 cm

40 cm black anodised aluminium profile.

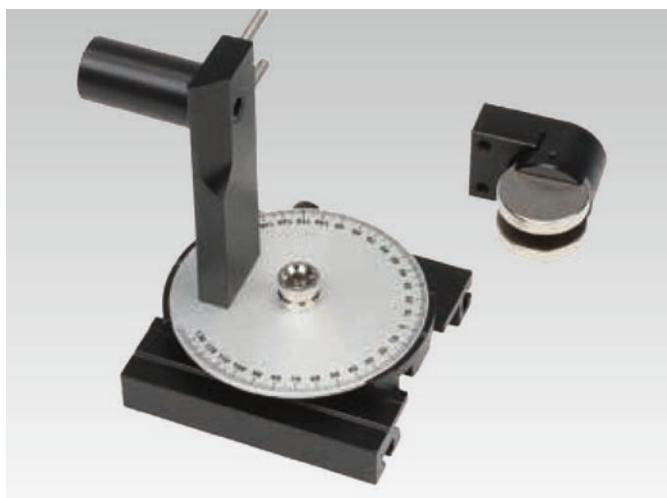
Item no. 514102



### Saddle with $\varnothing$ 10 mm hole.

For attaching small GM tubes.

Item no. 294610



### Deflection of beta particles

Simple but engaging apparatus with permanent magnets. The magnets can be rotated to invert the field, and they can also be completely removed.

Can be used on three levels: qualitative demonstration of the deflection of beta particles in a magnetic field, including the sign of the charge; simple beta spectrum, where the energy is determined by reading from a graph; detailed, relativistic processing of the beta spectrum. Supplement to mounting bench 514100. For use with Risø's beta source.

Item no. 514105



### Beta spectrum apparatus

For the familiar set-up using a variable magnetic field.

Beta-source holder with a circular groove for the radiation and a notch for the Hall effect probe.

For use with Teslometer 406050, two coils 459640, a large U-core 459700 and pole piece 459720. 364000 is recommended for powering the electromagnet.

Item no. 516500



### Source holder with absorber plates

Holder for Risø sources with absorber plates for experiments with absorption of radioactive emissions. The holder has a  $\varnothing$  10 mm support post and a  $\varnothing$  6 mm rod for suspending absorber plates. Includes a set of absorber plates in a case. The kit includes: Lead plates: 5 x 2 mm and 10 x 1 mm (the lead plates are painted to avoid contamination). Aluminium plates: 2 x 3 mm, 6 x 2 mm and 4 x 0.5 mm. Base not included.

Item no. 514005



### Absorber set

Set of absorber plates in a case. The kit includes: Lead plates: 5 x 2 mm and 10 x 1 mm (the lead plates are painted to avoid contamination). Aluminium plates: 2 x 3 mm, 6 x 2 mm and 4 x 0.5 mm.

Item no. 514006

### Absorber plates, supplementary

These are all 45 x 45 mm, with a  $\varnothing$  7 mm mounting hole.

514010 Painted lead plate, thickness: 1 mm

514011 Painted lead plate, thickness: 2 mm

514012 Aluminium plate, thickness: 0.5 mm

514013 Aluminium plate, thickness: 2 mm

514014 Aluminium plate, thickness: 3 mm

Item no. 514010-14 (unit price)



### Source holder for mounting bench

Simple model without option for rotating the source. Suitable for Risø sources.

Required for use with 51900 Compton scattering kit.

Item no. 514180



### Source holder without plates

Holder for Risø sources without absorber plates or base.

The holder has a  $\varnothing$  10 mm support post and a  $\varnothing$  6 mm rod for suspending absorber plates.

Item no. 514007



## Coincidence box

Used to detect simultaneous events in GM tubes.

The box's output sends an impulse to an external counter, when two (or optionally three) of the inputs receive an impulse simultaneously (i.e. within 1 microsecond).

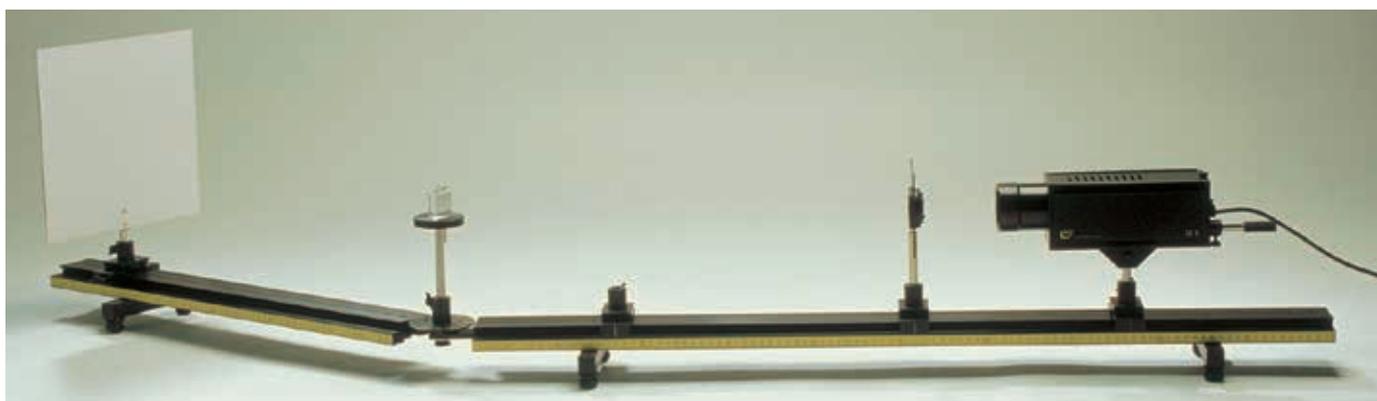
This allows you, for instance, to detect the gamma cascade in the decay of Co-60 or the fact that the annihilation quanta from Na-22 are radiated at 180° to each other.

The coincidence box is also used in the study of cosmic radiation.

It connects to two or three single GM tubes. The output impulses are registered by a GM counter 513600, counter 200250 or via a Pasco digital adapter PS-2159.

Comprehensive instructions included.

**Item no. 513800**



## Joint link for mounting bench/optical bench

This joint link and its accompanying source holder 514195 are used for investigating the angular dependency of coincidence events.

**Item no. 294650**

## Source holder for joint link

Using this source holder, a Risø source can be positioned precisely in the axis of rotation of the joint link. The holder is turned from plastic, to ensure its rotational symmetry.

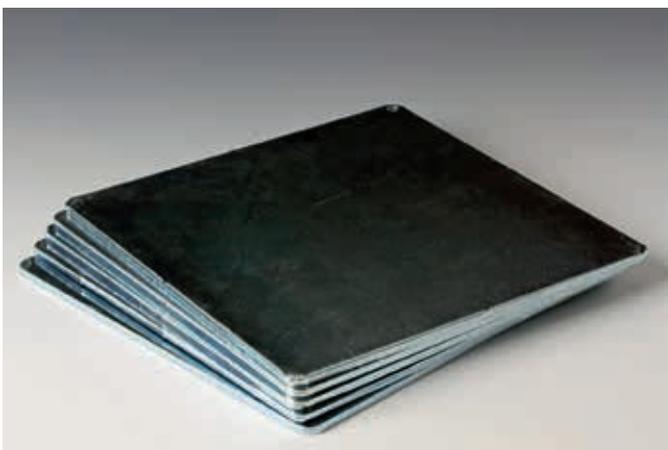
**Item no. 514195**



**Muon observatory**

Hardware for both shower mode and telescope mode experiments. Robust construction which takes up to 40 steel absorbers (20.5 kg). 25 absorbers are supplied in the form of 3 mm steel plates. In shower mode, the distance between the lowest absorber and the GM tubes can be varied between 0 and 180 mm. In telescope mode, the distance between the two outermost GM tubes can vary from 240 to 560 mm. A shorter distance can be obtained between the two uppermost positions (no absorbers). (For use with GM tubes 512525 or GM sensors 513565 and coincidence box 513800. Not included.)

**Item no. 514200**



**Extra absorber plates**

5 extra 148 x 148 x 3 mm steel plates.

**Item no. 514210**

**Simultaneous?**

In order to accept minor variations between GM tubes, the coincidence box defines "simultaneous" to mean "within 1 microsecond". In nuclear physics, a microsecond is quite a long time; the gamma cascade of Co-60 is traversed in around a picosecond, a million times faster. It takes a little longer for a Na-22 nucleus to decay until annihilation of the positron – a factor of "only" a thousand times smaller than a microsecond. But the conclusion remains that in both of these decay chains all the particles are emitted simultaneously, as measured by this equipment.

When a cosmic radiation particle passes two GM tubes, it will naturally take a small amount of time to go from one to the other. But again this happens on a time scale that is much smaller than 1 microsecond. There needs to be a couple of hundred metres between the tubes before the coincidence box ceases to see the two impulses as simultaneous.

**Random coincidence**

Regardless of the source being measured, there is a certain probability of registering simultaneous impulses from the GM tubes, deriving from the decay of two different nuclei. Such random coincidences are a kind of "background radiation" for coincidence measurements. Fortunately, it is relatively simple to compensate for them – this is explained in the equipment's manual.

With three tubes connected to the coincidence box, the probability of random coincidence naturally falls substantially. This fact can be utilised for muon observations.

**Muon observations**

Every second, every square metre of Earth is impacted by a few hundred particles deriving from cosmic radiation. Of these, three-quarters are muons with an average energy of around 4 GeV. The muons are produced in the highest levels of the atmosphere, when even more energetic particles collide with air molecules.

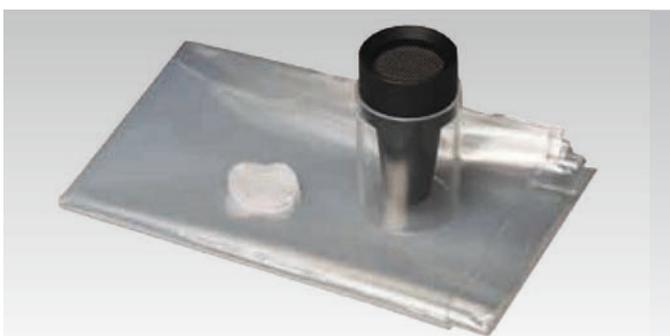
The particles in the cosmic radiation often distribute their energy through a so-called air shower, a cascade of secondary particles that in certain cases can be huge and cover several square kilometres of Earth's surface on impact.

In the shower mode set-up, a burst of coincidence is registered between three triangularly-spaced GM tubes. This geometry ensures that no single particle can be registered in all three tubes. The production of showers can be helped by allowing the radiation to pass through something slightly "thicker" than air, like a series of steel plates.

In the telescope mode set-up, two (or three) GM tubes are placed in a line, and if a muon passes through all the tubes in the set-up, it is registered as an impulse by the coincidence box. Having the steel plates situated between the tubes ensures that only highly energetic radiation is registered. The third GM tube is used to suppress random coincidences. The telescope can be set up at various angles to the vertical.

## Radon

Radon and its daughters are responsible for half of the radiation dose that an average Northern European receives during a year. Radon is a decay product of underground radioactive substances, and since it is chemically inert it leaks right up to the surface. Radon's decay products, which are also radioactive, can end up in the lungs, for instance after having attached themselves to dust particles.



## Radon measuring equipment

Kit for measuring radon daughters, consisting of a large plastic bag, 50 special filters and a filter holder for a vacuum cleaner. In combination with a GM tube (512525), quantitative measurements with good count statistics for radon daughters can be achieved.

Item no. 512600



## Radon measuring equipment supplies

Item no. 512601 Large plastic bag for radon measurements

Item no. 041505 Filters for radon measurements, 50 pcs

## Demonstration of radon daughters

Blow up a balloon and tie a knot. Tie a good half-metre of steel wire or stiff copper cable below the knot. Find a place in a cellar (or on the ground floor if there is no cellar) that is not ventilated. Rub the balloon on your clothes to give it a static charge and hang it up by the metal wire so it is not touching anything. Let it hang for half an hour to collect dust. In the meantime, get the counting equipment ready. An extra sensitive tube such as 512525 or 513565 is recommended. The tube needs to be used with its protective cap removed. Fasten it in a stand so it is pointing down, only about a millimetre above the table, where the balloon will shortly be placed.

For more quantitative results, while waiting, you could measure the background radiation.

Once the balloon has hung there long enough, puncture it with a pin or a small paperclip in the thick rubber just by the knot - you don't want it to burst with a bang. Snip off the knot and wire and take the balloon quickly but carefully to the measuring station. Use a Petri dish with a lid or similar and leave the balloon in the bottom of the dish while measuring.

Ensure that the GM equipment sounds in the presence of radiation - the amount of activity may come as a surprise.



## Balloons, pack of 100.

Round balloons in various colours.

Item no. 194510



## Radondetector

Designed for long-term radon measurements, e.g. in the home. This instrument shows average radon concentrations for a 1 week sliding window, and an average for the entire measurement period (up to 5 years). Directly calibrated in Bq/m<sup>3</sup>. Resolution: 1 Bq/m<sup>3</sup>. The measurements are precise to within 20%.

Item no. 512634

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## SOLAR RADIATION AND HEAT



### Solar cooker, parabolic

Ø 29 cm parabolic dish that acts like a large concave mirror, reflecting and concentrating the light that falls on it. A small copper crucible is positioned at the dish's focal point. A material placed in the crucible will be heated strongly. Very high temperatures can be reached in the summer sun. For students aged 10 and up.

**Item no. 503810**



### Solar cooker, parabolic Ø1.5 m

The purpose of a solar cooker is to convert sunlight into heat energy to cook food. There are three main types of solar cookers: box, panel, and parabolic. Box cookers act more as an oven and store a large amount of heat while panels and parabolas reflect light directly onto the cooking surface.

A parabolic reflector is one of the most efficient ways to harness sunlight; its unique shape concentrates all the sunlight at one focal point.

This particular parabolic solar cooker is also useful because it has an expansion pipe which allows the angle of the reflective dish to be adjusted while cooking. It is also large enough to capture and concentrate enough sunlight to boil water in 10 minutes.

**Item no. 503820**

### Halogen lamp

230 V work lamps that are perfect for using with solar cells and solar collectors. Includes Ø 10 mm support post, but no base.

**Item no. 280110 105 W**

**Item no. 280120 350-400 W**



### Solar cooker, compact

The solar cooker is a practical example of direct utilisation of the sun's radiant energy. The cooker has a chamber in its base where the objects to be heated are placed. On a cloudless summer's day, the temperature can quickly reach well over 100 °C.

**Item no. 503800**



### Solar thermal collector, complete

An improved model of our plate solar thermal collector, for both qualitative and quantitative experiments. The solar thermal collector is supplied with a circulation pump and hot water container. The hot water container can also be used empty to illustrate the heating of air by a radiator. Fitted with a peristaltic pump that easily fills and empties pipes and hoses. Dimensions: 31 x 31 x 6 cm.

**Item no. 503720 Complete**

**Item no. 503750 Hot water container**

### Handheld pyranometer with display

For measuring total solar irradiance. The instrument is equipped with a display for direct read-out of light intensity in  $W/m^2$ . An analogue output signal is provided through two safety sockets on the front plate, for use with data acquisition devices, for example. Dimensions: 172 x 108 x 58 mm. Measurement range: 0-1999  $W/m^2$ .

Resolution: 1  $W/m^2$ .

Precision: +/- 5%

Output signal: 100 mV = 1000  $W/m^2$ .

Battery: 1 x 9 V battery (351010)

**Item no. 489020**



## SOLAR CELLS

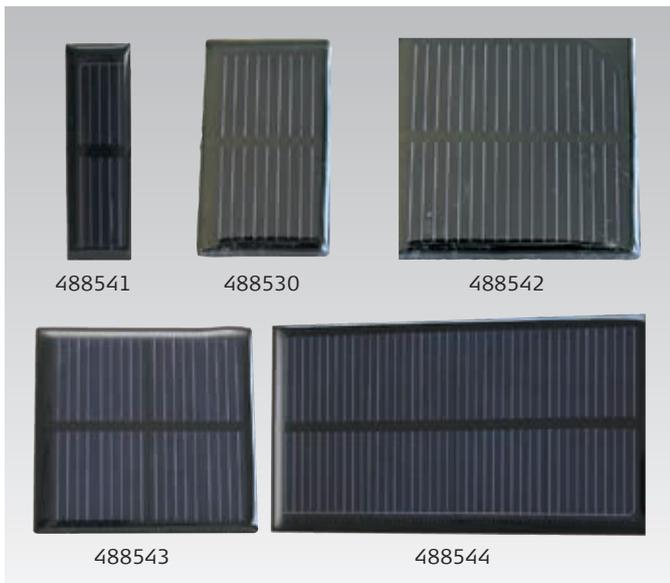


### Solar cell 3 A

Large individual cell, 100 x 100 mm, mounted in a strong casing with a clear acrylic cover and Ø 4 mm safety sockets. Maximum voltage and current are approx. 0.58 V and 3 A. Dimensions: 120 x 120 x 22 mm. Two versions available.

**Item no. 488500** With stand at 54° angle

**Item no. 488510** With support post, Ø 10 x 95 mm



### Solar panel with screw terminals

Ideal for investigating the significance of the area and number of the cells and for measuring their characteristics.

Sealed solar cells with screw terminals on the rear, so soldering is not required. Connections can also be made using alligator clips.

Item no.	Voltage	Current	Size
488541	0.5 V	150 mA	18 x 60 mm
488530	0.5 V	330 mA	30 x 60 mm
488542	0.5 V	850 mA	60 x 60 mm
488543	1 V	200 mA	60 x 60 mm
488544	2 V	380 mA	60 x 115 mm



### Solar panel 5 V / 300 mA

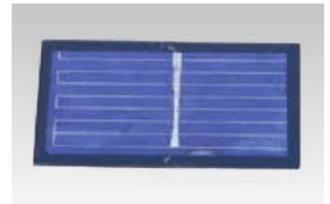
The panel is constructed from 10 individual cells and is fitted with a cable (no plugs).

**Item no. 488535**

### Solar cell 0.5 V / 380 mA

With power outlet on the rear. Ideal for a variety of experiments. Several cells can be connected in parallel or in series to vary the voltage or current.

**Item no. 488513**

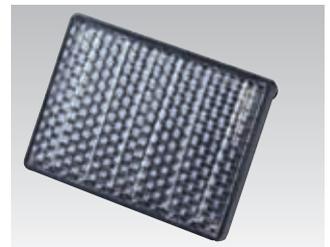


### Solar cell 0.5 V / 130 mA

Solar cell in a plastic casing with a glass cover. Screws on the rear for connecting leads.

Dimensions: 75 x 45 mm.

**Item no. 488511**



### Solar panel 10 W, monocrystalline

Solar panel consisting of 36 monocrystalline cells in an aluminium frame with front glass panel and equipped with safety leads.

Max. output at 18.0 V and 0.58 A.

Open-circuit voltage: 22 V.

Short-circuit current: 0.6 A.

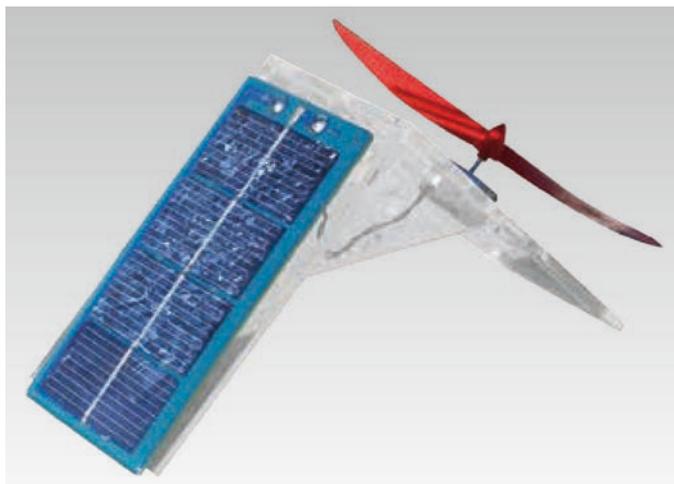
Dimensions: 383 x 299 x 34 mm

**Item no. 488538**



### Solar cells

A solar cell's short-circuit current (A) depends on the area and incidence of light, while the open-circuit voltage for all sizes will be the same, at around 0.58 V.



### Solar panel with motor and propeller

When the solar panel is illuminated by sunlight, it powers the fan. The kit is supplied unassembled and requires soldering. The panel has an open-circuit voltage of 2 V and a short-circuit current of 300 mA.

**Item no. 488524**



### Solar cell car, mini

Small, simple solar cell car that runs perfectly in sunshine. Dimensions: 2.4 x 2.1 cm

**Item no. 488532**



### Solar cell kit with motor and propeller

A popular little set for demonstrating the energy of solar radiation.

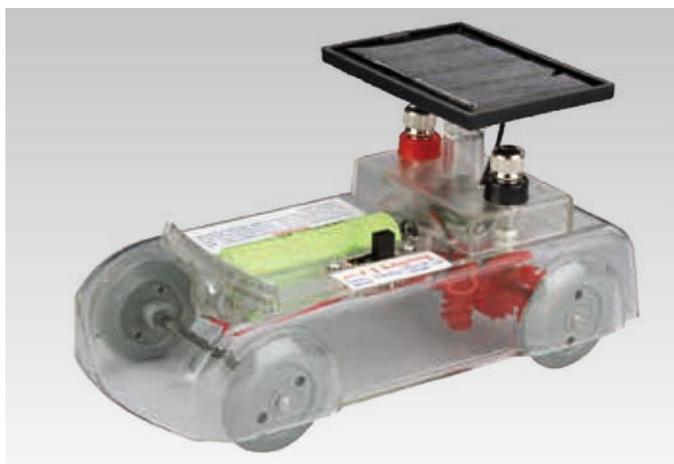
**Item no. 488531**



### Solar cell kit

A small solar cell kit, including a solar panel, motor, sounder, light source, connection leads and more. Also included is an easy-to-read 16-page booklet with suggested activities.

**Item no. 488580**



### Solar cell car, rechargeable

Solar cell car with rechargeable batteries. The batteries are charged when the solar cells are exposed to sunlight or a powerful lamp.

**Item no. 488534**

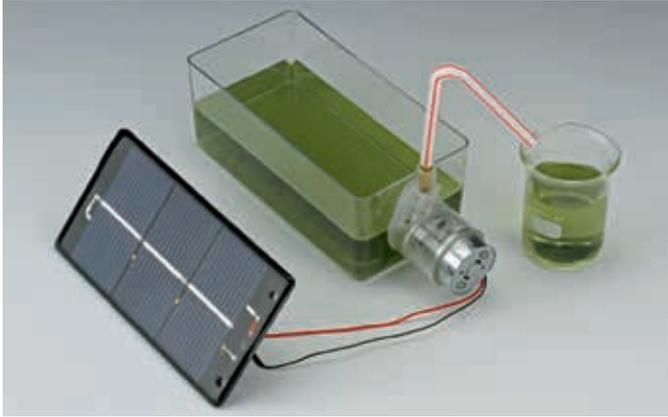


### Solar energy kit, 8 solar cells

Contains 8 solar cells that can be connected in series or in parallel. Motor, propeller and a handy case for the cells are included.

**Item no. 670076**

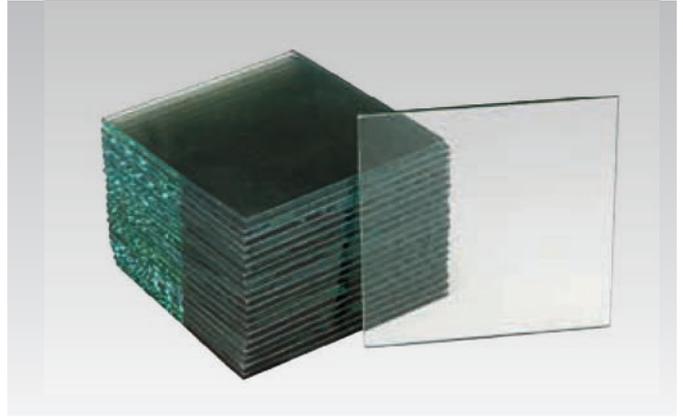
## ENERGY



### Solar cell with water pump

Kit consisting of a small 3-cell solar panel and a self-assembly water pump. Beyond illustrating solar-electrical-mechanical energy conversion, this little kit also shows how a water pump can be constructed. Supplied with glue and all leads ready attached.

**Item no. 488529**



### Electrically conductive glass

Use for making solar cells.  
Instructions at [www.frederiksen.eu](http://www.frederiksen.eu).  
Pack of 20 pcs.

**Item no. 488705**



### Fine mesh, nickel, 7 x 100 cm

Used for making fuel cells. There is an excellent laboratory manual for making fuel cells on our website at [www.frederiksen.eu](http://www.frederiksen.eu). Supplied as a roll. Dimensions: 7 x 100 cm, mesh size 0.125 mm.

**Item no. 452900**

## FUEL CELLS AND RENEWABLE ENERGY

### Renewable energy kit

Complete kit for activities based on renewable energy. For production of energy, a small solar panel and a wind turbine with options for setting pitch and blade shape are included. An electrolyser creates hydrogen and oxygen, which can be stored. A fuel cell converts this chemical energy back into electrical energy. The electrical energy released can power LEDs or a motor. Instructions included.

Item no. 452940



### Fuel cell vehicle, Hydrocar

With this kit, you can perform electrolysis using the solar panel, and power the car by combustion of hydrogen in the fuel cell. It is also possible to follow the production of H<sub>2</sub> and O<sub>2</sub>

Item no. 452980



### Wind turbine incl. blades and LEDs

A smaller version of set 452940, containing a wind turbine with 2 x 3 blades, LEDs and instructions.

Item no. 500545



### Fuel cell car, H-racer 2.0

H-racer 2.0 is a remote-controlled hydrogen-powered car. In addition to the car, includes a hydrogen station for electrolysis of water, a solar panel and a remote control for steering the car.

Item no. 452920



### HydroStik

A HydroStik is a container for storing hydrogen. The hydrogen is stored at low pressure as a metal hydride. It contains enough hydrogen for about 20 hours of use.

Heat is required to release the gas from the metal hydride, so a HydroStik gets cold as it operates.

Note that it can be ordered fully charged or empty.

Item no. 452995 empty

Item no. 452996 full

## ENERGY



### Hydrofill, recharge

When all the hydrogen in 452995 HydroStik has been discharged, it can be refilled with this recharging station.

**Item no. 452997**



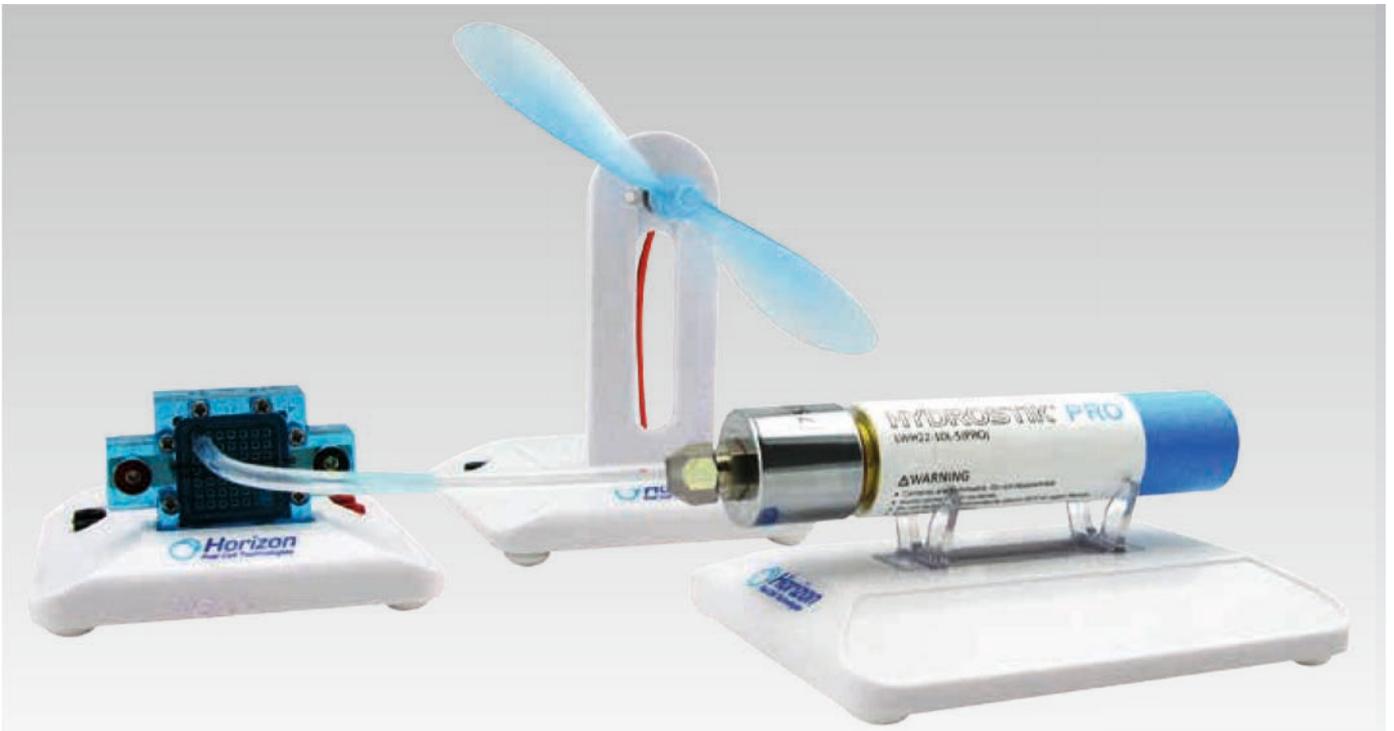
### Fuel cell vehicle. Kit with HydroStik

Using this kit, students can investigate different ways of acquiring, storing or using renewable energy. In addition to the car, the kit includes a fuel cell, micro fuel cell, salt-water fuel cell, hand-operated generator supercapacitor, solar panel, battery pack, various parts such as syringes, leads etc. and the brand new HydroStik for storing hydrogen.

Note that the kit normally comes with an empty HydroStik. It can also be ordered with a full HydroStik.

**Item no. 452990 With empty HydroStik**

**Item no. 452991 With full HydroStik**



### Fuel cell Micro kit with HydroStik

Hydrogen is combined with oxygen from the air in the micro fuel cell. The cell produces electrical current which can drive the supplied propeller. The set consists of a micro fuel cell, propeller, various leads, bases and hoses, etc., and the brand new HydroStik.

Note that the kit normally comes with an empty HydroStik. It can also be ordered with a full HydroStik.

**Item no. 452998 With empty HydroStik**

**Item no. 452999 With full HydroStik**



### Dr FuelCell fuel cell car, complete

The classic modular fuel cell car with safety sockets. The reversible PEM fuel cell fits easily on the car chassis, but can also be used on its own for measuring characteristics and efficiency.

A solar panel is included, itself a good subject for investigation, but which can also be used to recharge the hydrogen tank by the decomposition of water. The current from the solar panel is first used to perform electrolysis, after which hydrogen (the energy carrier) and oxygen are stored in the ratio of 2 to 1. The fuel cell can now run the model car using hydrogen combustion. The car can also be driven directly by the solar panel, which can be clicked onto the chassis.

Finally the supplied hand-operated generator can be used to rapidly generate hydrogen to power the car. In half a minute, enough hydrogen can be produced to run the car for several minutes.

**Item no. 452892**

### Dr FuelCell fuel cell car, basic

The same fuel cell car as in 452892 but excl. the hand-operated generator and load box.

**Item no. 452891**



### Fuel cell set, Dr FuelCell

This set includes all the necessary parts for studying a PEM fuel cell, with accompanying, separate PEM electrolysis cell. Includes Load and measuring box (452875 - see separate description). The set is supplied in a Grattells plastic tray, which also has space for a 452852 Dismantlable fuel cell and a 452861 Methanol fuel cell, and the comprehensive printed teaching materials. Brief instructions in Danish are also supplied.

**Item no. 452870**

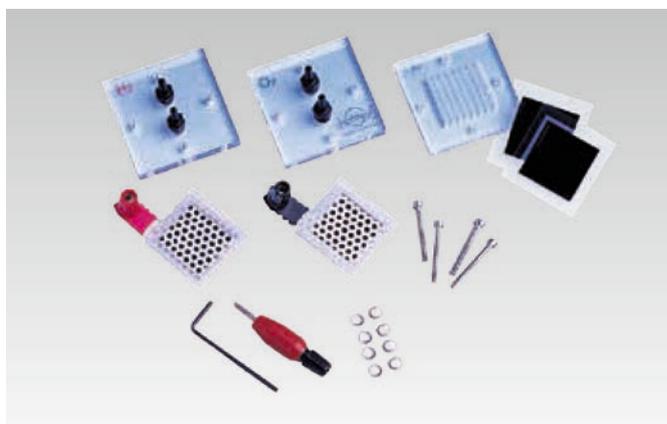
### Load and measuring box

Ideal for solar cells, fuel cells and other DC sources. Not for use with wind turbine and other power sources that deliver pulsed



DC. The load resistance is selected using a rotary knob. A mini bulb or a motor may also be selected. The resistance is connected in series with the built-in ammeter. The voltmeter is run out to separate sockets, to allow voltage differences to be measured at different points of the circuit. Also included in 452870 and 452892.

**Item no. 452875**



### Fuel cell, dismantlable

This fuel cell can be dismantled, so its constituent parts can be studied. Different variants can be built, since an electrode with less catalyst is supplied and the cell can be constructed to use atmospheric air or pure oxygen.

**Item no. 452852**

### Fuel cell, methanol

Experiment with the functional principles of a methanol-powered fuel cell (e.g. the relationship between performance and the methanol concentration). Contents: a methanol fuel cell and three dropper bottles for methanol solutions of 1%, 2% and 3% concentrations. Excl. methanol (see 862230-3).



Output voltage: 0.1 - 0.6 V. Max. current: 100 mA

**Item no. 452861**

### Methanol solution 3%

Methanol in aqueous solution that can easily be diluted. The solution is suitable for use in 452861 Fuel cell.

**Item no. 862230-3**

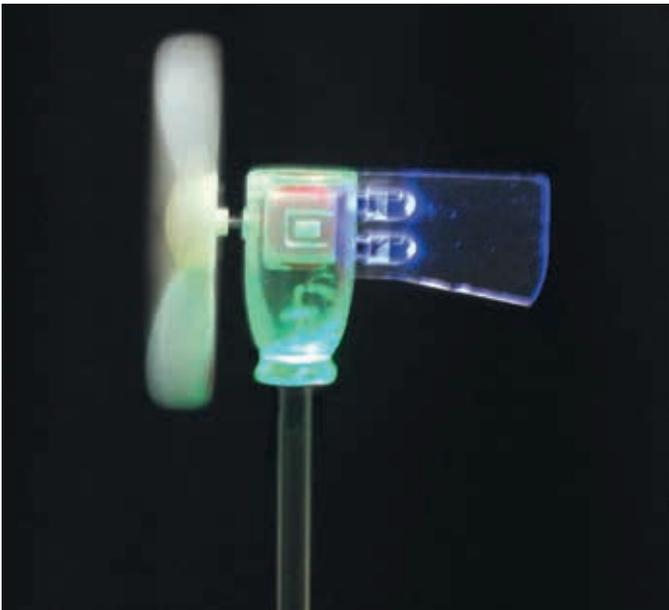
## WIND ENERGY



### Floor-standing fan

This large fan is brilliant for indoor experiments with wind turbine models. It has settings for three different blast strengths. Specifications: Ø 40cm, 230 V / 100 W

Item no. 500600



### Wind turbine, mini

The world's smallest wind generator. A small wind-powered generator on a post, with three LEDs to indicate the power being generated. Ideal for simple experiments on the external factors that affect the performance of wind turbines. Can also be used to visualise the turbulence around a wind turbine.

Item no. 500520



### Propeller

This three-bladed propeller was originally designed for use in model aircraft, but it works brilliantly as a wind turbine with a 12 V motor. The turbine does not produce a huge output, but sufficient to make different measurements. The propeller is moulded in grey plastic, and fits the winding shaft of motor 202500. (Tip: Works best with the flat side facing the wind).

Item no. 504600 Propeller, Ø 30 cm

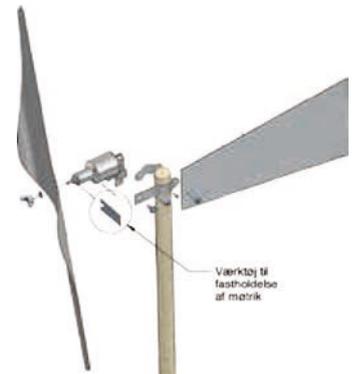
Item no. 504605 Propeller, Ø 40 cm

### Wind turbine, self-build

This kit offers a simple, DIY wind turbine. Everything is cut out and ready for the pieces to be assembled following the supplied instructions, which contain suggestions for experiments. For example, to see how much and what type of electricity the turbine produces. In a brisk wind, the turbine produces enough power to light a bulb.

Contents: Rinder bicycle dynamo, broomstick, electrical wiring, propeller, tail fin, nuts and bolts.

Item no. 599410





### Anemometer, digital

Electronic anemometer with easy-to-read digital display. Direct wind speed measurements (kph, m/s, knots or ft/min) are shown 2.5 times a second. The rotary mechanism is mounted in a protective housing which is connected to the display by a 110 cm cable.

Measurement range and resolution: 0.8-30 m/s, +/- 0.1 m/s.

Precision: +/- 3% of full scale, +/- 2 digits.

Battery: 1 x 9 V battery (351010).

Item no. 187605



### Digital anemometer, Hot wire anemometer

Featuring a sensor with a tiny thermistor, this anemometer can be used for examining wind profiles in quite some detail. Excellent for investigating aerodynamics. Measures in m/s, kph, ft/min, mph, knots. Measurement range is 0.2 to 20 m/s with a resolution of 0.1 m/s. Precision is 3% + 1 digit. The telescopic probe can be extended from 25 cm to 94 cm.

Item no. 187650

## ACCESSORIES FOR ENERGY EXPERIMENTS



### Motor, smooth-running

Very low torque 1.5 V motor on a post, supplied with turbine blades and protective rear plate to protect the blades against breakage. Specified to start at 85 mV, but will typically start at as low as 35-50 mV. Note: The turbine blades must not be confused with wind turbine blades; they are installed exclusively to clearly demonstrate the rotation. (Base not included).

Item no. 501500



### Motor for solar cell

Motor with propeller on stand, equipped with safety sockets. For use with solar cell 488500, for example. Specifications: 6 V DC motor.

Item no. 500500



### Solar cell motor on post

Motor with propeller in housing on a  $\varnothing$  10 mm x 105 mm support post. For use with 488500 Solar cell, for example. Fitted with sockets for safety plugs. (Base not included.)

Item no. 500510

### Measuring output

When metering solar cells or fuel cells, remember that the maximum electrical output is delivered when the cell is loaded with a relatively low resistance – typically in the order of  $1 \Omega$ .

For a solar cell, the maximum output corresponds to its maximum efficiency, since we can't save the incoming solar energy for later.

Conversely, the fuel cell's efficiency rises when it is not loaded so hard.

Also, for fuel cells, you need to check that the current does not exceed the maximum value.



### Motor/generator with winding shaft

Ideal for demonstrating energy conversion to and from mechanical energy. The motor can lift a weight or accelerate a flywheel, and then act as a generator, producing electrical energy while the weight falls or the flywheel is braked.

Item no. 202500

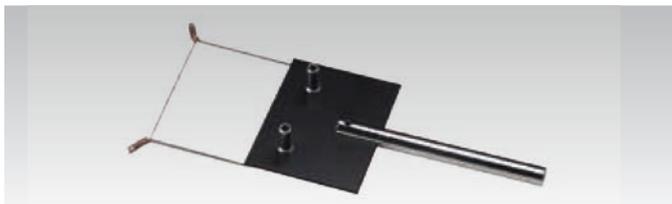
### Flywheel

Flywheel with a centre hole, compatible with 202500 motor/generator.

Item no. 501000



## THERMAL ENERGY



### Thermocouple

For demonstrating thermoelectricity. Consists of a piece of copper wire, stretched between two constantan wires. The copper wire is twisted and soldered to the constantan wires. If a temperature difference arises between the two solder joints, this will result in an electric voltage drop of a few mV. Equipped with sockets for safety leads and Ø 10 mm support post.

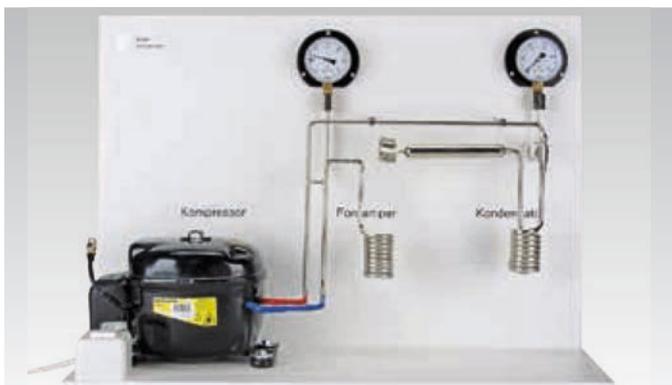
Item no. 486500



### Thermoelectric generator

Consists of a Peltier element with 72 series-connected thermoelectric elements, made from a semi-conductor material and mounted on a cooling plate. In a Peltier element, a voltage difference arises if there is a temperature difference between two sides of an element, and conversely an applied voltage will result in a temperature difference. The free side of a Peltier element can easily be heated or cooled using a metal container with hot or cold water, thereby creating a difference in electrical potential. The thermoelectric generator can power a bulb (425005 1.5V 0.09A), or a 501500 Smooth-running motor. When used as a heat pump, it can be operated from max. 8V (5 A).

Item no. 487500



### Heat pump

Demonstration heat pump specially for teaching purposes. Consists of a compressor and heating and cooling coils. On both the overpressure and underpressure sides are dials for the combined display of pressure and temperature. The heat pump is fitted with a safety valve and overpressure protection.

Dimensions: 48 x 65 x 25 cm

Item no. 490001

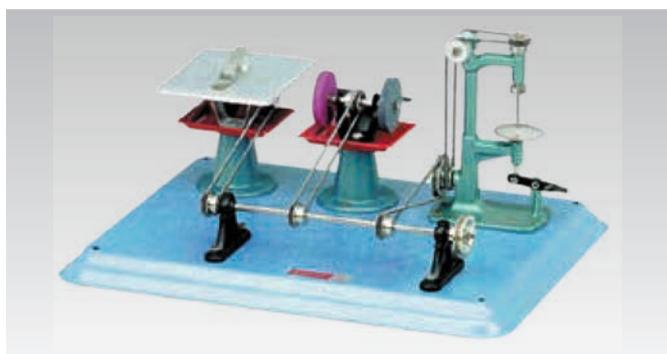
## STEAM ENGINES



### Steam engine D16

Classic steam engine model. Boiler with water gauge glass, whistle and safety valve, and double-acting cylinder. Includes regulating valve for steam supply. This model is powerful enough to drive various accessories. Uses fuel tablets for heating. Painted metal baseplate 25 x 31 cm.

Item no. 278000



### Accessories for steam engine

External devices that connect to and are driven by 278000 Steam engine. Contents: Drill, grinding machine and circular saw.

Item no. 278500

### Dynamo with bulb

Converts 278000 Steam engine into an electric power station.

Item no. 278501



### Drive belts

Drive belts for 278000 Steam engine. Dimensions: Ø 2 x 260 mm.

Item no. 278510



### Fuel tablets

Pack of 12 fuel tablets (Hexamine) for 278000 Steam engine.

Item no. 005300



## STIRLING ENGINES

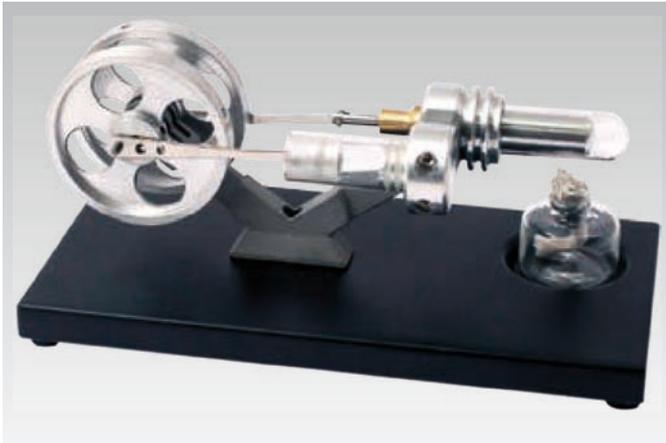
This type of engine, which dates back to 1816, has a number of theoretical advantages over traditional combustion engines. The Stirling engine converts thermal energy from an external heat source into mechanical energy. The fuel can therefore be anything at all, and the upper efficiency limit is the same as for the Carnot cycle.



### Stirling engine

Robust classroom model of a real Stirling engine that runs on methylated spirits. Instructions for experiments included.

Item no. 266900



### Stirling engine with glass cylinder

The Stirling engine is a piston engine with glass cylinders. This model uses methylated spirits as a fuel.

Dimensions: 18 x 9 x 9 cm

Item no. 266905



### Glass Stirling engine

Stirling engine with cylinders and displacing piston made from glass, allowing the engine's mode of operation to be clearly seen. The engine is equipped with measurement points for high and low temperature, a spigot for pressure measurement, a cord attachment device, to make it possible to measure the piston stroke and hence the volume, and a flywheel with light barriers to measure speed of rotation.

Item no. 266910

### Stirling engine, low temperature

The engine operates on very small temperature differences. A cup of hot water (min. approx. 60 °C) will make the engine run. A stunning illustration of the mode of operation of the Stirling engine and works with many different heat sources.

Dimensions: 14 x 9 x 9 cm

Item no. 266925



## ENERGY FORMS AND THEIR CONVERSION

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### Pelton turbine, model

Pelton turbine with a plexiglas turbine housing, black plastic turbine wheel and DC generator. Equipped with safety sockets. The turbine needs to be driven by a fast water jet, e.g. from a hose connector or a 069020 Waterjet vacuum pump, plastic. The Pelton turbine can then supply up to approx. 2.4 V and 0.6 A.

Dimensions: 19.5 x 17 x 10 cm

**Item no. 170500**



### Light energy apparatus

Consist of an incandescent lamp and a resistor of the same resistance. A fixed amount of electrical energy is applied to these in turn and the temperature rises in the surrounding water are measured. The lamp's efficiency is determined by finding the energy loss from the bulb (which heats the water) and the total energy deposited by the resistor. The difference between these is radiated as light.

**Item no. 320700**

**Item no. 425520 Spare bulb for 320700**



### Connected motors

Two identical electric motors are used to demonstrate the energy conversion of electrical energy. One motor will turn the other, which will act as a generator. The two 6 V motors are mounted on a base with safety sockets.

**Item no. 472400**

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## GEOSCIENCES



### Weather station, Davis Vantage Pro2 wireless

Wireless weather station with a range of up to 300 metres with line of sight and 60 - 120 m through masonry and walls. The data is displayed in the panel, but can also be transferred to a computer (requires Weatherlink item no. 185741 or 185743).

The delivery includes the main instrument with power adapter, sensor station with rain collector, temperature and humidity sensors, anemometer for measuring wind direction and speed, and mounting hardware.

**Item no. 185740**



### Weather station

For measuring wind, weather, barometric pressure, precipitation, humidity and temperature. Wireless transfer from sensors to display. Data can be transferred to a PC. The weather station includes the following 3 sensors and a display:



Thermo-hygro sensor: records temperature and atmospheric humidity (hPa)

- Wind sensor: Measures wind speed (m/s, kph and knots) and direction (in degrees or on a compass rose). Also incorporates separate temperature measurement.
- Rain collector: Measures rainfall (last hour, last 24 hours, yesterday, last week, last month, intensity)
- Display: Measures indoor temperature and humidity. Also works as a receiver for the other sensors' data. Includes clock and calendar functions. Wall-mountable or desktop use. Automatic forecast displayed using 6 icons. Information on sunrise and sunset times, moon phases and lunar calendar. Weather data can be transferred to computer by USB stick using the supplied software.

Range with line of sight, 25 m, and through walls, slightly less depending on their construction. Sensors and display use a total of 10 x AA/LR6 batteries (item no. 351005). The weather station is supplied with cables and software for transferring data to a computer.

**Item no. 185705**

### Weatherlink

A Weatherlink adapter is used to transfer data from 185740 to the computer.

**Item no. 185741 WeatherlinkUSB**

**Item no. 185743 WeatherlinkIP**

### Weather station, analogue

Simple weather station consisting of a weather-resistant aluminium mount with 3 separate, easy-to-read instruments: a barometer, a hygrometer and a thermometer. Measures 30 x 9.8 cm and the instruments are approx. 6.5 cm in diameter.

**Item no. 185715**



### Weather meter, Kestrel 5000

The Kestrel 5000 Weather Meter replaces the well-known and accurate Kestrel 4000. Its design is very similar to the Kestrel 4000, but it has been improved on several important features such as memory, larger display, dual color backlight and intuitive navigation in the menus.

A robust weather meter that makes it easy to measure altitude, barometric pressure, relative humidity, temperature and wind speed. From these measurements, the following functions can be derived: wind chill, heat stress index, dew point and density altitude. Data can be displayed in three different formats: current, minimum/maximum/average and charted. The display has two types of backlight and various interface languages are available. The instrument itself can store more than 10,000 data points and, using the USB Data Transfer Cable, data can be saved and processed (requires supplementary equipment). Data is stored with time and date.

#### Wind speed

The impeller is 25 mm in diameter and protected by a cover when not in use. Available as a spare part.

Measurement range: 0.6 - 40 m/s,

Units of measure: knots, m/s, kph, Beaufort,

Precision: +/- 3 %

Resolution: 0.1 knots; m/s; kph; 1 Beaufort.

#### Temperature

Measurement range: -29 °C to +70 °C

Units of measure: °C and °F

Precision: +/- 0.5 °C

Resolution: 0.1 degrees

#### Pressure

Measurement range: 700 - 1100 mb

Units of measure: mb, inHg, hPa, PSI

Precision: +/- 1.5 mb

Resolution: 0.1 mb

#### Relative humidity

Measurement range: 10 - 90%

Precision: +/- 2 %

Resolution: +/- 0.1 %

Kestrel 5000 uses 1 x AA battery (item no. 351005).

The unit is waterproof and can safely withstand minor knocks and bumps. Color: black

**Item no. 792095**



### USB Data Transfer Cable

USB Data Transfer Cable allows wired communication between the Kestrel 5000 Weather Meter and Windows/Mac computers with a USB port. Use the cable and Kestrel LiNK software to install firmware updates and upload logged data from your Kestrel.

Communication between the cable and Kestrel is optical, and therefore does not compromise the Kestrel's watertight seal. This unit requires no external power source. It features a three-foot cable and data transfer speeds of up to 230 Kbps.

**Item no. 792096**



## PRECIPITATION

### Rain gauge with ground spike

Capacity: 0-45 mm. Handy model in plastic. With ground spike.

Item no. 187006



## HUMIDITY

### Hair hygrometer

For measuring atmospheric humidity in the range 0 - 100%. Diameter: 10 cm. With chromed frame. Adjustable. Instructions included.

Item no. 185000



### Psychrometer

For measuring relative humidity and temperature.

Very precise instrument, which never needs adjusting. After reading the two thermometer values, the humidity is found by using the table printed on the front.

The psychrometer must be hung out of the draught. Requires filling with demineralised water approx. every 3 months.

Item no. 185610



### Thermometer/hygrometer

Digital model. Shows indoor and outdoor temperatures and relative humidity. Max-min function with memory. The outside temperature sensor is connected by an approx. 3 m cable.

Dimensions: 120 x 73 x 18 mm,

Measurement ranges:

Indoors: -10 to +40 °C,

Outdoors: -50 to +60 °C,

Humidity: 25 to 95%.

Battery supplied.

Item no. 062400



## BAROMETRIC PRESSURE



### Barometer, Ø 100 mm

Aneroid barometer for wall-mounting. Scale graduated in hPa and mmHg. Equipped with an adjustable pointer to indicate the last registered measurement. Robust, adjustable model. Diameter: 104 mm.

Item no. 185800



### Barometer, Ø 95 mm

Aneroid type suitable for both wall-mounting and use out in the field. Scales: 705 - 800 mmHg and 940 - 1060 mPa. Diameter: 95 mm.

Item no. 177111



### Barometer, Ø 72 mm

Aneroid type suitable for both wall-mounting and field use.

Scales: 705 - 800 mmHg and 940 - 1060 mPa. Diameter: 72 mm.

Item no. 177110

## WIND



### Anemometer, digital

Electronic anemometer with easy-to-read digital display, showing wind speed in kph, m/s, knots and feet/minute.

Measurement range: 0.8 – 30.0 m/s; resolution: +/- 0.1 m/s.

The value is updated 2.5 times a second.

Power supply: 1 x 9 V E-block battery.

Item no. 187605

### Anemometer, electronic

Attractive handheld anemometer with temperature sensor and carry-strap. Has a solid yellow soft plastic hood, which protects it and makes it easy to find, if lost outdoors.

Measures temperatures from -10 to +45 °C ± 2 °C and wind speed from 0 to 30 m/s ± 5%. Other units of measure (mph, kph, knots and °F) can be selected. Wind speed can also be measured using the Beaufort scale.

There are 3 ways of recording wind speed:

CU: Current wind speed

MAX: Maximum wind speed

AVG: Average wind speed

Shuts off automatically after

14 minutes of inactivity. The backlight comes on when any button is pressed and goes off automatically after 12 seconds.

Uses 1 x CR2032 battery (351606).

Item no. 187525



### Cup anemometer

Wind meter featuring a rotor with cups which measure wind speed (kph or Beaufort) regardless of wind direction. The scales make it easy to see the force of the wind in a teaching situation. The anemometer is threaded in the base of the handle to allow it to be mounted on a tripod. Supplied with a protective cover for the rotor.

Item no. 187510



### Wind meter, iPad/Smartphone

Danish-designed wind meter that works with recent smartphones and tablets with built-in magnetic field sensors.

The wind meter only contains 2 magnets and no electronics, and is extremely easy to use. It is connected via the mini jack socket and just requires the free Vaavud app, a free download from AppStore/Play.

Using the app, you can get real-time wind-speed measurements, incl. current, average and maximum. You can of course switch between units of measure (m/s, kph, mph, knots and Beaufort). If you have an internet connection, you can upload your data to a website and view it, along with other users' measurements.

Note that the wind meter is not compatible with all smartphones and tablets, but is very likely to work on recent models. For Android, version 2.3.3 or later is required. There is a complete compatibility list at: <http://vaavud.com/compatibility/>

Upcoming updates to the app are expected to add an option for measurement data exports.

Measurement range: 2 - 20 m/s (24 m/s for iPhone 5S and 48 m/s for certain Android phones).

Precision: +/- 4% or 0.2 m/s

Item no. 187500

## TEMPERATURE

### Maximum-minimum thermometer

Push-button for zeroing. Shows the highest and lowest temperatures for a given period of time. Black plastic casing and red alcohol column.

Measurement range: -30 °C – +50 °C

Item no. 060510



### Thermometer, wireless, indoor-outdoor, with clock

Wireless thermometer with memory function for maximum and minimum both outdoors and indoors.

Features a display with built-in sensor and radio-controlled clock, together with a wireless sensor for recording the temperature outside.

Memory for max/min temperatures.

Outdoor sensor

Radio-controlled 24-hour clock.

Alarm clock.

Batteries included: Display: 2 x LR6 (351005), Sensor: 2 x LR6 (351005)

The display can be mounted on the wall or on a stand.

Item no. 062310



### Field thermometer

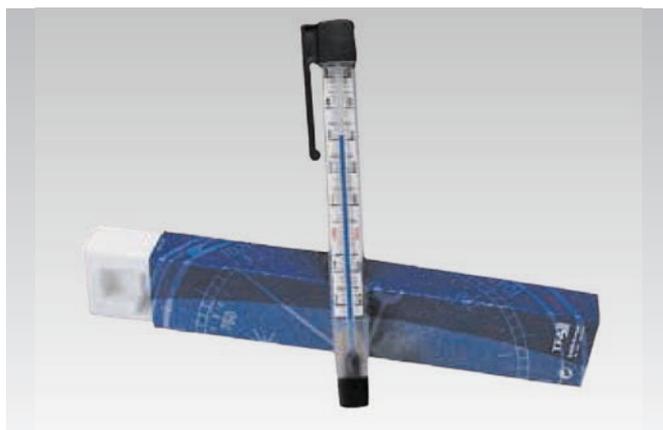
Small plastic thermometer with pocket clip. An excellent field thermometer which rapidly displays the correct temperature. Withstands minor knocks and bumps.

Measurement range:

-20 - +50 °C

Length: 13 cm

Item no. 061006



### Field thermometer

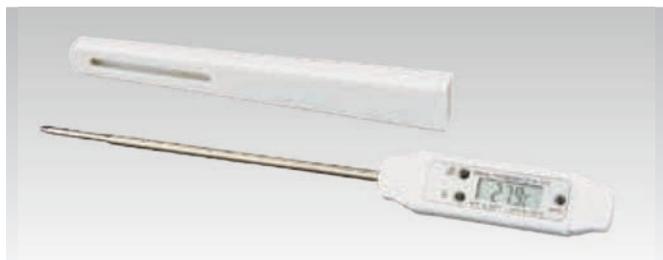
Prismatic thermometer with white background and blue, mercury-free column. Mounted in plastic housing with pocket clip.

Temperature range: -20 to +50 °C

Resolution: 1/1

Length: 13.5 cm

Item no. 061010



### Thermometer, digital lab. -40 - +200 °C

Suitable for laboratory use or as a field thermometer.

Measurement range: -40 to +200 °C

Resolution: 0.1 °C

The thermometer is waterproof.

A pocket clip with a suspension hole means that this thermometer can sit in your pocket with your ballpoint pens or hang nearby on a wall. Auto shut-off after 5 minutes.

Item no. 062100



### Thermometer, infrared

Infrared thermometer for measuring surface temperature by aiming it at an object or surface. After a second, the temperature is shown in the display. Optical

resolution: 1:1, i.e. at a distance of 1 m, the temperature is measured over a circular surface 1 m in diameter. At a distance of 5 m, a 5 m wide spot is measured and so forth.

Measurement range: -20 to +220 °C

Resolution: 0.1 °C

Precision: +/- 2 °C / 2% (highest)

Item no. 260801

### Thermometer, infra-red with pistol grip

An infrared thermometer can be used to measure the surface temperature by pointing it at an object or surface.

This model has a pistol-grip, large measuring range and laser sight (less than 1 mW) which makes taking a measurement quick and easy. Includes LCD display, max/min function, hold function and automatic shut-off. Measurement range: -50 °C- +550 °C (-58 °F- +1022 °F)

Resolution: 0.1 °C/°F

Accuracy: +/- 2 % of reading or +/- 2 °C/°F

Optical resolution: 12:1, i.e. at 1 m distance, the temperature of a circular area of diameter 8.3 cm is measured. At 5 m, the circle is 41.6 cm in diameter.

Uses one 9 V battery, included.

Item no. 260805



### Handheld pyranometer with display

For measuring total solar irradiance. The instrument has a read-out display and data can be transferred to a data logger using the two 4 mm safety sockets on the front panel. The handheld pyranometer is easy to use: Simply switch it on and read off the solar irradiance (W/m<sup>2</sup>). The measurement is an expression of global irradiance. The angle that the instrument is held at is important, and this can be investigated by measuring at different angles.

#### Specifications

Dimensions: 18.5 x 10.8 x 5.6 cm

Measurement range: 0-1999 W/m<sup>2</sup>

Resolution: 1 W/m<sup>2</sup>

Precision: +/- 5 %

Output signal: 100 mV = 1000 W/m<sup>2</sup>.

Power supply: 1 x 9V battery (351010)

Item no. 489020



### Soil thermometers:

Item no.	Length	Measurement range
061515	mini	-10 - +100 °C
061520	20 cm	-20 - +60 °C
061530	30 cm	-20 - +60 °C
061540	40 cm	-20 - +60 °C
061550	50 cm	-20 - +60 °C

### Albedo and radiation balance

When the Sun's rays strike Earth, some of the solar irradiance will be absorbed, while the remainder will be reflected. Albedo is the proportion of insolation that is reflected back into space, and for the planet as a whole is around 31% on average.

When determining the radiation balance, which is important when discussing the greenhouse effect, it is interesting to measure both short-wave and long-wave radiation. For the short-wave measurements, a pyranometer is used, while long-wave measurements are performed using an infrared thermometer, after which the recorded temperature can be converted to W/m<sup>2</sup> (using the Stefan-Boltzmann law).

Albedo depends on many factors, such as surface type, cloud cover and so forth, and, for studying the radiation balance, albedo offers many opportunities for experiments both out in the field and in the lab.



### Convection chamber, air

This convection chamber is designed for demonstrating convection processes in air. The simple, illustrative experiments help to clearly explain the principles of convection and facilitate discussion of how high and low pressure and winds arise.

The chamber itself is made from acrylic and is mounted on an aluminium base plate.

Tealights included.

Item no. 268800

## WATER AND THE WATER CYCLE



### Model of the Water Cycle

Make it rain in the classroom! This equipment allows students to replicate the evaporation, condensation and precipitation of the water cycle. The sloping bottom is shaped like a coastline with a range of hills behind. The upper section features a cloud formation that can be filled with ice cubes.

Dimensions: 42 x 30 x 12 cm

Item no. 797000



### Water flow tray

Follow the genesis and development of a watercourse. The model shows how erosion and sedimentation affect the progress of a watercourse. Supplied with inlet hose with adjustment screw and outlet hose. For recirculation, pump no. 761410 can be used.

Dimensions: 122 x 37 cm

Item no. 798000

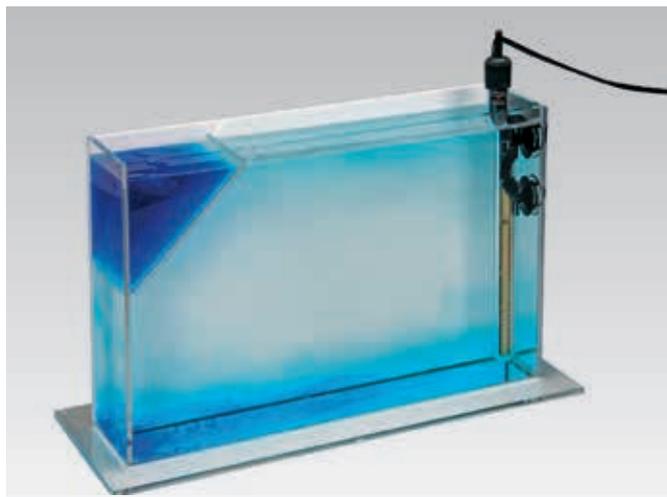
### Submersible circulation pump

Submersible pump for aquariums with adjustable speed from 150 to 600 litres per hour. 13 mm outflow connector. Hoses with an internal diameter of 12 mm fit the connector. Must be immersed in water.

Lift height: 1.3 m.

Connects to 230 V mains.

Item no. 761410



### Ocean currents – the Greenland Pump

This classic model for demonstrating ocean circulation – including the Greenland Pump – was developed in collaboration with Danish teachers. It is made from clear acrylic, with one white side to make the ocean currents easy to recognise.

Dimensions: 23 x 8 x 35 cm

Base plate: 14 x 39 cm

Supplied without a heating element (796015) and dyes (309800).

Item no. 796020

### Thermostat heater Jæger 50 W

50 W thermostat heater for use with the Greenland Pump model 796020.

Waterproof, with auto shut-off function to protect the heating element when not immersed.

Made from Schott DURAN splinter-free glass, which is resistant to thermal shock. Powered by 230 V AC.

Item no. 796015



### Food Coloring Set

Red, green, blue and yellow. 30 mL in total. Suitable for colouring the water in the ocean current model.

Item no. 309800



**Refractometer, salinity**

With automatic temperature compensation for measuring the salt content of seawater. Good for field work. The instrument has a number of scales which allow direct reading of the specific gravity and salinity of water.

Measurement range: 0-100 ‰; precision: +/- 1 ‰.

Item no. 545913

**Salinometer with suction bulb**

Salinometer with integral scale, for reading salt content in g/L. Comprises a suction bulb mounted on the end of a strong clear plastic tube. In the tube is a hydrometer with a scale, against which salt content can be read directly. The salinometer is calibrated for a water temperature of 15 °C +/- 3 °C. Temperature: 8 - 36 °C

Salt content: 0 - 40 g/L

Item no. 545916



**pH/mV - meter M350**

Battery-operated pH/mV meter with digital display. Good for field work. The instrument has a reproducibility of 0.01 pH. With electrode, battery and manual.

Item no. 541240



**Water Laboratory Kit**

Complete water testing kit for investigating water quality in lakes, watercourses, drinking water and aquaria. Contains instructions and reagents for approx. 50 tests.

The following environmental parameters can be investigated:

pH: 5.0 - 9.0.

Nitrate: 10 - 80 mg/L.

Ammonium: 0.05 - 10 mg/L.

Phosphate: 0.5 - 6.0 mg/L.

Nitrite: 0.02 - 1.0 mg/L

Total hardness: 1 drop = 1° hardness

Supplied in a small plastic case with a clear lid.

Item no. 890700



**Flow meter**

Compact flow meter with option for transferring data to a computer (CSV file). The clear display shows flow speed in m/s or mph. The meter features a data logging function for later analysis and/or transfer to a computer. The sensor rod comprises four 25 cm sections and breaks down for easy transport. Can be extended by three riser rods (25 cm, 12.5 cm and 7.5 cm) to a total length of 140 cm.

Note: The handheld device is NOT waterproof, and must be protected from rain and other water ingress.

Supplied with mini-USB cable, separate instrument case and a handy protective carry case.

Item no. 541251

## SOIL



### Settling cone

For measuring sedimentation and precipitate. Made from clear plastic with graduations up to 1000 mL.

**Item no. 767100**

### Stand for settling cone

In wood, with space for two settling cones.

**Item no. 767110**



### Soil sieve set, 9 sieves, aluminium

Robustly made from aluminium, comprising 9 sieves, cover and base. The sieve mesh is made from brass wire.

Sieve diameter: 100 mm

Sieve height: 40 mm

Mesh width:

- 2.0 mm (10 mesh)
- 0.9 mm (20 mesh)
- 0.6 mm (30 mesh)
- 0.4 mm (40 mesh)
- 0.250 mm (60 mesh)
- 0.2 mm (80 mesh)
- 0.140 mm (100 mesh)
- 0.125 mm (120 mesh)
- 0.063 mm (250 mesh)

Mesh widths in mm, and the mesh values are the manufacturer's. The set withstands heating to above 100 °C and can be autoclaved.

**Item no. 768502**

### Auger

Tube length: 500 mm. For soil sampling down to 40 cm deep. Marked at 10 cm depths. Core diameter: 20 mm. Supplied with tools for extracting samples. Made from rust-protected steel.

**Item no. 768000**



See more field equipment at [www.frederiksen.eu](http://www.frederiksen.eu)



### Geophone

Single geophone in plastic housing with steel spike. Used to determine the speed of seismic waves in the ground by connecting two geophones to voltage sensors which in turn are connected to data acquisition devices (or a digital oscilloscope). If the geophones are placed a known distance apart, it is possible to determine propagation velocity in the ground. Using many geophones, one can create a very detailed analysis of the ground from the data.

Fitted with a 1 m cable with safety plugs.

Resonance frequency: 10 Hz

Impedance: 375 Ohm

Load for Q = 0.6: 1339 Ohm

Sensitivity: 28.8 V/(m/s)

**Item no. 799200**

### Field spade

Robust folding spade that fits easily into a field bag. Total unfolded length: 71 cm.

**Item no. 768100**



**Trowel**

Standard robust garden model. Length: 32 cm.

**Item no. 768160**



**Trowel, small**

Strong, lightweight model, good for taking small cylindrical soil cores. Dimensions: 19 x 4,5 cm. With wooden handle.

**Item no. 768170**



**Soil permeability tube**

For determining permeability and field capacity. The tube is made from transparent acrylic and features a drain spigot with a pinch valve.

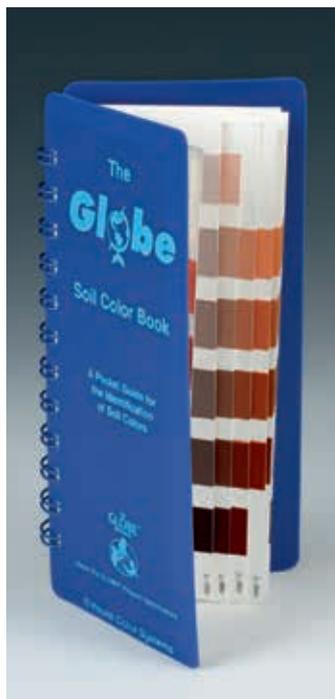
**Item no. 768560**



**Soil colour chart**

Colour chart for classifying soil colours. This attractive colour chart allows colour determination of soil samples to be more objective. Contains more than 200 colour plates classified using the Munsell system, but measures only 19 x 9.5 x 4 cm. Takes up little space and is a less expensive alternative to the large Munsell colour system charts. We can also supply the large Munsell Soil Colour Charts. Contact us for details of price and delivery time.

**Item no. 768012**



**Scale, pocket scale, 200 g / 0.01 g**

Handy pocket scale with hinged lid. Case and weighing pan included. High precision at low cost.

**Item no. 102770**

**Overflow vessel, aluminium**

A body is immersed in the overflow vessel, causing the displaced liquid to run out through the overflow pipe where it can be collected in a measuring beaker. From this, the specific gravity of, for example, a rock can be determined.

Dimensions: Ø 77 x 127 mm

**Item no. 164520**



**Folding loupe Ø 20 mm**

An elegant little botanist's loupe with a solid metal housing. 10x magnification and lens diameter of 18 mm. The visible (active) diameter of the lens is 15 mm. Supplied in a handy plastic case.

**Item no. 078422**

### Geology field set

Contains most of the materials required for investigating different minerals and rocks. Porcelain plates for testing streaks, glass plate, copper clip and nail for hardness determination, magnet, loupe and dropper bottle for hydrochloric acid (hydrochloric acid not supplied).

**Item no. 768280**



### Rock collection, metamorphic rocks, 24 specimens

Metamorphic rocks are created when sedimentary rocks under pressure and heat are crystallised into a more compact and resistant form. This set contains different types of marble, slate and gneiss.

**Item no. 768030**

### Rock collection, igneous rocks, 24 specimens

Igneous rocks are formed when flowing magma cools and solidifies. This set contains different types of basalt, granite and volcanic glass.

**Item no. 768032**

### Geologist's hammer

Specially designed for use with rocks. Supplied with either a flat or pointed head.

**Item no. 768260 chisel-shaped**

**Item no. 768270 pointed**



## ROCK COLLECTIONS

### Hardness scale, Mohs

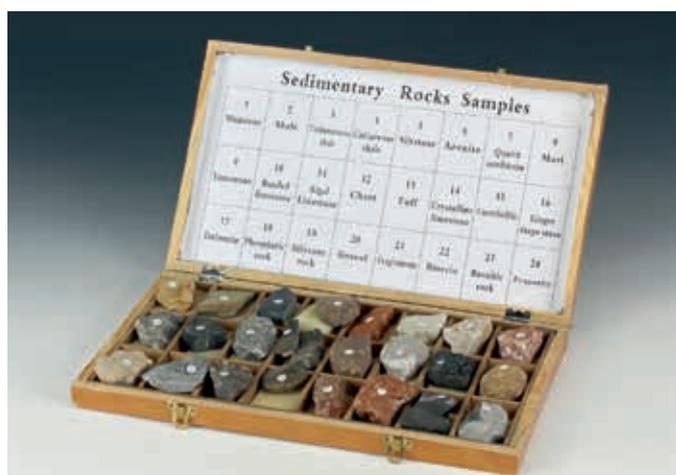
Small collection of 9 minerals of differing hardness in accordance with Mohs's scale (hardness 1-10). This collection enables the hardness of other rocks to be determined. Contents: Talc, gypsum, calcite, fluorite, apatite, feldspar, quartz, topaz and corundum. Also included are a white streak plate, magnet, glass plate (with rounded corners) and copper. Diamond (hardness 10) is not included. Supplied in a case with a full description.

**Item no. 768047**

### Rock collection, oil rocks

Set of 7 rocks that are important to the oil industry. Contains source rocks, reservoir rocks and cap rocks (seal). Also included is a folding loupe, for closer inspection. The rocks are black shale, coal, basalt, shale, sandstone, limestone and chalk. Norwegian manual included.

**Item no. 768025**



### Rock collection, sedimentary rocks, 24 specimens

Sedimentary rocks derive from sediments that have been cemented together under the pressure of overlying sediments. This set contains various types of sandstone, shale and limestone.

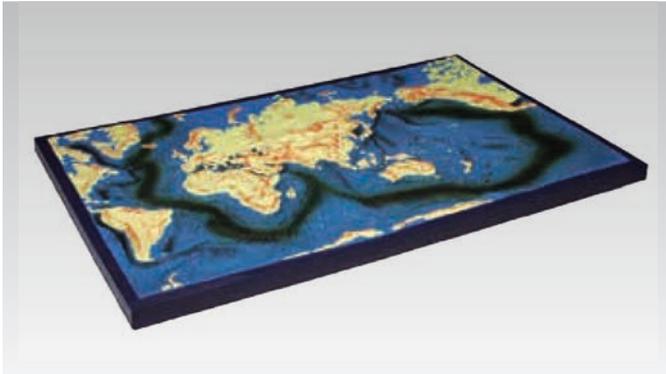
**Item no. 768031**

### Rock collection, rocks/minerals

Rock collection containing four important types of rock and four constituent minerals. Rocks: Sandstone, limestone, granite and gneiss. Minerals: Quartz, calcite, feldspar and mica. Supplied in a box. Large specimens that can be readily handled and inspected.

**Item no. 768027**

## GEOLOGICAL MODELS

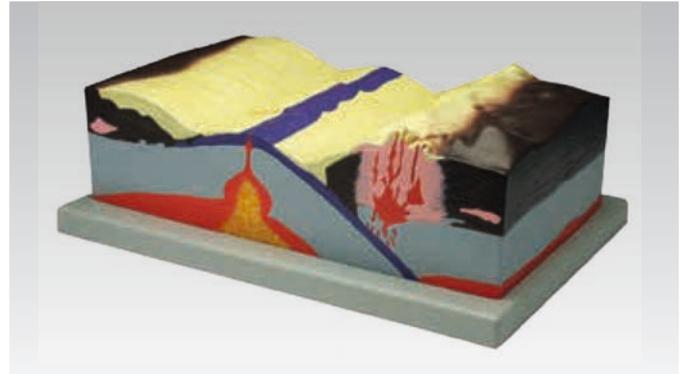


### The world in 3D

Get a real sense of the mountain chains on land and the mid-ocean ridges. It can be difficult to imagine what the seabed looks like. This model lets you both see and feel the submarine mountain ranges. The boundary between the ocean floor and the continents (the continental slope) and faults on the ocean ridges can also be seen. The model is made from strong, soft plastic (PVC). Note that the model exaggerates heights for display purposes and, in some places, the seabed appears higher than the land.

Dimensions: 55 x 40 x 3 cm

Item no. 799000



### Tectonic plate model

A model of an underwater volcano forming a new seabed. Also demonstrates fault lines, fold mountains and oceanic trench formation. The model is made from strong, soft plastic (PVC).

Dimensions: 53 x 38 x 25 cm

Item no. 799011

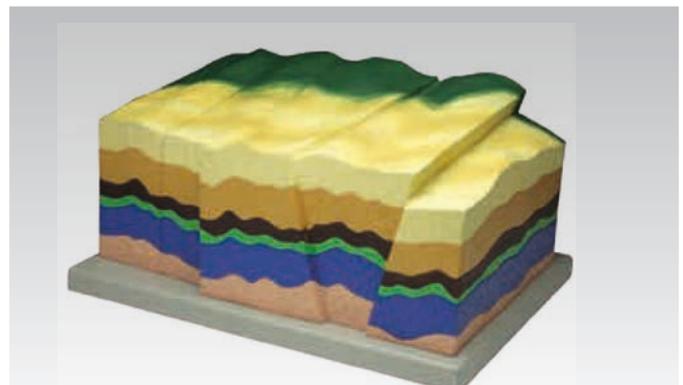


### Mid-Atlantic Ridge model

Superb 3D model of the Mid-Atlantic Ridge made from PVC. The model shows the gigantic mountain range, where volcanic activity occurs, and explains why specific regions experience high levels of volcanic activity. Scale at the Equator: 1 : 320 million.

Dimensions: 66 x 50 x 9 cm Weight: 6.5 kg

Item no. 799005



### Folds, faults and oil traps

As strata are compressed or stretched, faults can arise. Where there are several faults, blocks can be raised up or thrown down between them. This is called a horst, while a large block that has subsided is called a graben or rift. The Oslo Graben is a famous example. The model is made from strong, soft plastic (PVC).

Dimensions: 53 x 38 x 30 cm

Item no. 799013

## GLOBES



### Rotating globe, satellite view, 11 cm

This small globe (approx. Ø 11 cm) shows Earth as you would see it from space. This is called a "satellite view", and is why there are clouds over some of the land masses, including Northern Europe. The globe is normally placed in its stand, and is unique, in that it rotates automatically in response to daylight.

Its size makes it easy to handle and it resembles a stunning magician's prop when held up.

The globe consists of an outer clear plastic shell, within which the coloured globe itself floats in a liquid. The motor is powered by solar cells inside the coloured globe. The solar cells are very sensitive, so not much light is required to make the globe start turning.

**Item no. 792005**



### Rotating globe, physical, 21 cm

Rotating globe with classical physical display, showing ocean currents, country borders, names of countries/capitals and oceans.

Its size (approx. Ø 21 cm) makes for a stunning display, but it is rather heavy to pick up.

It operates in the same way as the smaller model 792005.

Since the globe rotates within its outer shell, it is not possible to achieve the 23.5 degree inclination that ordinary globes have. On the other hand, this is a stunningly beautiful globe that will enthrall the viewer.

**Item no. 792006**



### Globe, relief, 30 cm

Relief globe, showing the land areas in 3D, with mountain ranges specially emphasised.

The globe incorporates a light and also functions as a general physical/political globe, in other words, the globe is physical with the light off, and political with it on.

Equipped with a black plastic base and a transparent plastic meridian. Diameter: 30 cm, height: 43 cm

Language: English

See page 191 for ordinary globes.

**Item no. 792040**



### Globe with magnet

Globe with built-in bar magnet. Used to simulate Earth's magnetic field, which can then be investigated using a Magnaprobe (343500), for example, or a compass. Supplied with an acrylic stand in which to sit the magnet.

Diameter of globe: 12 cm, Overall dimensions: 22 x 16 x 20 cm

**Item no. 792045**



### Write-on Globe, white, 30 cm

With outlines of the continents, major land borders and large rivers. Includes 4 dry wipe pens in different colours for drawing on the globe.

Can be easily wiped clean again, as long as you always use dry wipe/dry erase pens (many white board pens are dry erase, but it is best to check before use). Diameter: 30 cm. See [www.frederiksen.eu](http://www.frederiksen.eu) for other write-on globes.

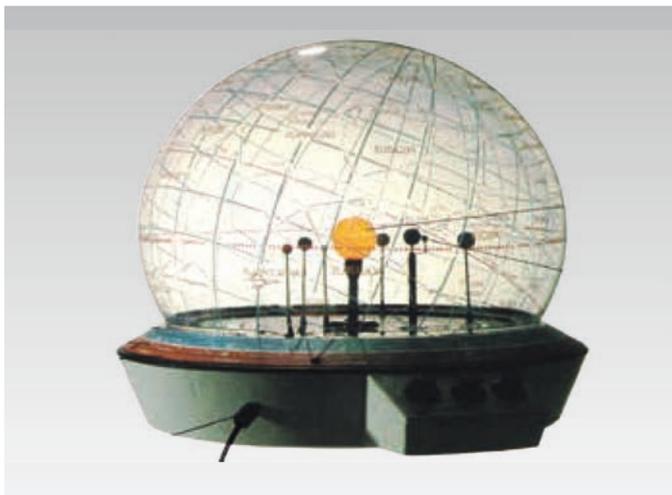
**Item no. 792055**

## ASTRONOMY

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## EARTH AND THE SOLAR SYSTEM



### Planetarium, Helios

A mechanical model of the solar system. Mercury, Venus, Earth, Mars, Jupiter and Saturn orbit the Sun at their correct relative speeds. The speed can be continuously varied (both forwards and backwards), to allow phenomena such as the retrograde motion of Mars to be clearly demonstrated. A model of the Moon orbits Earth. The removable dome shows the night sky in the northern hemisphere. Also supplied is a larger version of Earth in the form of a 100 mm diameter globe, for illustrating the seasons, diurnal variation, phases of the moon, etc.

Item no. 560000

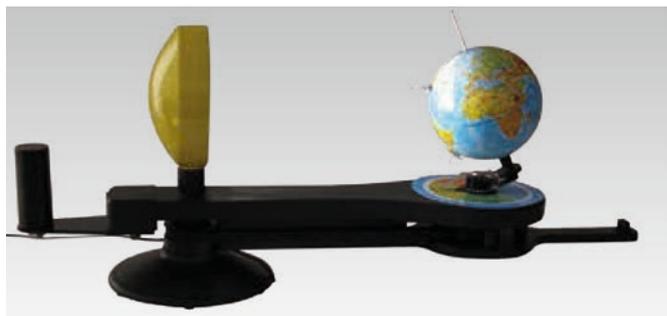


### Tellurium N

Robust, mobile model of the Sun, Earth and Moon. The Sun is at the centre and has a light source, which allows the apparatus to be used without dimming the classroom lights. The lens concentrates the light from the halogen bulb in the Sun into parallel rays, illuminating Earth more intensely and producing a greater contrast between light and shadow. Ideal for illustrating Earth's day and night, lunar and solar eclipses and the phases of the moon. Supplied with a comprehensive manual.

Dimensions: 72 x 37 x 25 cm

Item no. 561020

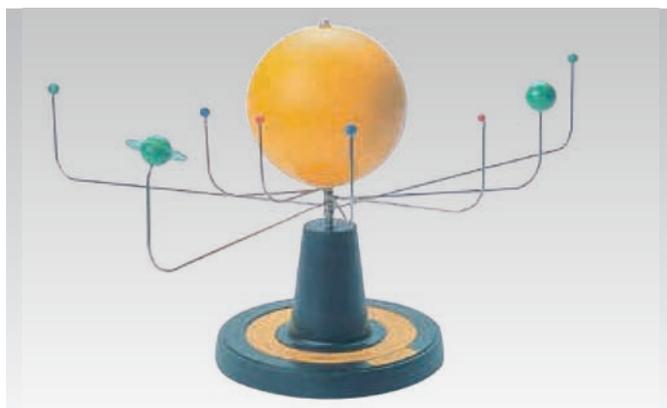


### Tellurium, illuminated

Demonstration model of Earth and the Moon's relative movements around the Sun. The model is correctly geared to show their positions month by month. The light is used to illustrate the seasons, eclipses, day and night. Contents: Tellurium with two sizes of Earth and Moon, stick-on model person, sundial, date, eclipse and phase of the moon indicator cards, teacher's guide and mains adapter.

Dimensions: 65 x 25 cm

Item no. 561030

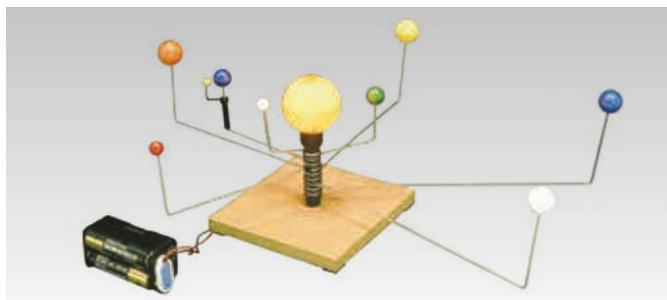


### Planetarium, unilluminated

Three-dimensional model of our solar system with its 8 planets. Ideal for giving pupils an understanding of relative sizes, distances, colours and speed as the planets orbit the Sun. Makes it easy to show why certain planets are only visible for part of the year.

Height: 32 cm. Diameter of outermost orbit: 100 cm

Item no. 560020



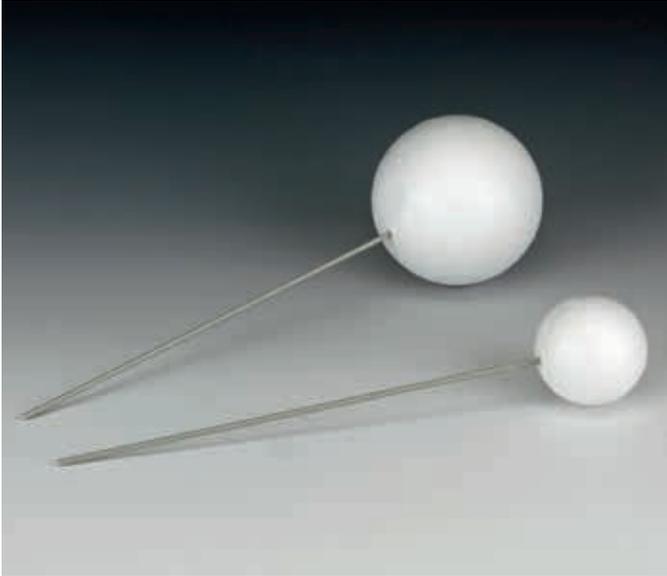
### Planetarium, mini

For demonstrating our solar system, i.e. the orbits of the eight planets and the Moon. The planets are mounted on moveable arms, which rotate around the Sun, and the Moon rotates around Earth. A 3.5 V / 0.3 A bulb illuminates the Sun.

Diameter of the Sun: 3.8 cm. Max. orbit radius: 19 cm.

Includes bulb, but not batteries (2 x 351005).

Item no. 560030



**Earth/Moon model**

Comprises 2 polystyrene balls mounted on rods. The large ball represents Earth and the small one the Moon. For demonstrating the phases of the moon and solar and lunar eclipses. An overhead projector or the sun can be used as a light source.  
 Dimensions: Ø 10 cm and Ø 6 cm

**Item no. 566115**



**Polystyrene globe**

Globe mounted on a stand at an angle of 67.5 degrees between stand and axis. Use for demonstrating day and night, day length and the different seasons. An overhead projector can stand in for the "Sun". Made from polystyrene, so can be drawn on and will accept pins to show shadows etc.  
 Dimensions: Ø 12 cm

**Item no. 566000**



**Solar system, inflatable**

Inflatable beachball models of the Sun, the planets, Pluto and the Moon - 11 celestial bodies in all. They are not to scale. Activity ideas and a foot pump are included.

**Item no. 566130**

## OBSERVATION OF THE CELESTIAL BODIES



### Telescope, Astromaster 130 EQ MD

Classical astronomical Newtonian reflector telescope, suitable for observing objects both on Earth's surface and in the sky, due to its upright viewfinder. The telescope is fitted with a battery-operated motor drive for automatic tracking of the celestial bodies you have selected. Supplied with StarPointer finder, 2 eyepieces, accessory tray, stable steel tripod, and more.

#### Specifications

Optics design:	Reflector
Mirror diameter:	130 mm
Focal length:	650 mm
Eyepieces:	33x (20 mm) and 65x (10 mm)
Finder:	StarPointer
Accessory tray	Rubber-coated holder for eyepieces etc.
Battery pack:	Uses 1 x 9 V battery 351010 (not included)
Warranty:	2-year telescope warranty

**Item no. 565145**



### Telescope, Astro Fi 90 WiFi

See the night sky in a whole new way with Celestron's Astro Fi 90 WiFi telescope and a smartphone or tablet!

The new Celestron Skyportal mobile app replaces the traditional manual controls with a 100% wireless experience and easy access to more than 120,000 celestial bodies. Just point your smartphone or tablet up into the night sky and, when you've found the object you want to observe, touch the screen. The telescope points automatically towards the object while the screen shows information about it. Look through the eyepiece and see the celestial object live. Exploring the universe has never been more fun!

You are ready to observe quickly and easily thanks to Celestron's award-winning SkyAlign technology. Centre three bright objects in the eyepiece and the telescope is ready to calculate the position.

The fully coated 90 mm refractor provides outstanding views of the craters of the Moon, the rings of Saturn, Jupiter's great red spot, the Orion Nebula, the Hercules Globular Cluster (M13) and much more.

Includes a StarPointer finderscope, 2 Kellner eyepieces, diagonal prism, battery pack, accessory tray, aluminium tripod and more.

#### Specifications

Optics design:	Refractor
Objective diameter:	90 mm
Focal length:	910 mm
Eyepieces:	36x (25 mm) and 91x (10 mm)
Finder:	StarPointer
App:	Celestron Skyportal for iOS and Android
Accessory tray	Rubber-coated holder for smartphone or tablet included
Battery pack:	Uses 8 x AA batteries 351005 (not included)
Warranty:	2-year telescope warranty

**Item no. 565140**

## ASTRONOMY



### Build your own telescope, kit

This set is for building a 20x magnification refracting telescope. Gives students a good insight into how a refracting telescope is constructed and how it works. An ideal project for science and technology classes to make concepts like optics and astronomy more tangible. Note that the image is reversed and upside down. All necessary parts and materials are included in the kit.

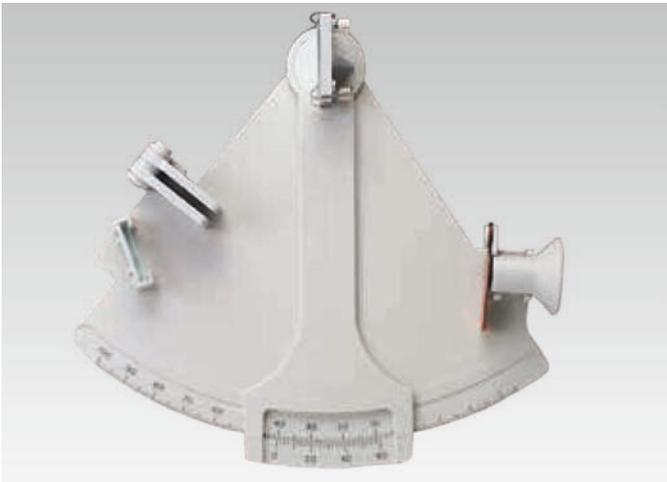
**Item no. 564900**



### Solar eclipse goggles

Safe goggles for looking at the Sun. Designed for solar eclipses, but equally suitable for observing the Sun or viewing sun spots at times of high activity. Fitted with Baader solar film, which shows the Sun as whitish. Guidelines printed on the glasses.

**Item no. 085110**



### Sextant DA-3

A sextant is used to determine the angle of a celestial body above the horizon. By measuring the angle between the sun and the horizon (the solar altitude) at midday, latitude can be calculated. Precision:  $1/30$  degree = 2 arcminutes. Supplied with very comprehensive user manual.

**Item no. 563180**



### Solarscope, large

The solar scope permits astronomical observations of our closest star during the daytime. It is designed for viewing sun spots, solar eclipses and planetary transits. The apparatus enables determination of Earth's speed of rotation, day length, etc. The model is supplied with a 32-page manual and is ideal for groups of 2-5, since the projected diameter of the solar disc is approx. 115 mm.

Dimensions: 46 x 38 x 60 cm

**Item no. 563425**

## POSTERS, MAPS, ETC.

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### **Meteorite in case**

Fragment from a meteorite that fell to earth in Russia in 1947. It measures approx. 2 x 2 x 1 cm and is mounted in a membrane box, which holds it in place and makes it easy to study. The meteorite can also be removed from the box for closer inspection. The box also contains an information brochure and a signed certificate of authenticity. Find out more on the "Treasures from space" website: [www.treasuresfromspace.com](http://www.treasuresfromspace.com).

**Item no. 768075**

## LABORATORY FIXTURES AND FITTINGS

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## GRATNELLS TRAYS

Gratnells system trays are specially designed for school use. Empty trays can be stacked inside one another. If every other tray is reversed, they can be stacked on top of one another. The trays are available in many different colours, three different depths and come with labels.

Dimensions: 312 x 427 mm.



### Tray, 75 mm deep

Colour	blue	red	yellow	light grey	transparent
item no.	576610	576620	576625	576627	576628

### Tray, 150 mm deep

Colour	blue	red	yellow	light grey	transparent
item no.	576631	576632	576635	576637	576638

### Tray, 300 mm deep

Colour	blue	red	transparent
item no.	576641	576642	576644

### Lid

Trays can be fitted with a transparent lid featuring a snaplock. The lid sits low, so the trays still fit into the runners on system trolleys and frames.

**Item no. 576682**



### Labels

Sheet of 6 extra, removable, adhesive labels.

**Item no. 576688**

There are many different tray inserts available to help you keep your collection in order. The following pages provide an overview of the range of options available.



## SYSTEM TROLLEYS

The trolleys are available with 1, 2 or 3 sections. The trolley frames are made from painted steel tube, available in white. The image below shows a 3-section trolley, equipped with 75 mm and 150 mm deep trays.



N.B: Trays sold separately. Don't forget to order a matching quantity of 576695 Runners.

### System trolley, single

Dimensions: 850 x 380 x 420 mm.

Item no. 576506

### System trolley, double

Dimensions: 850 x 710 x 420 mm.

Item no. 576516

### System trolley, treble

Dimensions: 805 x 1055 x 420 mm

Item no. 576527

### System frames

For static storage of trays.

N.B: Trays sold separately. Don't forget to order an equivalent quantity of 576695 Runners.

### System frame without trays, treble

White. Dimensions:  
1850 x 1055 x 420 mm.

Item no. 576706

## ACCESSORIES FOR SYSTEM TROLLEYS, FRAMES AND TRAYS

### Metal runners

Colour: white. Sold in pairs.

Item no. 576695

## SHELF

### White shelf for system frame

Item no. 576698

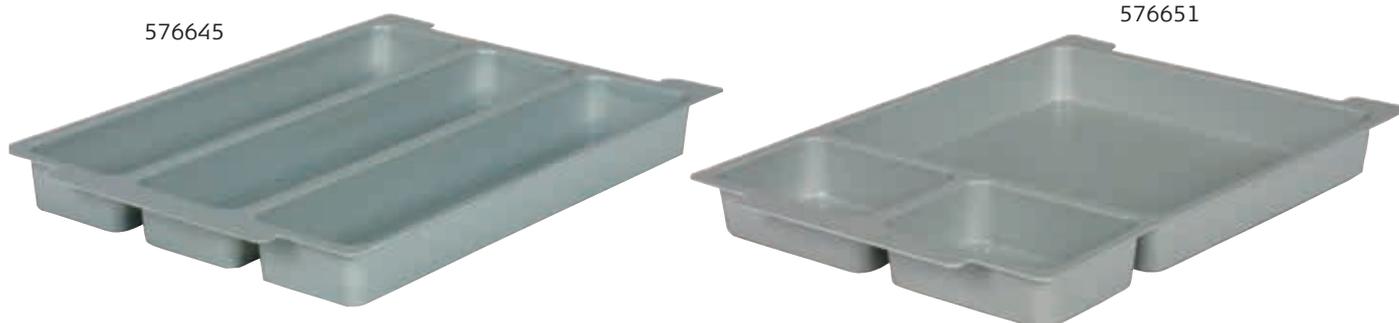


## INSERTS FOR SYSTEM TRAYS

### Foam inserts

Inserts to fit 75 mm, 150 mm and 225 mm trays. Easy to customise with a knife and suitable for small dropper bottles and the like- item nos 052710, 052810, 055520, 056220, for example. 30 holes in total: Ø 44 mm.

**Item no. 576680**



### Solid inserts

Only compatible with 75 mm deep trays. The inserts are approx. 40 mm deep, and made from hard plastic.

Item no.	No. of compartments	Compartment size	Suitable for (e.g.)
576645	3	80 x 340 mm	001800-40 Stand clamps
576646	4	120 x 160 mm	Miscellaneous, e.g. stoppers
576647	6	75 x 160 mm	352110 Battery holder, 472400 Connected motors, 002300-20, 002700 and 002800 stand fittings, 048500 Wooden splints, 050000 plastic spatulas
576648	8	75 x 120 mm	420536-48 Resistors, 434000 Rectifier, 415000 Push-button switch, 472010 Motor on base
576650	30	45 x 50 mm	462510-40 Student coils
576651	3		Miscellaneous
576652	6		Miscellaneous
576654	12		453000 Voltmeter
576655	12		412000-10 Lamp holders, 414000 Telegraph key
576656	12		Thermometers
576657	12 + 12 + 6		341000 Compass needle
576658	12 + 12		330510, 331510 Magnets
576659	30		Wire coils
576660	12/6		150000 Specific gravity blocks,, 151000 Specific gravity weights, 272500 Specific heat weights, 287210 UVA accessories
576661	6 + 6 + 1		Glass jars and electrodes
576663	6		463000 U/I core (can be stored in two layers)
576678	30		Foam insert with 30 spaces for smartphones

LABORATORY FIXTURES AND FITTINGS



576680



576646



576648



576650



576652



576654



576655



576656



576657



576658



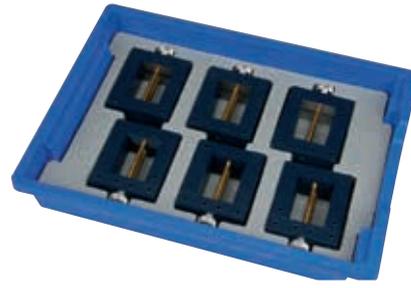
576659



576660



576661



576663

## SHOW IT ON CAMERA!

On these pages, we present a number of USB cameras that are excellent for displaying experiments and close-up details on an interactive board using a projector. They each have their benefits, depending on intended use. All the cameras have an option for saving images and video using the supplied software, and, for the Ken-A-Vision products, the ability to stream the images wirelessly using the EduCam app.



### Digital microscope, USB, 5 MP

A neat little microscope with 5 MP resolution and stand. Easy to use for examining small details and surfaces, and includes adjustable built-in LED illumination. When mounted in the stand, allows a slightly larger working distance, and less magnification. When holding it over a surface, you can use the focusing wheel to ensure sharp images at two different magnifications. Supplied with Windows and Mac compatible software.

**Item no. 078106**

### Microscope camera WIFI 5 MP

This WiFi microscope camera can connect to a microscope in several ways. Either via the microscopes CCD adapter with C-mount or more commonly via an adapter that fits into the eyepiece tube instead of the eyepiece. The camera has a resolution of 5 MP (15 fps) and can connect to a computer via a USB 2.0 cable or to a smartphone/iPad via WiFi. The app Ucam is available for both Android and iOS and a CD-rom holds the PC software for cabled use. Equipped with a lithium battery that can be charged with the accompanying charger or via the USB cable when connected to a PC.

Resolution: 2592 x 1944 pixels

Framerate: 15 fps @ 5 MP

40 fps @ 1.2 MP

Chip: 1/2.5" CMOS

Adapters: 30 mm, 30.5 mm and 23.2 mm

**Item no. 078115**



## STANDS

### Retort stand with flat base

Stand base in painted steel with rubber feet and threaded socket for supplied  $\varnothing$  12/10 x 600 mm nickel-plated steel post. The base weighs 1.7 kg.

Item no. 001100



### Retort Stand Rods

Item no.	Length/cm	Diameter/mm
000800	150	12/10
000810	100	12/10
000820	75	12/10
000830	50	12/10
000840	60	10
000850	25	10
000860	10	10



Item no. 000100 Retort stand base, A-shaped, 2.0 kg

Item no. 000600 Retort stand base, tripod, 1.0 kg

Item no. 000400 Retort stand base, round, 0.43 kg

Item no. 000410 Retort stand base, square, 0.57 kg



### Table clamp

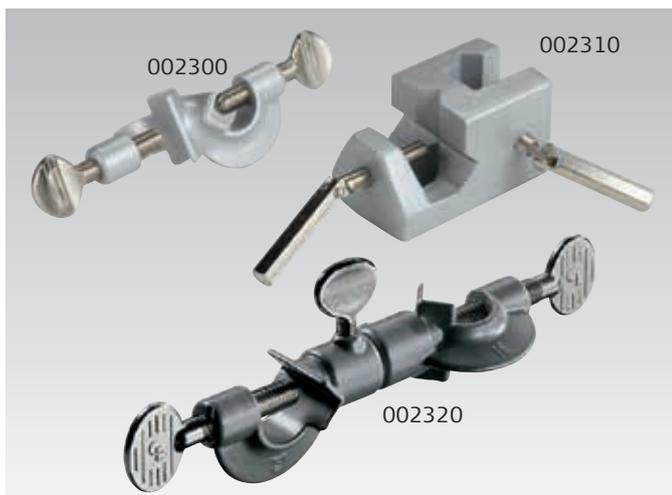
Holds retort stand rods up to  $\varnothing$  13 mm. Max. clampable width: 65 mm

Item no. 001600



### Laboratory jacks

Item no.	Platform	Height
003710	painted, 200 x 200 mm	70 - 300 mm
003700	painted, 150 x 135 mm	51 - 250 mm
003610	stainless, 200 x 200 mm	62 - 277 mm



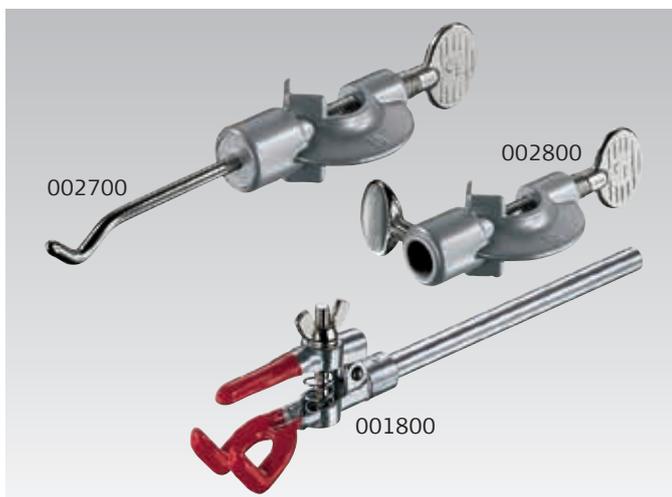
Item no. 002300 Boss head

Item no. 002310 Square boss head, Universal

Item no. 002320 Boss head, swivel



Item no. 003810 Retort ring, Ø 10 cm, with clamp



Item no. 002700 Stand clamp, with hook

Item no. 002800 Stand clamp with Ø 10 mm socket

Item no. 001800 Stand clamp with overlapping jaws



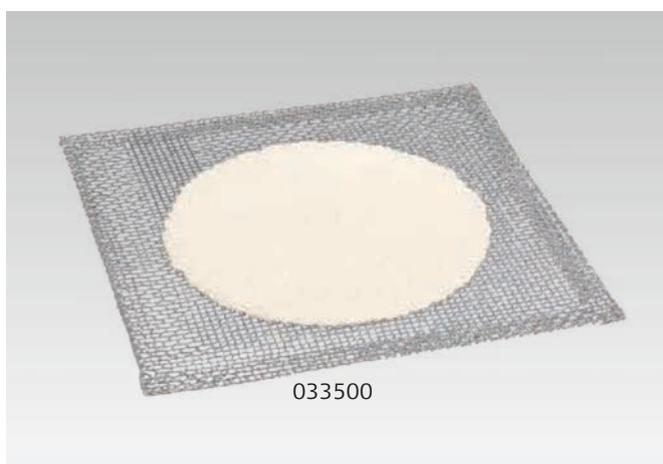
Item no. 004100 Tripod, Ø 10 cm, height: 18 cm



Item no. 001810 Stand clamp with rounded jaws

Item no. 001830 Stand clamp with angular jaws

Item no. 001840 Stand clamp, universal



Item no. 033500 Ceramic gauze, 120 x 120 mm

## GLASSWARE, ETC.

This is just a small selection of our glassware. See the full range in our chemistry catalogue and at [www.frederiksen.eu](http://www.frederiksen.eu). For most of these items, a volume discount is available for purchases of 10 or more.



**Graduated cylinder, tall**  
Borosilicate glass, round base.

Item no. 011020 10 ml  
Item no. 011050 100 ml

### Graduated cylinder, plastic

Transparent PMP plastic with raised scale and hexagonal base.

Item no. 011810 10 ml  
Item no. 011850 100 ml

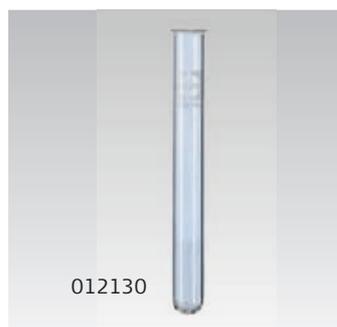


### Test tube

Heat-resistant, DURAN glass

Item no. 012130  
Ø 18 x 180 mm,  
100 pcs

Item no. 012140  
Ø 25 x 200 mm



### Test tube stands, 3 x 4 holes

Item no. 031060 For test tubes up to Ø 20 mm  
Item no. 031070 For test tubes up to Ø 26 mm

### Test tube clamp

12 pcs in wood.  
Overall length: 170 mm.

Item no. 032500



### Squeeze bottles

Squeeze bottles in soft plastic, with oval shape for easy handling.

Item no. 052511 250 ml  
Item no. 052521 500 ml



### Beaker, short

Heat-resistant, DURAN glass

Item no. 007490 10 ml  
Item no. 007520 100 ml  
Item no. 007530 250 ml

### Beaker, tall

Beaker made from DURAN borosilicate glass.

Item no. 006910 100 ml

Item no. 006940 400 ml



### Beaker, plastic

Item no. 007720 100 ml

Item no. 007730 250 ml

### Erlenmeyer flask

Item no. 008010 250 ml  
DURAN glass

Item no. 008030 500 ml  
DURAN glass



### Stoppers

Item no. Ø mm Application

043010 14/19 no hole, for test tube Ø 18 x 180 mm

043020 14/19 1 hole, for test tube Ø 18 x 180 mm

043030 14/19 2 holes, for test tube Ø 18 x 180 mm

043710 20/25 no hole, for test tube Ø 25 x 200 mm

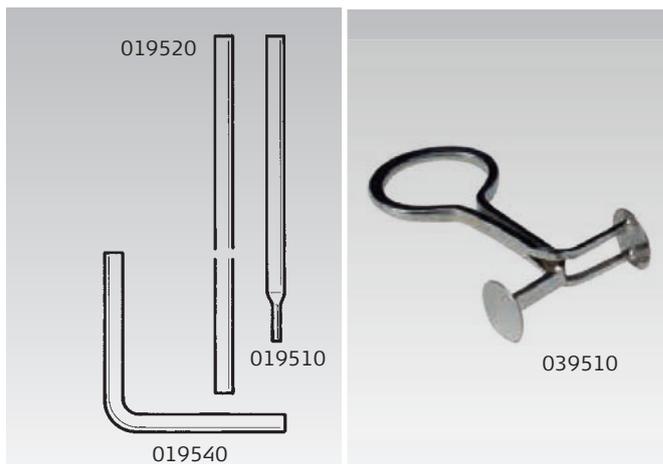
043720 20/25 1 hole, for test tube Ø 25 x 200 mm

043730 20/25 2 holes, for test tube Ø 25 x 200 mm

045010 30/35 no hole, for flask 250 ml

045020 30/35 1 hole, for flask 250 ml

045030 30/35 2 holes, for flask 250 ml



### Glass tube Ø 7 mm

Item no. 019510 Straight with tip, 12 cm

Item no. 019520 Straight, 18 cm

Item no. 019540 90° angle, 7 x 7 cm

### Hose clamps

Item no. 039510 Mohr, pinchcock clamp

Item no. 039530 Hofmann, screw clamp

Item no. 039540 Hofmann, large screw clamp

### Hose – 5 m

Item no. 038520 PVC Ø/ø 9/6 mm

Item no. 038530 Silicone Ø/ø 8/6 mm

### Hose connectors

Item no. 039110 Hose connector Ø 4.5-7 mm. Pack of 10

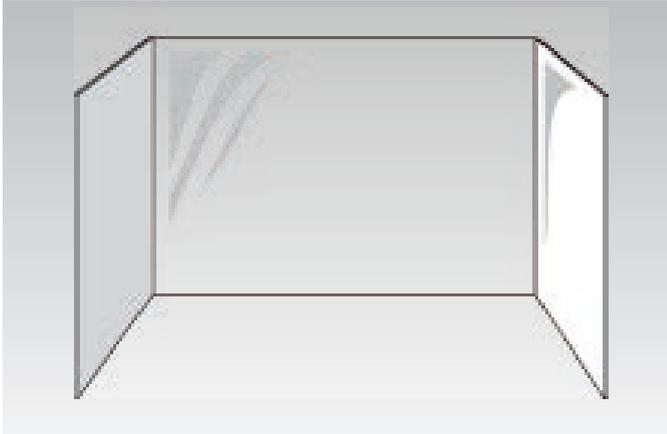
Item no. 039020 T connector Ø 5-7 mm. Pack of 10



### Drainer with tray

Item no. 031600

## SAFETY EQUIPMENT



### Protective screen, 3 leaf

Free-standing 3-leaf plexiglas screen, 880 x 600 x 4 mm, with two 440 mm hinged leaves.

Item no. 084020



### Safety goggles

Made from impact-resistant clear plastic. Can be worn over ordinary spectacles.

Item no. 085000



### Disposable gloves, polyethylene

Petrol station type.

Item no. 086020 Large

Item no. 086021 Medium



### Nitrile gloves

Disposable nitrile gloves are as close-fitting as latex ones, but with no latex proteins or other allergens. Good chemical resistance.

Item no.	Size	Quantity
086046	Small	100 pcs.
086047	Medium	100 pcs.
086048	Large	100 pcs.
086049	X-Large	100 pcs.



### Eyewash on stand

2 x 1 litre bottles of sterile isotonic NaCl 0.9% solution. Total rinse time approx. 10 mins.

Item no. 086520

Item no. 086530 Eyewash in 1L bottle for 086520



## **Trolley**

Worktop and lower shelf in plastic laminate with raised edges. Frame in lacquered tube, Ø 38 mm.

Equipped with 4 large Ø 10 cm castors, two of them with brakes. Worktop: 95 x 54 cm; lower shelf: 86 x 41 cm. Height: 88 cm.

**Item no. 901224**

## TOOLS

### Scissors with plastic handles

Stainless steel Length: 160 mm.

Item no. 078720



### Screwdriver

Screwdriver with plastic handle and 2 mm flat blade. Length: 83 mm.

Item no. 700105

### Screwdriver set

Millarco, 21 piece: 6 screwdrivers (Flat 4-5.5-8 mm / PH2 / T15-20), bit holder, 14 bits (PH1-2-3 / PZ1-2-3 / T10-15-20-25 / Hex 2-2.5-3-4).

Item no. 701850

### Miscellaneous hand tools

Item no. 703115 Wire stripper

Item no. 703125 Wire stripper, self-adjusting

Item no. 704010 Adjustable wrench, 4 inch

Item no. 704210 Utility knife M9

Item no. 704211 Spare blades, 9 mm, pack of 10

Item no. 704530 Hammer with wooden handle, 200 g

### Saws

Item no. 704710 Junior hacksaw for metal, plastic and wood

Item no. 336010 Hacksaw blades, short, length 153 mm  
Pack of 12

Item no. 336000 Hacksaw blades, standard, length 313 mm  
Pack of 10



### Clamping

Item no. 001510 Screw clamp. Max. clampable width: 150 mm



### Soldering

Item no. 708010 Soldering iron, ANTEX. 230 V, 25 W

Item no. 708410 Universal stand with sponge

Item no. 647515 Solder 500 g, lead-free

## MISCELLANEOUS MATERIALS

### Rods and tubes

Item no. 504093 Straws, Ø 3 x 250 mm, 1000 pcs

Item no. 504096 Straws, Ø 6 x 255 mm, with bend, 500 pcs

Item no. 504097 Pipe cleaners, Ø 6mm, 30 cm, 50 pcs

### Metal

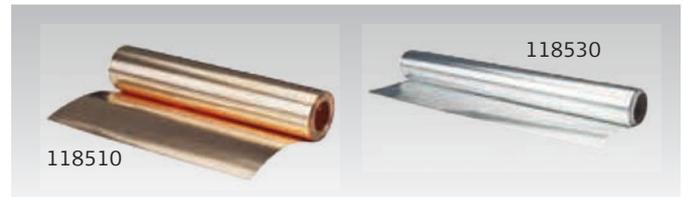
Item no. 118610 Copper plate, 200 x 500 x 1 mm

Item no. 753500 Bi-metallic strip, 0.3 x 5 x 2000 mm

### Thread

Item no. 116500 Extra strong thread, large roll

Item no. 116800 Fishing line, Ø 0.4 mm, roll of 100 m



### Foils

Item no. 118530 Aluminium foil, 20 m, roll

Item no. 118510 Copper foil, 0.1 x 150 mm, roll of 500 g

Item no. 118540 Plastic foil, 60 m, roll

### Polystyrene

Item no. 590620 Polystyrene, 15 x 15 x 3 cm

### Tape, paper clips, fasteners

Item no. 591200 Tape, ordinary, clear, 15 mm x 33 m, roll

Item no. 591600 Tape, black, PVC, 15 mm x 10 m, roll

Item no. 591030 Rubber bands, approx. 110 pcs

Item no. 591800 Paper clips, tin of 1000

Item no. 754530 Paper fasteners, 100 pcs

### Bags

Item no. 503301 Zip bags, 150 x 250 mm, 50 pcs

### Glue

Item no. 691010 Contact adhesive, 40 g tube

### Other

Item no. 291710 Glass-headed pins, pack

Item no. 590200 Cotton wool, 100 g

Item no. 595000 Ping pong ball

Item no. 590400 Steel wool, 500 g, fine

Item no. 590500 Emery cloth, P 120, 38 mm wide,  
5 pcs of 20 cm

Item no. 590000 Modelling wax, waterproof, 250 g

Item no. 593700 Marker pen for glass

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