



STUDENT EXPERIMENTS GENERAL CATALOGUE

PHYSICS - CHEMISTRY

Only action results in satisfaction



P 1010

The various physics topics have been structured in experiment modules. One module consists of:

- Student Experiment Kit(s) "SEK"
- Experiment manual
- Accessories

The chart included shows which kits are required for the specific modules.

Experiment manuals

NTL experiment manuals are prepared according to educational principles by highly qualified professionals.

This ensures users the most in fun when performing experiments.

These are available in printed form (P9160-ff)



or in digital Adobe Acrobat format on a CD-ROM (P9150-ff).



The CD-ROM also contains experiment results and experiment videos.

KITS (SEK)

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MODULES

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Block storage in trays

Similar items are stored in a tray, each student group then receives only those items which are required for the experiment.



NTL trays:

- Solid trays with reinforced bottom
- Grooves for optimal spacing of partitions
- Deep, moulded handles positioned at the front and back
- Slots for inserting labels
- Transparent partitions
- Material: PP



Trays for divided storage:

C7850-1A	Storage tray, 400x240x95mm, blue
C7850-1B	Storage tray, 400x120x95mm, blue
C7850-1C	Storage tray, 600x120x95mm, blue
C7859-1A	Partition for storage tray, 240x95mm, transparent
C7859-1B	Partition for storage tray, 120x95mm, transparent
C7850-1T	Storage tray for up to 28 PIBs, blue
C7858-1B	Labels with storage box holders, 30x75 mm, set

- ▶ Each student group receives only those items which are required for the experiment
- ▶ Easy to check for completeness when collecting items
- ▶ Items used in several chapters need only be ordered once – saves costs
- ▶ Optimum use of given storage space
- ▶ The trays can be divided up using partitions, allowing optimum use of space within the trays.
- ▶ The trays can be easily labelled with symbols, item numbers and descriptions
- ▶ Easy to check whether your collection is complete

Storage in sets (kits)

All material required for one complete physics topic is stored in a single box. Each student group thus gets the all necessary equipment for their experiments.



NTL boxes:

- Solid construction
- Lockable covers
- Anti-slip, stackable
- Handles on both sides
- Material: PP



- ▶ Each group in one class can perform a different experiment
- ▶ Less time required when handing out and collecting items
- ▶ The box is very solidly constructed of polypropylene, stackable, with replaceable cover
- ▶ The box insert, made of plastic, is not susceptible to becoming brittle
- ▶ Thanks to a special module storage system, items can be visibly stored in predefined places
- ▶ Plans for storage of all components provided to easily replace items after use as well to facilitate ordering spare parts



Boxes for Storage:

P7806-1G Storage box II large, with cover
External dimensions: 60 x 40 x 12 cm

P7806-1K Storage box II small, with cover
External dimensions: 40 x 32 x 12 cm

P7806-1S Storage box II mini, with cover
External dimensions: 30 x 20 x 12 cm

P7790-2A Storage wagon for NTL boxes II

For portable storage of up to 12 large or 24 small storage boxes, load capacity up to 200 kg;

Wagon on castors made of ABS with 4 swiveling castors (D = 100 mm) and stop brake

External dimensions: approx. 615 x 415 x 140 mm

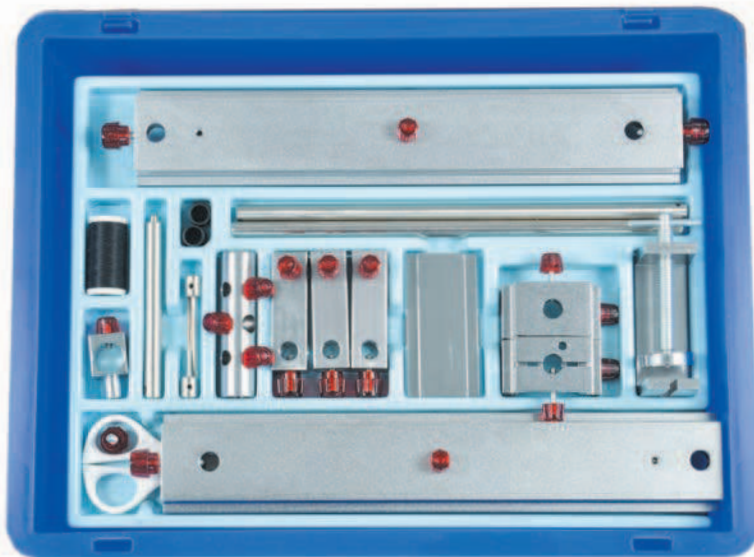


Rail stand material

Most of the components in this set are manufactured from aluminium which is anodised for additional protection. Aluminium is highly resistant and does not rust. The threaded ends of all of screws are rounded, ensuring that components are held very firmly in place. The rods and bolts are made of nickel-plated steel. All rods provided with the student experiment equipment have a standard diameter of 10 mm.



Multifunctional use



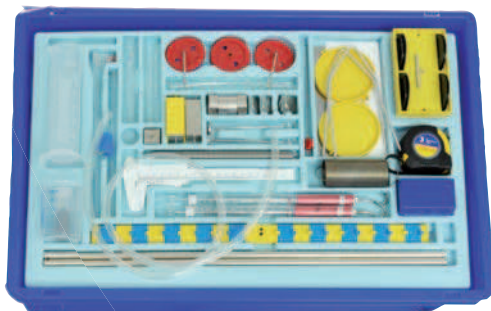
The rail stand material is the basis for the modules ...



... Optics 2



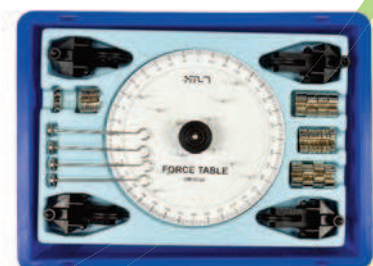
... Heat 1



... Mechanics 1



... Vibrations and waves



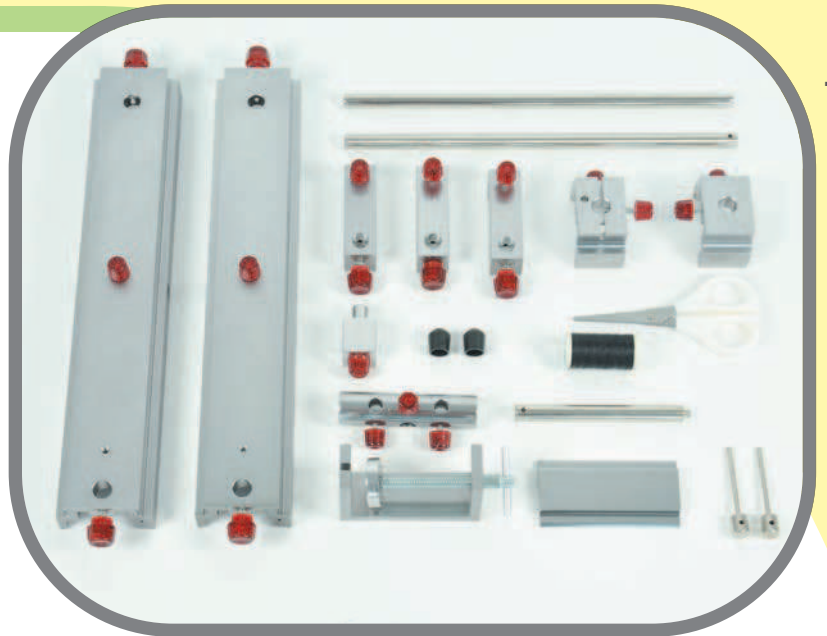
... Forces and torque



... Dynamics

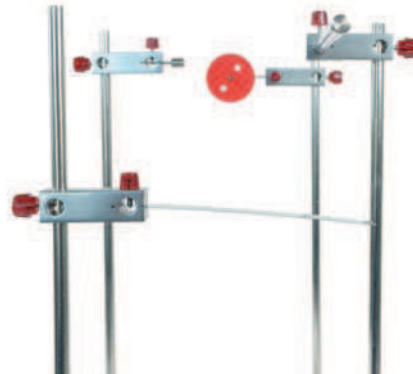
Kit consisting of:

Qty	Item no.	Description
2	P7230-4E	Bearing pin
1	P7230-4H	Holder for dynamometers and test tubes, SE
1	P7220-2D	Table clamp, NTL – SE
2	P7210-5C	Stand rail, 300 mm, NTL – SE
		NTL aluminium profile for use as standbase or inclined plane
1	P5310-1S	Rail connector SE, universal
		Special NTL aluminium profile, for connecting NTL rails
3	P7230-1M	Bosshead, universal, NTL – SE
		Rectangular aluminium profile, for mounting shafts, pins and / or springs
1	P7230-1K	Bosshead, round, NTL – SE
1	P5310-1H	Sliding saddle with set screw
		Special NTL profile
1	P5310-1F	Sliding saddle for screens, springs and pointers
		Special NTL profile
2	P7240-1C	Support rod, round, L = 250 mm, D = 10 mm
2	P7240-1D	End cap for rods, plastics
		Creates a stand base out of a stand rail and a support rod
1	P7240-1A	Support rod with pivot pin, L = 100 mm, D = 10 mm
1	P7502-1A	Pair of scissors, SE
1	P7100-1A	Cord, roll, 30 m, high tensile strength
Storage:		
1	P7806-4A	Box insert Rail stand material, SE
1	P7806-1K	Storage box II small, with cover
		Box insert plan with 2 labels



P9901-4A SEK Rail stand material

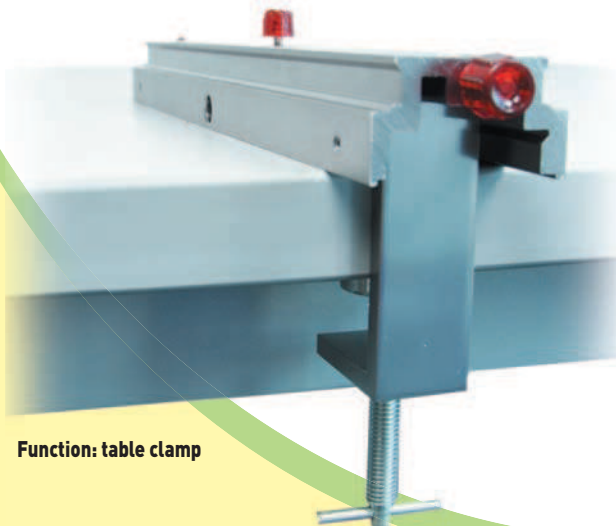
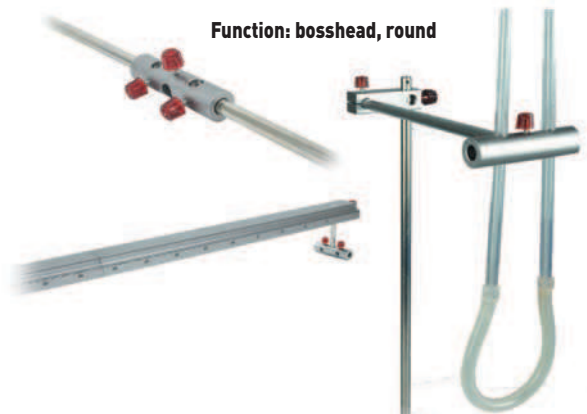
Function: NTL universal bosshead



Function: bearing pin



Function: bosshead, round



Function: table clamp

Ordering information

P9901-4A	SEK Rail stand material
P9901-4B	SEK Mechanics 1
P9160-4B	Experiment manual Mechanics 1



Experiments

1. MEASURING PHYSICAL QUANTITIES:

MES 1.1	Measuring length by means of measuring tape and caliper
MES 1.2	Volume of solid and liquid materials
MES 1.2.1	Volume of gases
MES 1.3	Time measurement
MES 1.4	Mass and units of mass
MES 1.5	Density of solid bodies
MES 1.6	Density of liquids
MES 1.6.1	Determination of densities of liquids (U-tube method)

2. FORCES:

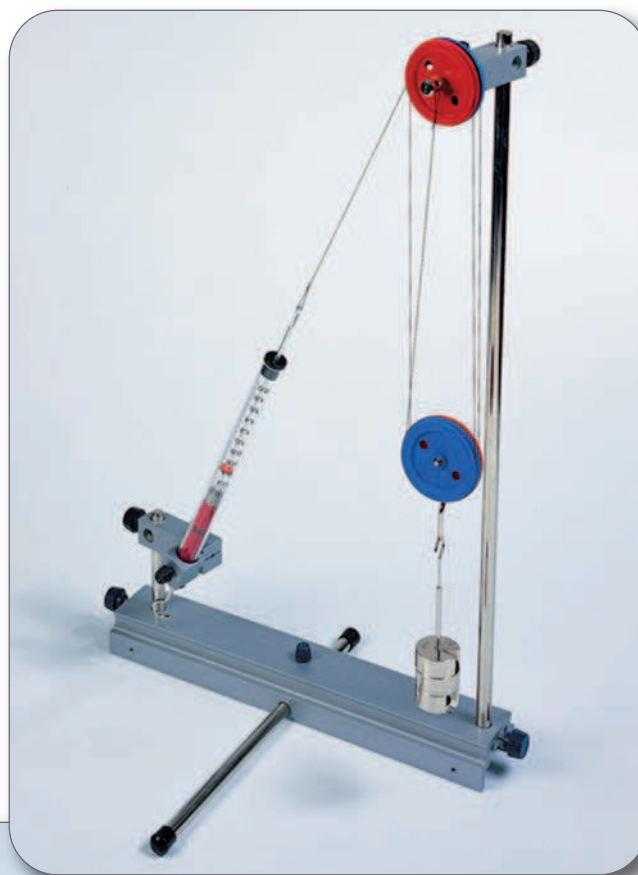
MES 2.1	Force of weight
MES 2.2	Force measuring
MES 2.3	Elongation of a coil spring – Hooke's Law
MES 2.4	Direction of force and point of impact
MES 2.5	Composition of forces – parallelogram of forces
MES 2.5.1	Composition of three forces
MES 2.6	Inclined plane
MES 2.7	Decomposition of forces on an inclined plane
MES 2.8	Frictional force
MES 2.8.1	Determination of the coefficient of friction

3. SIMPLE MACHINES:

MES 3.1	Two-sided lever
MES 3.2	Model of a beam balance
MES 3.3	One-sided lever
MES 3.4	Simple fixed pulley
MES 3.5	Pulley
MES 3.6	Single block and tackle
MES 3.7	Compound block and tackle
MES 3.8	Mechanical work
MES 3.9	Work on an inclined plane
MES 3.10	Stability
MES 3.11	Tipping work

4. HYDROSTATICS:

MES 4.1	Communicating vessels
MES 4.2	Effects of air pressure
MES 4.3	Buoyancy
MES 4.4	Archimedes' Principle
MES 4.5	Load capacity of a ship
MES 4.6	Model of a hydrometer
MES 4.7	Hydrostatic pressure
MES 4.8	Capillarity



MES 3.7 Compound block and tackle



MES 3.2 Model of a beam balance



MES 2.6. Inclined plane

Kit consisting of:

Qty	Item no.	Description
1	P1311-2A	Dynamics trolley, SE
1	P1100-1E	Measuring tape, L = 300 cm
2	P1220-2D	Scale pan with suspension
1	P1220-2C	Pointer for lever rod
1	P1220-2B	Scale, graduated, SE
1	P1220-2E	Sliding saddle for lever rod
1	P1120-1S	Lead (tare) shot, 50 g
1	P1100-2B	Vernier calliper, plastic
1	P7400-2C	Beaker, plastic, 100 ml
1	P7400-4A	Graduated cylinder, plastic, 100 ml
1	P1410-1F	Immersion probes, set of, SE
2	P7400-1C	Manometer tube, acrylic, D = 8 mm, L = 200 mm
1	P7400-1A	Acrylic tube, D = 20 mm, L = 120 mm
1	C7320-1D	Stopper, silicone, 12.5/18/27 mm, 1 hole
1	P7405-1A	Test tube, glass 12x100 mm
4	P1120-2F	Slotted weight, 50 g, SE
4	P1120-2D	Slotted weight, 10 g, SE
2	P1120-2C	Holder for slotted weights, 10 g, SE
1	P1120-1B	Balance weights set, 1...50 g
2	P7240-1G	Support rod, round, L = 500 mm, D = 10 mm
1	P7400-1B	Acrylic tube, D = 8 mm, L = 80 mm

- 1 P1120-3E **Hollow block (Archimedes)**
50 x 20 x 20 mm
for easy calculation of volume (without calculator)

- 1 P1120-3A Aluminium block
1 P1120-3B Iron block with hook, large
1 P1120-3D Iron block with hook, small
1 P1810-2A Coil spring 3 N/m, D = 35 mm approx.
1 P1810-2B Coil spring 20 N/m, D = 12 mm approx.

- 1 P1220-2A **Lever rod for balance SE, L = 420 mm**
Solid aluminium profile with plastic elements and protrusions for suspending weights or scale pans, two drilled holes for stable and instable equilibrium, threaded hole for pointer

- 1 P1810-1C Flat spring, steel, 0.4mm, L = 165 mm
1 P7422-9A Capillary tubes, set of 3
1 P1230-3B Pulleys, set of 4, plastic, SE
with very deep grooves
1 P7132-1A Tubing, plastic, 100 cm, transparent
1 P7132-1B Tubing, plastic, 16 cm, transparent

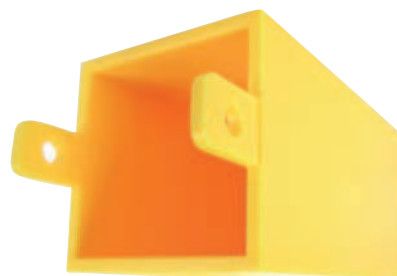
- 2 P1130-1C **Dynamometer, 2 N, transparent,**
Graduation in 0.02 N increments,
transparent housing for observing the
spring, zero-point calibration, arrester position for avoiding
overexpansion of the spring

Storage:

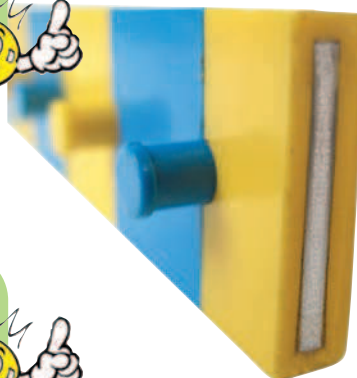
- 1 P7806-4B Box insert Mechanics 1, SE
1 P7806-1G Storage box II large, with cover
Box insert plan with 2 labels



P9901-4B SEK Mechanics 1



Hollow block (Archimedes)



Lever rod for balance

Dynamometer



Accessories

BEST PRICE



Dynamometers, transparent, with zero-point calibration and arresting

- P1130-1S Dynamometer 0.1 N, transparent
P1130-1A Dynamometer 0.2 N, transparent
P1130-1B Dynamometer 1 N, transparent
P1130-1D Dynamometer 5 N, transparent
P1130-1E Dynamometer 10 N, transparent
P1130-1F Dynamometer 20 N, transparent



DM125-3C Electronic digital balance, 2000/0.1 g

Precise digital balance with tare function
Weighing range: 0 ... 2000 g
Resolution: 0.1 g, battery-powered
Weighing surface dimensions: 100 x 95 mm



DM680-2S Friction block, multifunctional, 40x40x160 mm

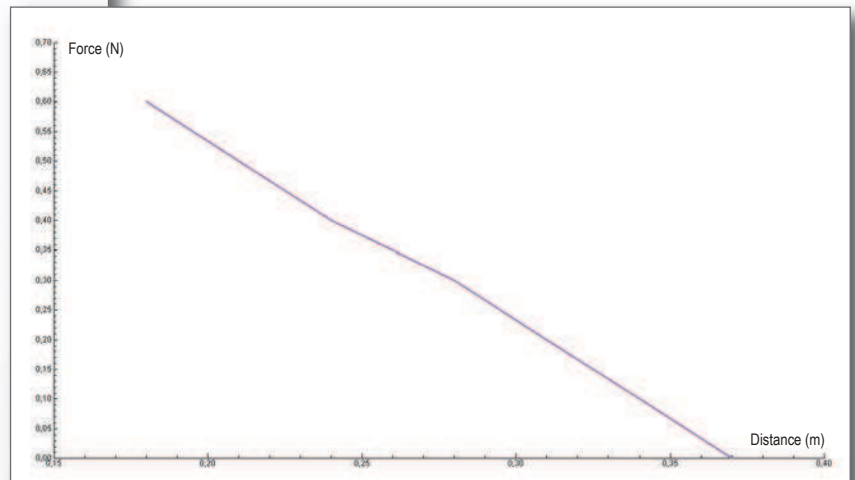
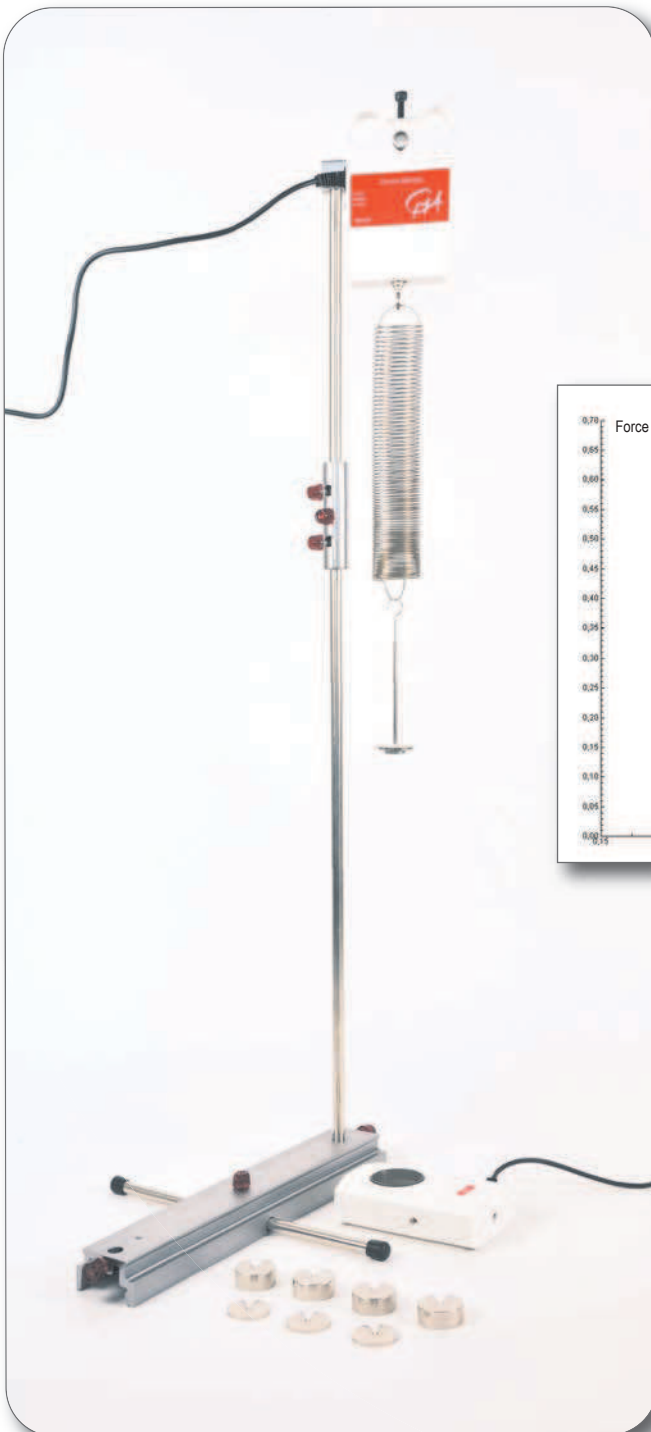
For experiments involving static, dynamic and rolling friction
Surfaces: wood, rubber, leather and sand paper
Wood surface can be doubled by unfolding the block
Dimensions: 40 x 40 x 160 mm
Weight: approx. 200 g

Ordering information

P4910-1	ULAB datalogger, USB, serial, incl. Coach 6 Lite
P4210-1K	Sensor force, 2 ranges: -5 .. +5 N, - 50 .. +50 N
P4210-5B	Sensor motion, 0.2 ... 6 m

Supplement for Mechanics 1 module:

In contrast to conventional methods using “manual” measurement, the two parameters force and distance (i.e. spring expansion) are recorded, allowing the spring constant to be calculated immediately.



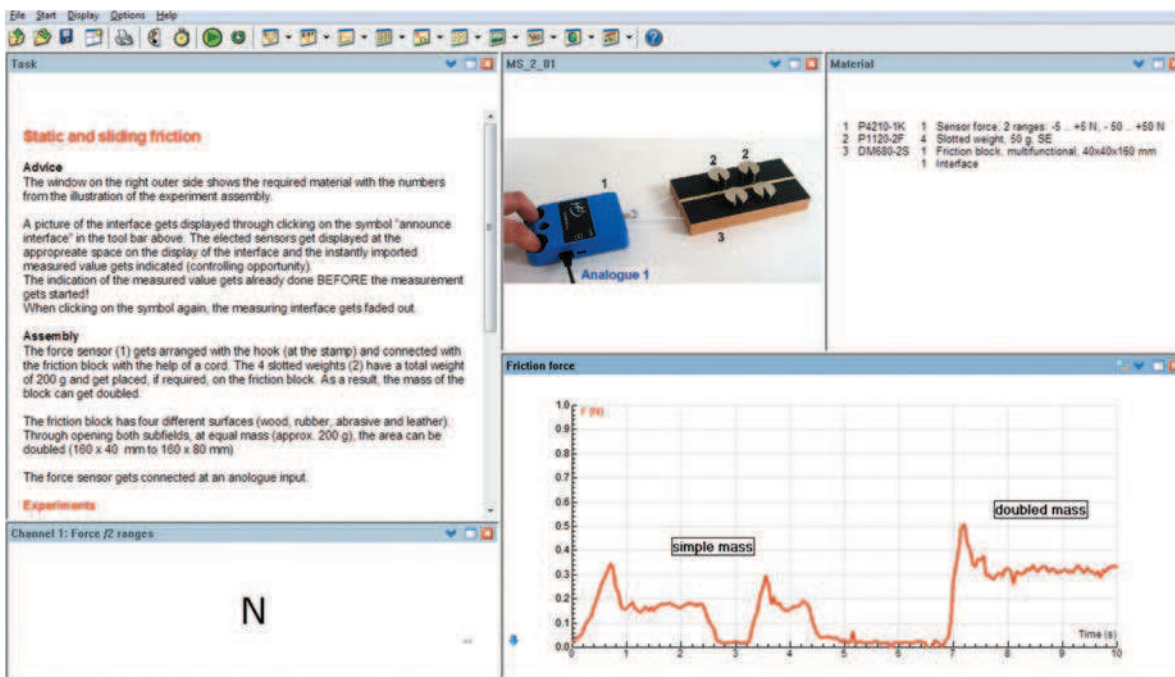
Hooke's law

Ordering information

P4910-1U ULAB datalogger, USB, serial,
incl. Coach 6 Lite

P4210-1K Sensor force, 2 ranges:
-5 .. +5 N, - 50 .. +50 N

P4210-5B Sensor motion, 0.2 ... 6 m



Example of an experiment using menu-driven software

A force/time diagram allows the measured force to be recorded completely, facilitating unequivocal readings.



Static and rolling friction

Ordering information

P9901-4A SEK Stand rail material
 P9902-4J SEK Dynamics
 P9160-4J Experiment manual Dynamics

Accessories:

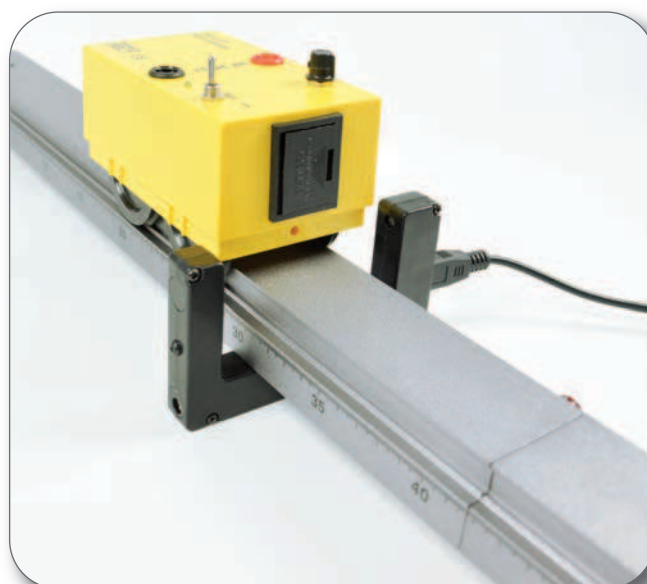
P1311-2H Ticker tape timer
 P1311-2G Metallic paper
 or
 P1325-9S Counter with 2 light gates, set



Experiments

5. DYNAMICS:

- MES 5.1 Uniform motion
- MES 5.2 Variable motion
- MES 5.3 Average and momentary speed
- MES 5.4 Uniformly accelerated motion
- MES 5.5 Free-fall acceleration
- MES 5.6 Basic dynamics equation and "Newton" – definition
- MES 5.7 Impact experiments – principle of linear momentum
- MES 5.8 Dynamic mass determination
- MES 5.9 Potential and kinetic energy



MES 5.1 Uniform motion



MES 5.4 Uniformly accelerated motion



MES 5.5 Free-fall acceleration

Kit consisting of:

Qty	Item no.	Description
2	P1311-2A	Dynamics trolley, SE, low friction, with turret for mounting slotted weights SE
4	P1120-2F	Slotted weight, 50 g, SE
3	P1120-2D	Slotted weight, 10 g, SE
1	P1120-2C	Holder for slotted weights, 10 g, SE
2	P1311-2D	Spring bumper Steel spring for demonstrating elastic collision, stackable
1	DM355-5S	Pulley with very low friction, with holder and fixing screw for mounting on tables and tracks; the pulley with bracket is continuously variable and fixable
2	P1312-2A	Car body for trolley SE
1	P1311-2E	Flat spring for collision experiments with trolleys
1	P7240-1B	Support rod, round, L = 60 mm, D = 10 mm
1	P1100-1E	Measuring tape, L = 300 cm



P9902-4J SEK Dynamics



Variable speed trolley
(battery-driven)

- 1 DM300-3A Trolley with variable speed**
Battery-powered, for experiments involving uniform motion; potentiometer for continuously variable speed adjustment. Mode switch: Forward/Off/Reverse, sockets for external power supply (non-uniform motion), battery (9V) can be exchanged without opening the case



- 1 P5310-1B Track and optical bench, 2 x 50 cm**
NTL aluminium rail profile, anodised, very thick and solid, with screen-printed millimeter scale, can be assembled to a 1-m rail with the help of a rail connector; drilled holes on the face for mounting pulleys or a rod to incline the track in any position or at any angle



- 1 P5310-1S Rail connector SE, universal

Storage:

- 1 P7906-4J Box insert, Dynamics
1 P7806-1G Plastic box II large, with cover
Box insert plan with 2 labels

Track and optical bench



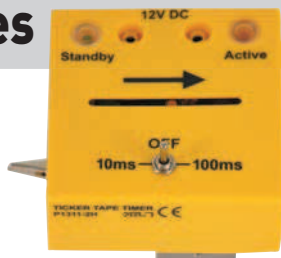
Accessories

P1311-2H Ticker tape timer

For generating virtually frictionless indication points on a metallic paper roll.

Selection switch with the following positions:

- Off
- Points in 10-ms intervals (for free fall)
- Points in 100-ms intervals (for dynamics experiments with the trolley)



P1311-2G Metallic paper roll

30 m roll, for use with the ticker tape timer



P1325-9S Counter with two light gates, set

- Counter, digital, SE
Solid, handy counter with LC display, digit height 12.5 mm, accuracy 10 ms, battery-powered, modes: stopwatch / start - stop / gate

- 2 light gates
Bracket width: 78 mm

- 2 connection cables
L = approx 135 cm each

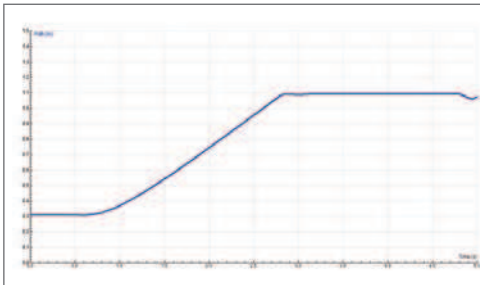


Ordering information

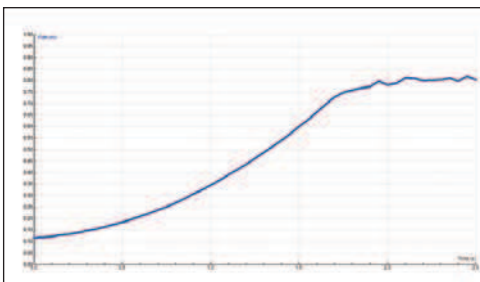
P4910-1U	ULAB datalogger, USB, serial, incl. Coach 6 Lite
P4210-5B	Sensor motion 0.2 ... 6 m
P4210-1B	Sensor acceleration, +/- 5 g
P4210-1K	Sensor force, 2 ranges: -5 .. +5 N, - 50 .. +50 N

Supplement for Dynamics module:

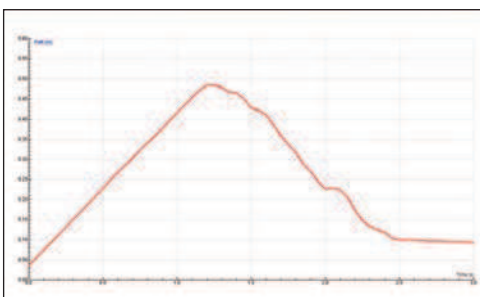
In contrast to conventional measurement methods, such as a ticker tape timer or light gates, moving objects can be scanned 20 times per second with the help of a motion detector. The results can then be represented in graphic form or, if required, exported to a chart for further processing.



Uniform motion (s/t diagram)

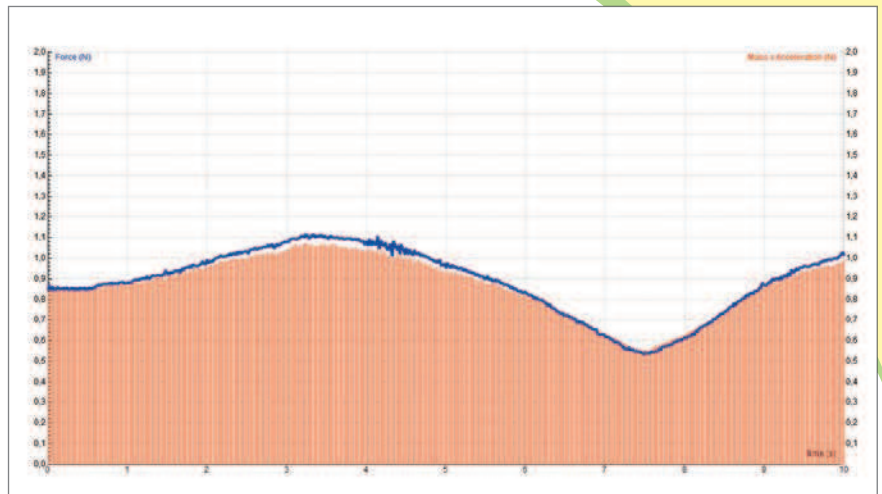


Uniformly accelerated motion (s/t diagram and v/t diagram)

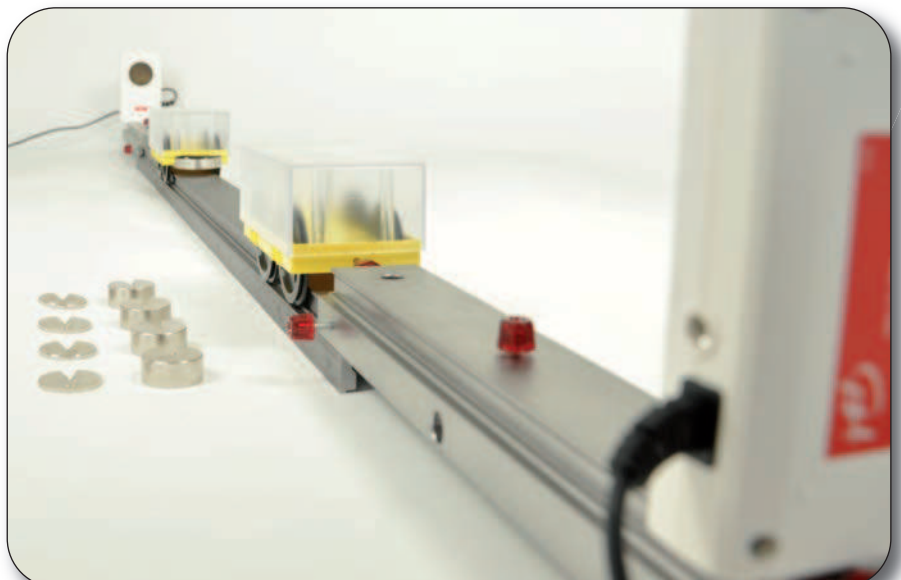
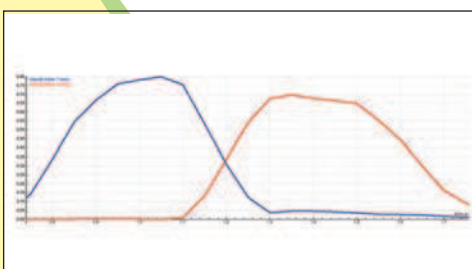
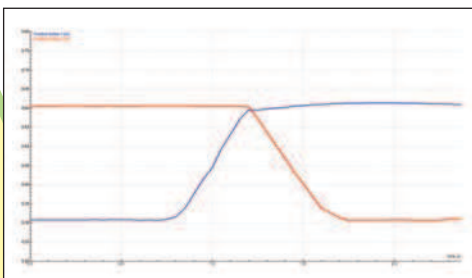


Clear experimental proof of the law
of dynamics
(Newton's second law)

$$F = m \cdot a$$



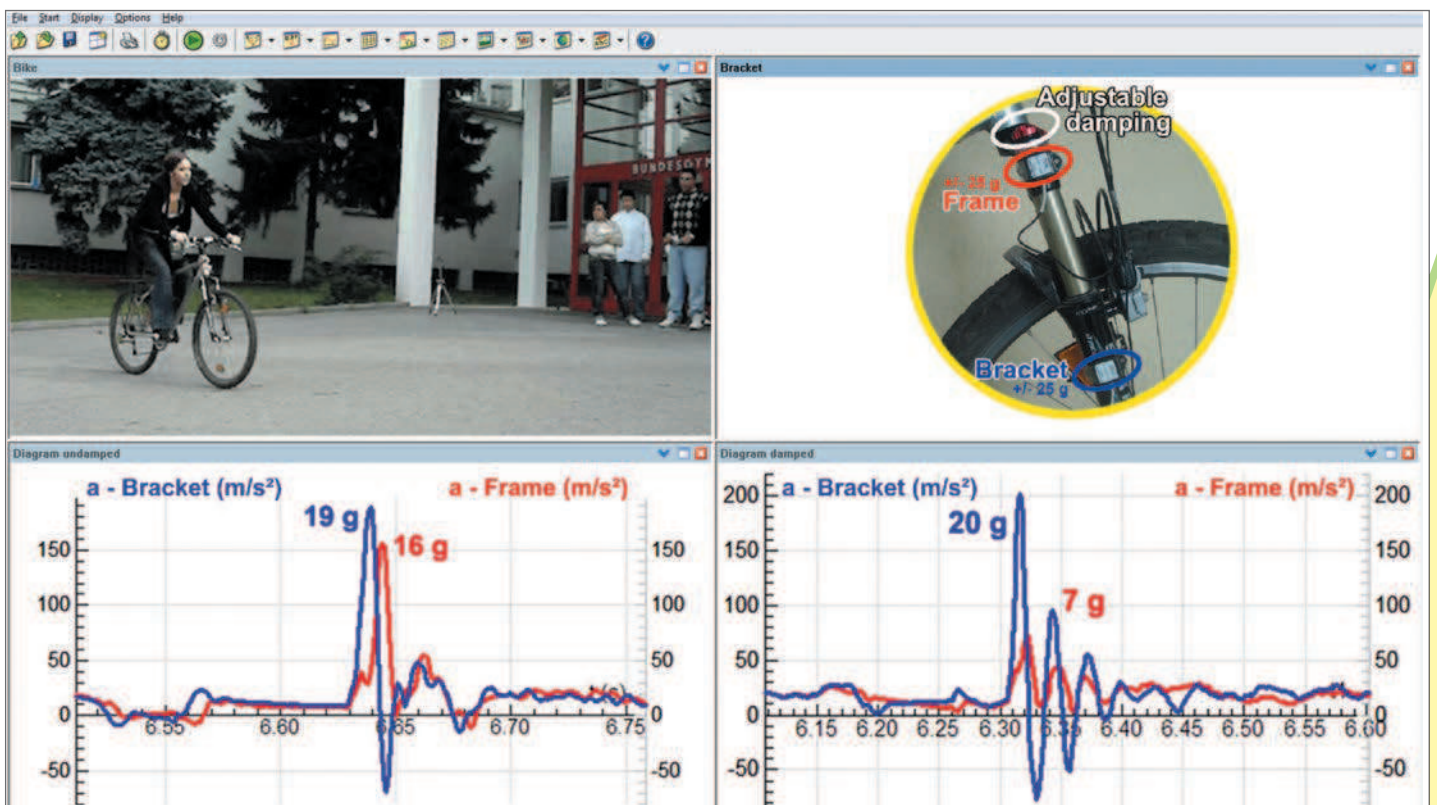
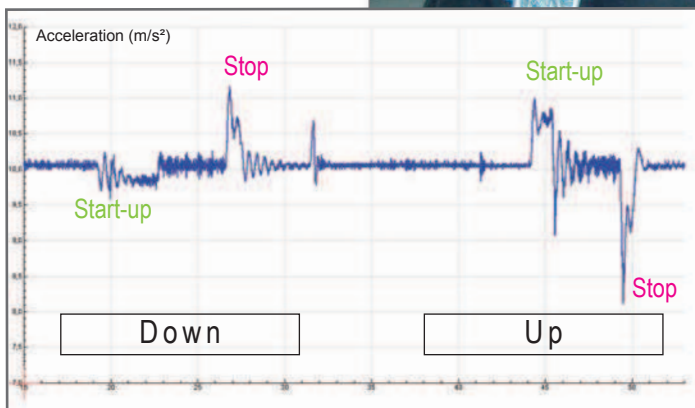
Basic law of dynamics



Elastic collision

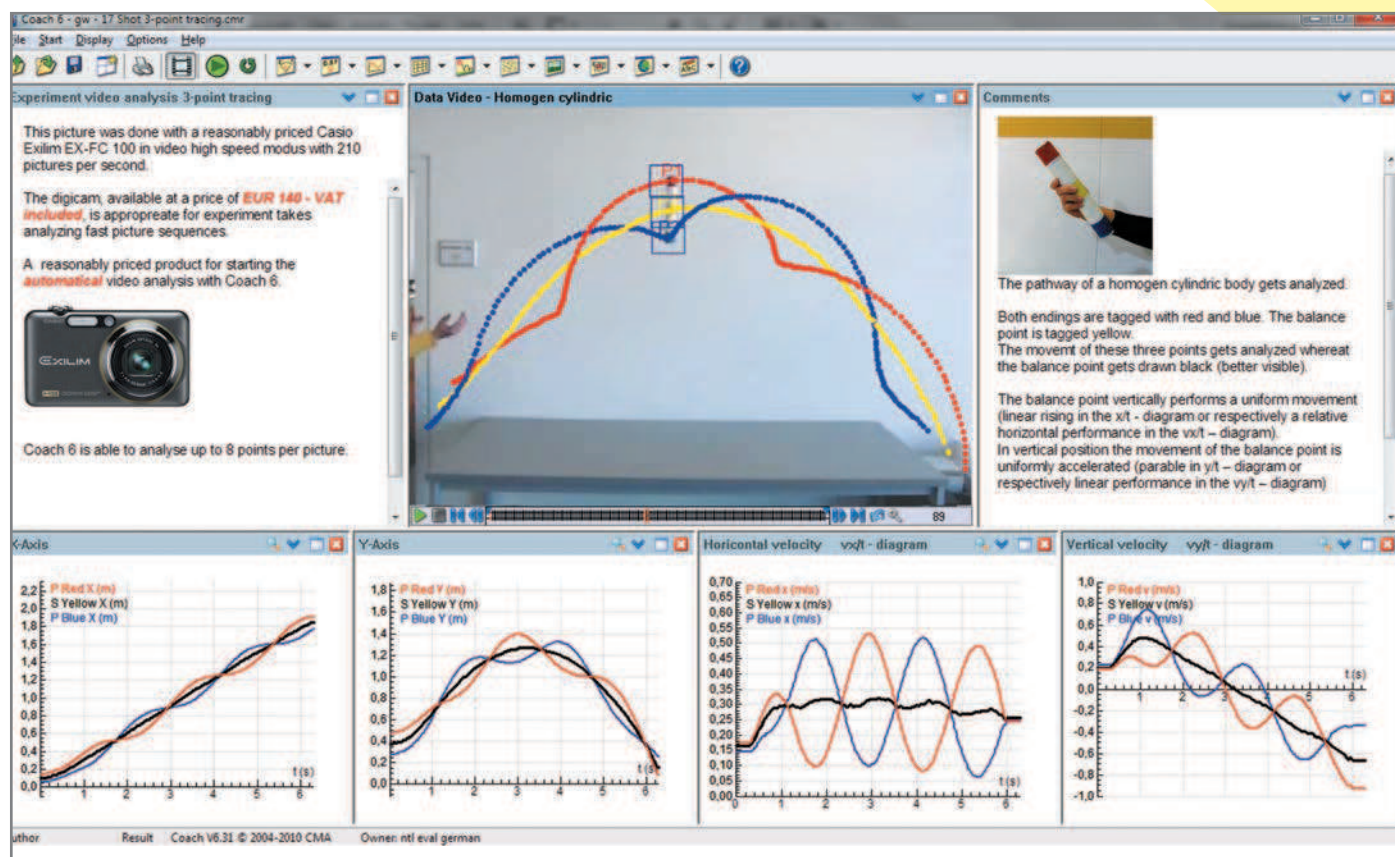


Acceleration in an elevator



Fork-mounted bicycle shock absorber

An important part of the “Coach 6” software (full version) is the video analysis with automatic point tracking.



Synchronous and real-time, manual and automatic

Regardless whether you analyse saved videos or real-time sequences – you will have fun. Make a video in the gym of a basketball match or shot: your students will be excited and curious about the analysis.

Investigate, for example, **the trajectory of a homogeneous cylindrical body** as in our picture above.

The two ends are red and blue and the centre of mass is marked yellow. The movement of these 3 points (**up to 8 points** can be tracked simultaneously) is analysed, with the focus in all diagrams marked black for better visibility. The centre of mass displays uniform motion (linear increase on the x/t diagram or approximately horizontal gradient on the v_x/t diagram) in the horizontal plane. In the vertical plane, the motion of the centre of mass is uniformly accelerated (parabolic curve on the y/t diagram or linear gradient on the v_y/t diagram). The ends describe rolling curves. At horizontal speed, the superimposed sinusoidal velocity change becomes clearly visible.

Video analysis enables measurement and reporting of transactions recorded on video clips, even outside the classroom. These could be ordinary everyday events, such as, for example, the trajectory of a basketball or a ride with the roller coaster.

But it could also include unusual events – such as the impact of a crash-test dummy on an airbag. The location and time data of motion are defined by mouse-click in the frames of the video clip. This data can be displayed in a graph or table and are available for further analyses.

The data can also be compared using analytical functions (fit) or numerical calculations (modelling).

By including events outside the classroom, students learn the importance of science in their own lives and the use of mathematically stated laws to understand nature.

Coach 6 has been developed by the AMSTEL Institute/CMA (Centre for Microcomputer Applications), University of Amsterdam.

Detailed information about

- Software
- Interfaces and
- Sensors

can be found at www.ntl.at/cma

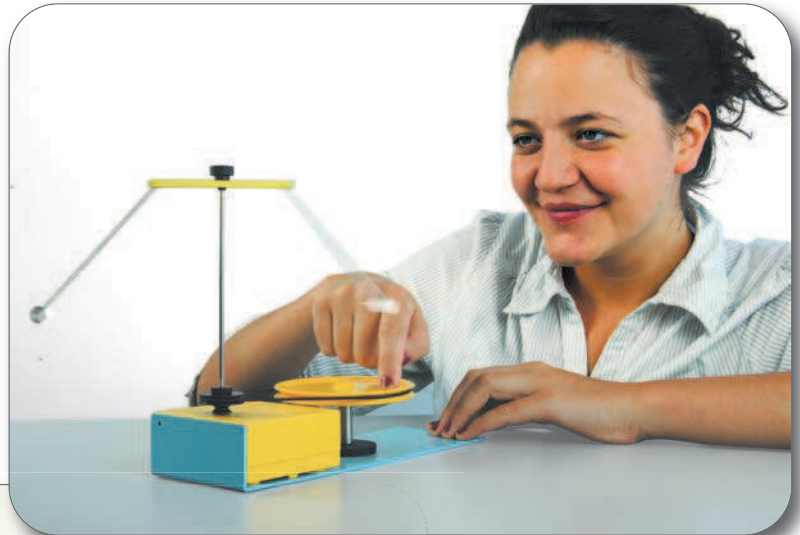
Ordering information

P9901-4R SEK Circular motion
 P9160-5D Experiment manual
 Circular motion

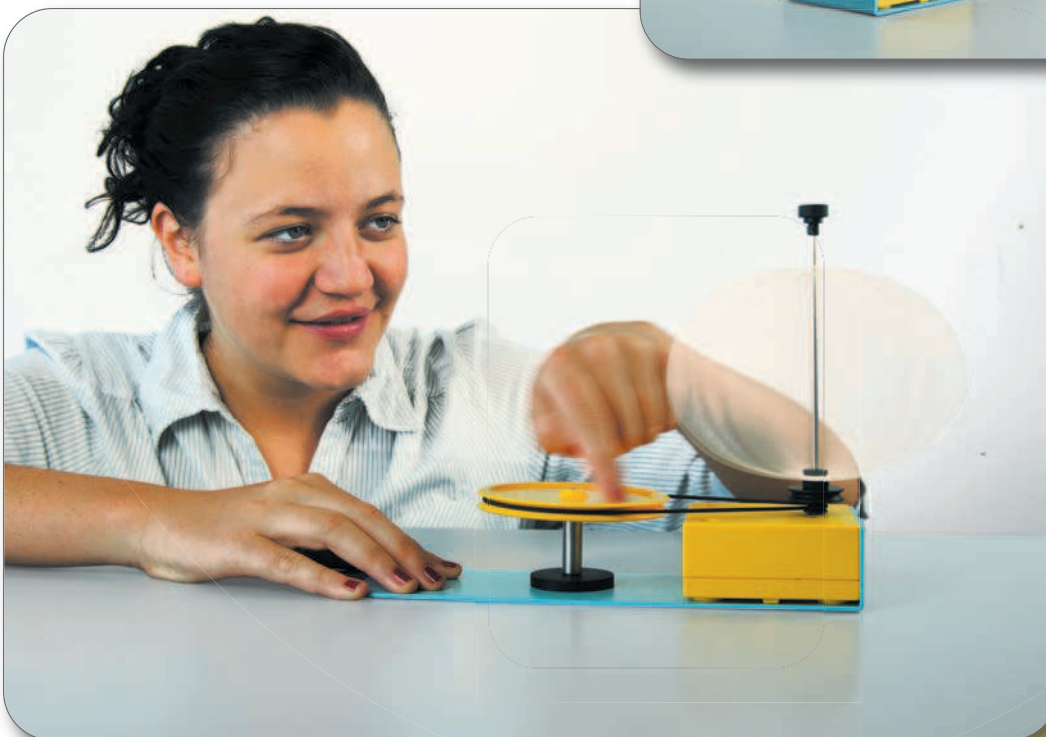


Experiments

- MEC 041 Centrifugal force
- MEC 042 Centrifugal force – suspended balls
- MEC 043 Regulator for centrifugal force
- MEC 044 Centrifugal force – earth flattening rings
- MEC 045 Rotating liquid
- MEC 046 Rotating pendulum (Foucault pendulum)



MEC 041 Centrifugal force



MEC 044 Centrifugal force - earth flattening rings

Kit consisting of:

Qty	Item no.	Description
1	P1340-2E	Centrifugal hoops "compact"
1	P1340-2Z	Watt's governor "compact"
1	P1340-2R	Foucault's pendulum "compact"
1	P1340-2D	Rotating disk "compact"
1	P1340-2C	Locking screw M3, small
1	P1340-2S	Steel balls $\frac{1}{2}$ " (12.7 mm), set of 2



- | | | |
|---|----------|--|
| 1 | P1340-2K | Rotational dynamics paradox/accelerometer "compact"
Centrifugal cuvette and suspended balls combined in one item |
|---|----------|--|



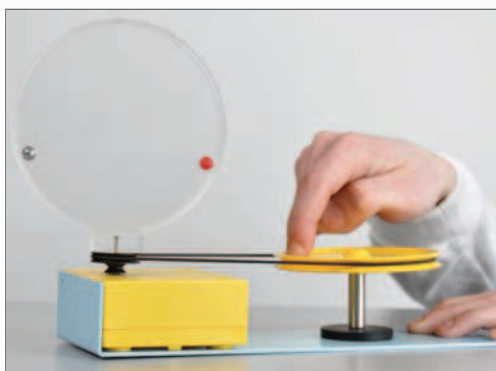
P9901-4R SEK Circular motion

- | | | |
|---|----------|--|
| Drive engine "compact":
Simple, solid hand drive unit consisting of: | | |
| 1 | P1345-1D | MBC pivot bearing with transmission gear |
| 1 | P1345-1M | Magnetic base for drive pulley "compact" |
| 1 | P3410-4A | Drive pulley "compact", D = 100 mm |
| 1 | P3410-5A | Drive belt "compact" |
| 1 | P3410-1A | Assembly platform for MBCs |



- | | | |
|-----------------|----------|---|
| Storage: | | |
| 1 | P7906-4R | Box insert Circular motion, SE |
| 1 | P7806-1K | Storage box II small, with cover
Box insert plan with 2 labels |

MEC 045 Rotating liquid



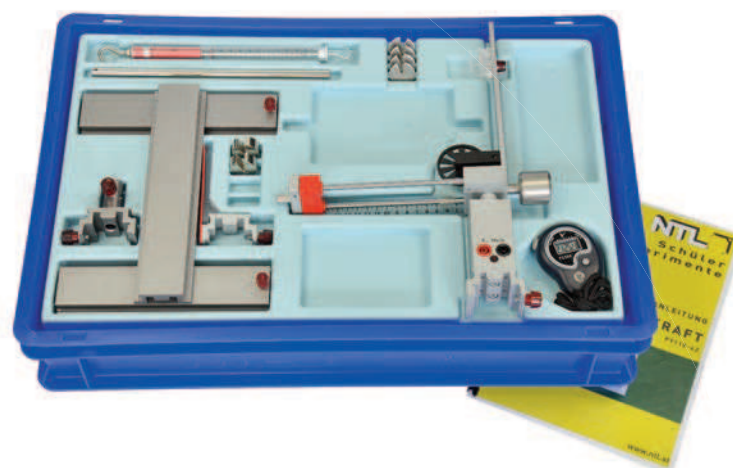
MEC 042 Centrifugal force - suspended balls



Ordering information

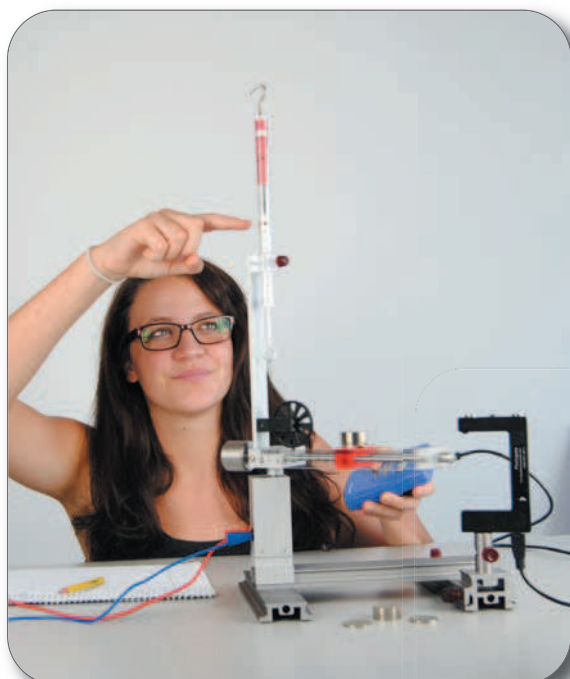
P9902-4Z SEK Centrifugal force

P9160-4Z Experiment manual Centrifugal force

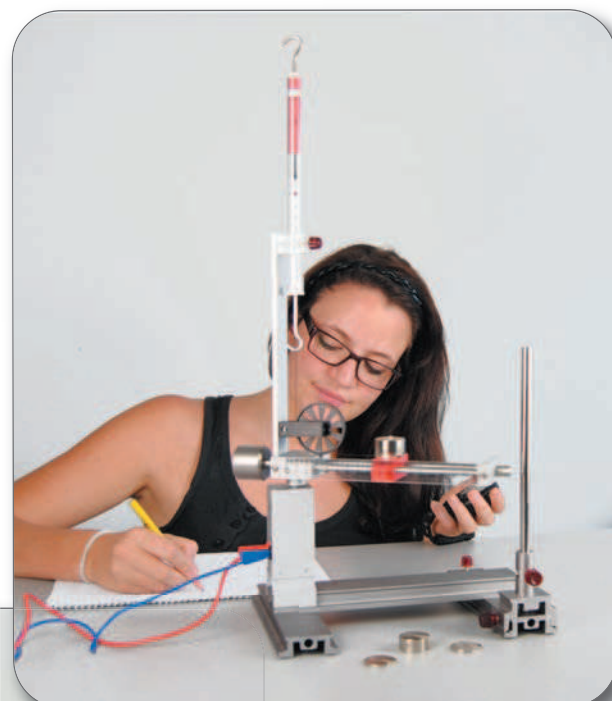


Experiments

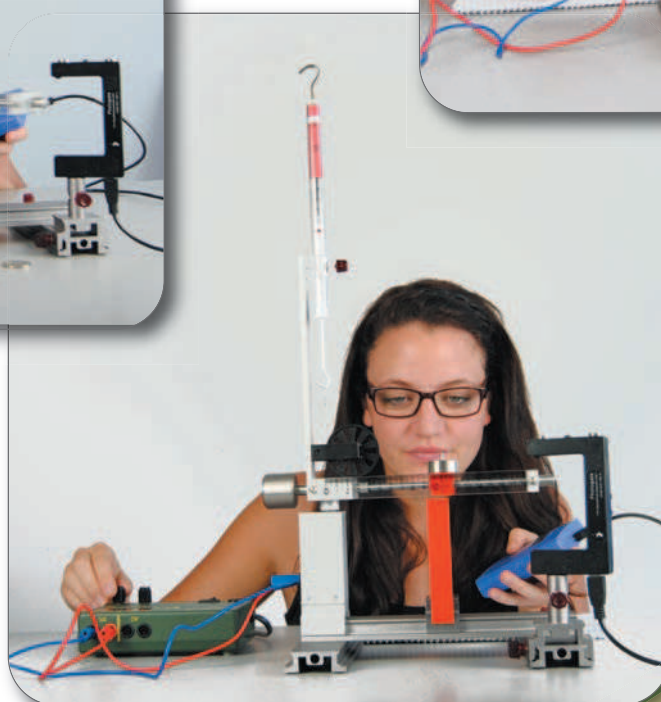
- MRS 2.1 Determination of the centrifugal force as a function of the mass
 MRS 2.2 Determination of the centrifugal force as a function of the radius
 MRS 2.3 Determination of the centrifugal force as a function of the angular velocity



MRS 2.2 Determination of the centrifugal force as a function of the radius



MRS 2.1 Determination of the centrifugal force as a function of the mass



MRS 2.3 Determination of the centrifugal force as a function of the angular velocity

Kit consisting of:

P9902-4Z SEK Centrifugal force

Qty	Item no.	Description
1	P1350-1Z	Centripetal force apparatus with motor
1	DS100-1H	Support base, L = 250 mm H-shaped Solid aluminium base, 250 x 200 mm, with rubber feet, levelling screws and the option of fastening in place using table clamps;
		Sliding saddle with rod serves as a "counting gate":
1	DS103-04	Sliding saddle, H = 40 mm
1	P7240-1C	Support rod, round, L = 250 mm, D = 10 mm
1	P1350-1R	Slider with gate for centripetal force apparatus
2	P1120-2F	Slotted weight, 50 g, SE
4	P1120-2D	Slotted weight, 10 g, SE
1	P1130-1C	Dynamometer 2 N, transparent, Range: 2 N, resolution: 0.02 N
1	P1150-1D	Handheld stopwatch, digital, SE, 1/100 s

Weight for compensation on the opposite of the rotation unit

Motor with solid metal gear in aluminium housing with 4-mm safety jacks, Supply voltage: 0 ... 12 V DC

Transparent holder for dynamometer, low-friction pulley

Sliding weight on ball bearing, visibly painted, 50 g, on 2 precision rods for low-friction motion, with shaft for mounting additional weights

Permanently mounted rotation arm, r (working area) = 50 ... 170 mm, mm scale

Storage:

1	P7906-4Z	Box insert Centrifugal force
1	P7806-1G	Plastic box II large, with cover Box insert plan with 2 labels

Accessories

P1325-9S Counter with 2 light gates

- Counter, digital, SE
Solid, handy counter with LC display, digit height 12.5 mm
Accuracy 10 ms, battery-powered
Modes: stopwatch / start – stop / gate
- 2 light gates
Bracket width: 78 mm
- 2 connection cables
L = approx. 135 cm each



module Forces and torque

Ordering information

P9901-4A	SEK Rail stand material
P9902-4P	SEK Forces and torque
P9160-4P	Experiment manual Forces and torque



Kit consisting of:

Qty	Item no.	Description
1	DM355-5A	Force table For quantitative demonstration of the resolution of forces. Metal working disk, D = 200 mm, painted white, with precise graduations. Using a support rod fastened through the centre hole (D = 10 mm), the table is mounted on available support material. Up to 4 pulleys can be fastened to the edge at any angle. Weights can then be suspended from strings running along the pulleys.
4	DM355-5S	Pulley, plastic, very low friction with holder and set screw for mounting on tables and tracks; the pulley with bracket is continuously variable and may be fastened in any position
4	P1120-2C	Holder for slotted weights, 10 g, SE
8	P1120-2F	Slotted weight, 50 g, SE
8	P1120-1E	Slotted weight, 20 g, SE
8	P1120-2D	Slotted weight, 10 g, SE
4	P1120-2B	Slotted weight, 5 g, SE
1	DM355-5M	Torque accessory for force table For experiments with torque; acrylic disk, D = 160 mm, with centre axis on ball bearings for mounting on the force table; 4 rows with 3 metal pins each at 90° to each other, 25, 50 and 75 mm from the centre point, for fastening the strings (included) running over the pulleys deflecting force over the edge of the force table
1	DM355-5Z	Additional weight for torque accessory

Storage:

1	P7906-4P	Box insert Forces and torque, SE
1	P7806-1K	Storage box II small, with cover Box insert plan with 2 labels

Experiments

MEK 1.1	Composition of several forces
MEK 1.2	Force direction and application point
MEK 2.1	Torque – equilibrium
MEK 2.2	Torques with different application points

MEK 3.1 *	Rotary motion – uniformly accelerated
MEK 3.2 *	Moment of inertia and angular acceleration

The measurements marked with a * can only be recorded using interface and sensor (refer to the next page).



Equilibrium of torques



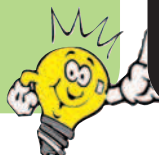
Composition of several forces

Computer-assisted data logging

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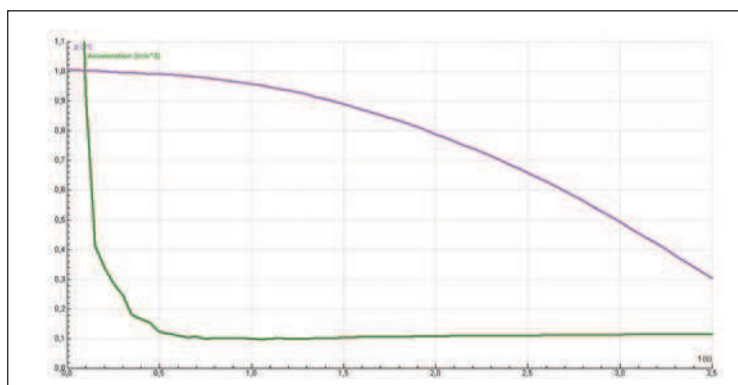
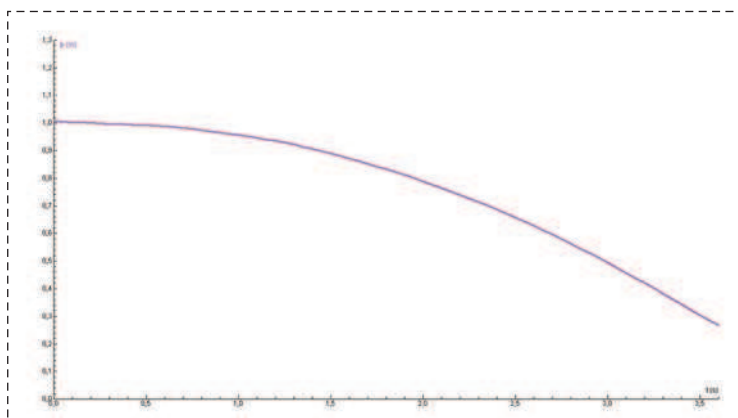
Supplement to the Forces and torque module

In contrast to conventional measurement methods, such as light gates, moving objects can be scanned 20 times per second with the help of a motion detector. The results can then be represented in graphic form or, if required, exported to a chart for further processing.

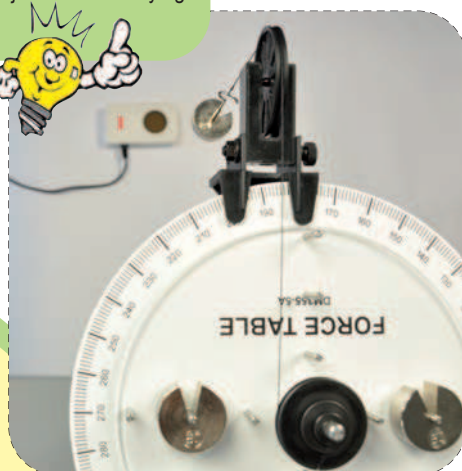


Ordering information

P4910-1U ULAB datalogger, USB, serial,
incl. Coach 6 Lite
P4210-5B Sensor motion 0.2 ... 6 m



By mounting additional weights, the moment of inertia of a rotating body can be easily varied. To achieve this, the additional weight DM355-5Z or slotted weights can be added. The drive pulley, positioned at centre, allows adjustment to varying radii.



Demonstration of the law of angle and time in uniformly accelerated rotary motion

Ordering information

P9902-4V SEK Air pressure
 P9160-4V Experiment manual Air pressure



Experiments

- MELS 01 Demonstrating the existence of air pressure
- MELS 02 "Magdeburg Hemispheres"
- MELS 03 Air pressure measurement
- MELS 04 Air pressure effect – external pressure diminished
- MELS 05 Air pressure effect – water boils at 60 degrees
- MELS 06 Air pressure effect – internal pressure diminished
- MELS 07 Free fall – free fall tube
- MELS 08 Transmission of sound in a vacuum
- MELS 09 Boyle – Mariott Law
- MELS 10 * Determination of the weight of air



MELS 04 Air pressure effect - external pressure diminished



MELS 09 Boyle - Mariott Law

- * Note:
 A balance is required for performing the experiment
 "determination of the weight of air";
 range: 500 g min; accuracy: 0.1 g min.



MELS 08 Transmission of sound in a vacuum

Kit consisting of:

Qty	Item no.	Description
1	P1522-1S	Signaller (alarm annunciator)
1	P1522-1T	Sound-absorbing pad, D = 80 mm
1	P1522-1M	"Magdeburg disks", SE, rubber, pair
1	P1410-1L	Balloons, set of 2
1	P1410-1K	Clamp for balloons
1	P1530-1B	Bubble burster, SE
1	P1530-1C	Plastic film for bubble burster, set of
1	P1530-1D	Capsule plastics with cover, D = 75 mm
1	P1560-1F	Free-fall tube SE, L = 35 cm, with free-fall bodies Acrylic tube, with gasket ring, for mounting on the cover of vacuum chamber P1520-2G, set of free-fall bodies (feather, wool, plastic and steel ball) included; Dimensions: D = 50 mm, L = 350 mm

1	P1520-2G	Vacuum chamber complete, 1000 ml, with manometer Solid cylindric vacuum chamber, with gasket ring; Cover with permanently mounted ventilation valve, barometer 0 ... 1000 hPa; volume: 1000 ml
1	C6100-2G	Syringe, plastic, 120 ml, for vacuum experiments Gas syringe made of durable plastic, well-sealed, smooth-running piston with solid grip; 2 adapters for connecting with plastics tube D = 6mm (outer dimension); clearly readable printed scale; volume: 120 ml
1	C1520-1S	Vacuum hose, plastic, SE, 300 x 6 mm Plastic tube, suitable for investigating overpressure and underpressure, highly flexible; D(ext.) = 6 mm; D (int.) = 4 mm

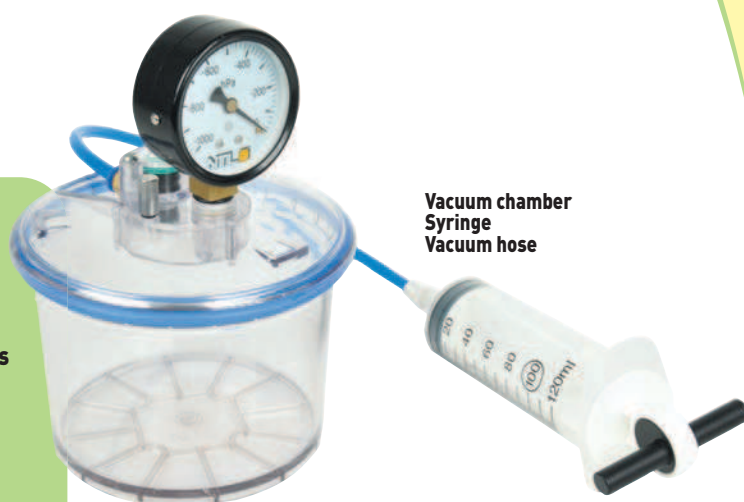
1	P1515-1B	Manometer SE, for Boyle-Mariotte experiment For analysing the relationship between pressure and volume of gas at a constant temperature; manometer with easily readable scale, range: -1000 ... +3000 hPa. Plastic cylinder with cone inside for attaching syringe C6100-2G
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Storage:

1	P7906-4V	Box insert Air pressure
1	P7806-1K	Storage box II small, with cover Box insert plan with 2 labels



P9902-4V SEK Air pressure



Manometer

Accessories

DM125-3C Digital balance, electronic, 2000/0.1 g

Digital precision balance with tare function
Weighing range: 0 ... 2000 g
Resolution: 0.1 g, battery powered
Weighing surface dimensions: 100 x 95 mm



module Vibrations and waves

Ordering information

P9901-4A	SEK Rail stand material
P9901-4B	SEK Mechanics 1
P9901-4S	SEK Vibrations and waves
P9160-4S	Experiment manual Vibrations and waves



Experiments

1. VIBRATIONS:

- SWS 1.1.1 Oscillation period of a simple pendulum
- SWS 1.1.2 Oscillation period of a coil spring pendulum
- SWS 1.1.3 Oscillation period of a flat spring
- SWS 1.2 Path time chart of harmonic oscillation
- SWS 1.3 Measuring acceleration due to gravity
- SWS 1.4.1 Resonance of a simple pendulum
- SWS 1.4.2 Resonance of a coil spring pendulum
- SWS 1.4.3 Resonance of a flat spring
- SWS 1.5 Principle of a resonant vibrating-reed frequency meter
- SWS 1.6 Dynamic measuring of a spring constant

2. WAVES:

- SWS 2.1 Stationary transverse wave
- SWS 2.2 Stationary longitudinal wave
- SWS 2.3 Reflection of waves at their fixed and loose ends



SWS 2.1 Stationary transverse wave



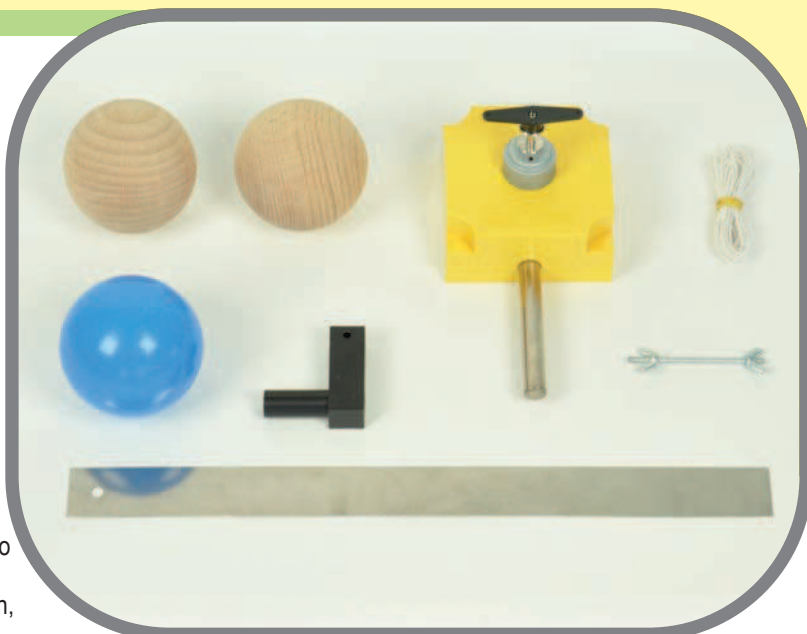
SWS 1.1.1 Oscillation period of a simple pendulum

Kit consisting of:

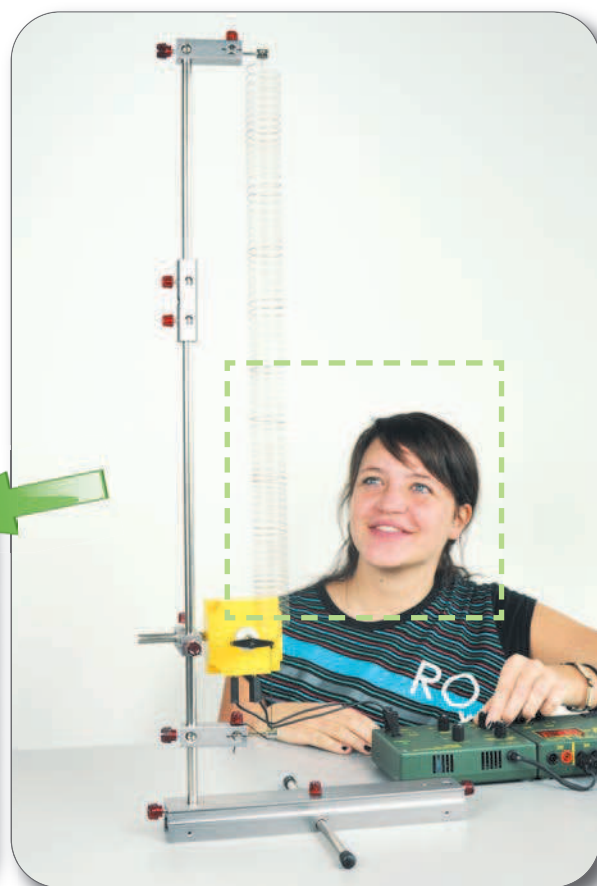
Qty	Item no.	Description
1	P1810-3A	Rubber string, 3 m
1	P1810-1D	Flat spring, steel, 0.6mm, L = 300 mm
1	P1810-1F	Holder for pencil
1	P1810-1G	Threaded rod with wing nut for connecting the pencil holder to the steel flat spring
2	DM386-1H	Pendulum ball with hook, wooden, D = 60 mm
1	DM386-1K	Pendulum ball with hook, plastic, D = 60 mm
1	P1825-1A	Motor with toggle for oscillation tests, used to generate transverse and longitudinal waves; recommended as drive unit for function generator

Storage:

1	P7906-4S	Box insert Vibrations and waves, SE
1	P7806-1S	Storage box II mini with cover Box insert plan with 2 labels



P9901-4S SEK Vibrations and waves



SWS 2.2 Stationary longitudinal wave

Accessories

P1325-9S Counter with 2 light gates, set

- Counter, digital, SE
Solid, handy counter with LC display,
digit height 12.5 mm
Accuracy 10 ms, battery-powered
Modes: stopwatch / start – stop / gate

- 2 light gates
Bracket width: 78 mm
- 2 connection cables
L = approx. 135 cm each



P3120-3F Function generator

Please refer to page 57 for technical details



P1150-1D Handheld stopwatch, digital, SE, 1/100 s

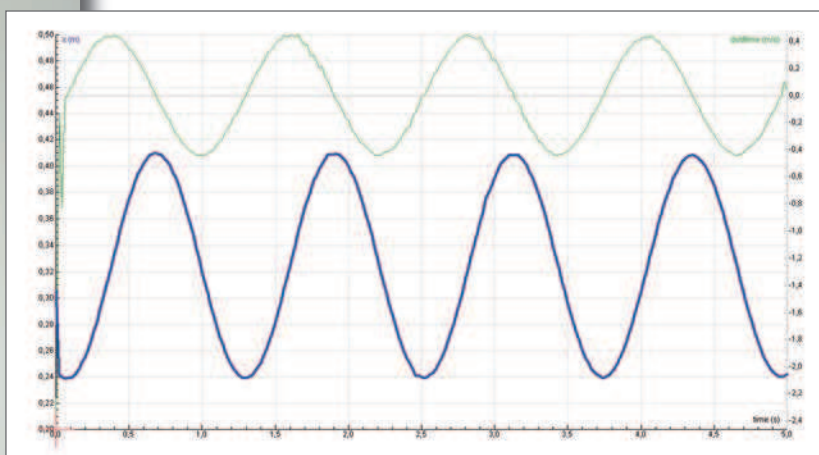
Ranges: 1 / 100 sec. to 30 min., 1 sec. to 24 h, with alarm, battery included

Ordering information

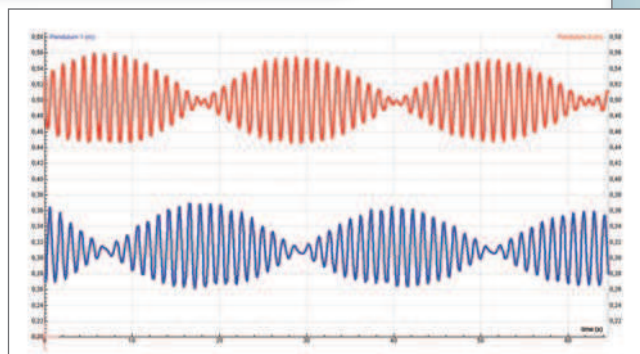
P4910-1U ULAB datalogger, USB, serial,
incl. Coach 6 Lite
P4210-5B Sensor motion 0.2 ... 6 m

Supplement to the Vibrations and waves module

In contrast to conventional measurement methods, such as stop watches or light gates, moving objects can be scanned 20 times per second with the help of a motion detector. The results can then be represented in graphic form or, if required, exported to a chart for further processing.



Oscillation period of a coil spring pendulum

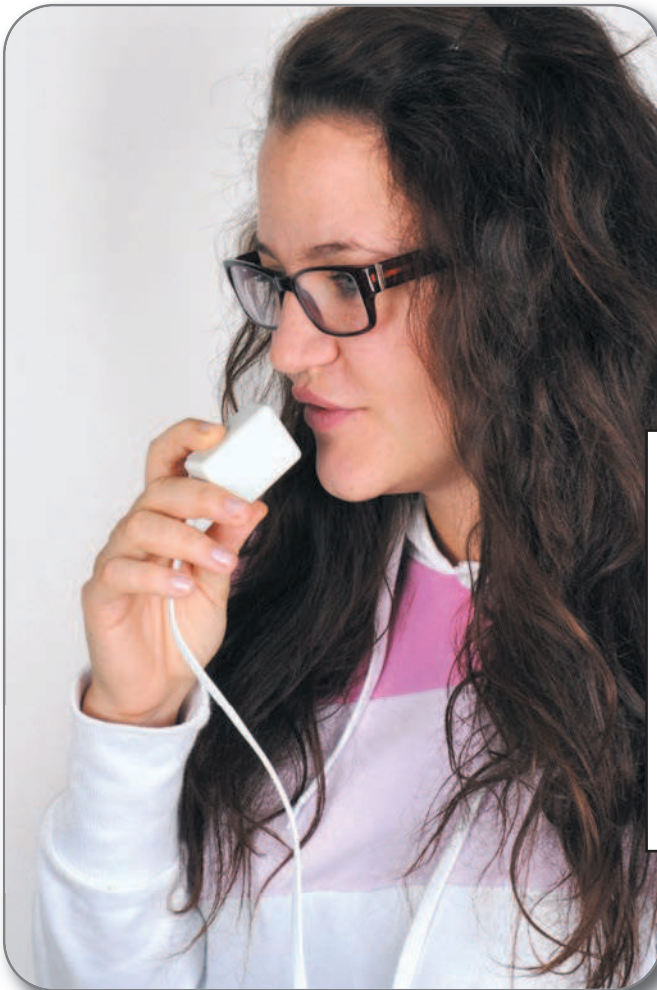


Coupled pendulum

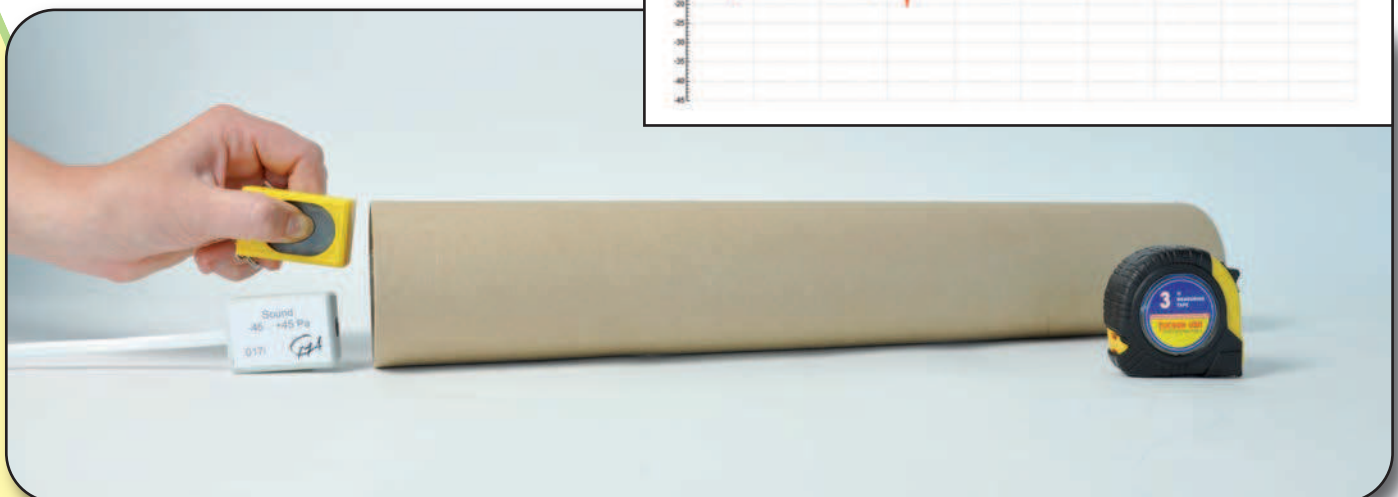
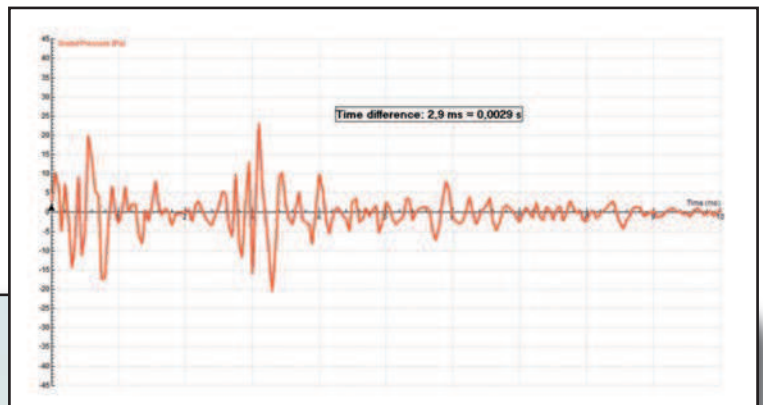
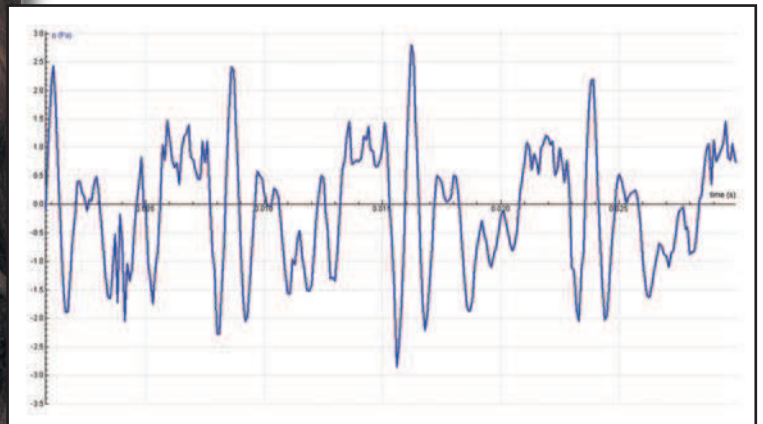


Ordering information

P4910-1U	ULAB datalogger, USB, serial, incl. Coach 6 Lite
P4210-1A	Sensor sound, -45 ...+45 Pa



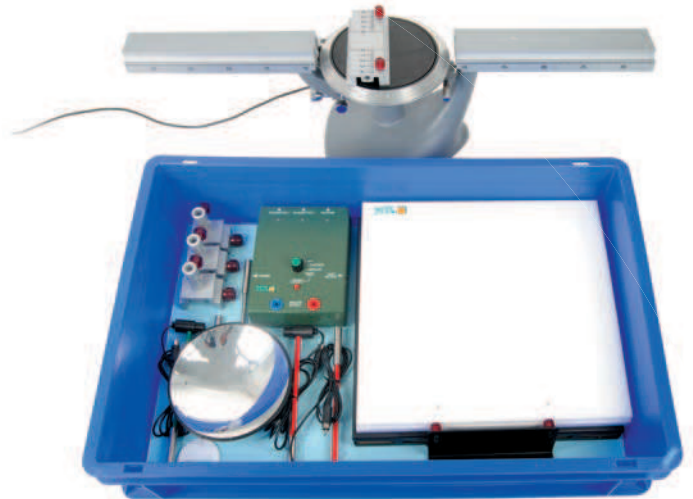
Recording the human voice



Measuring the speed of sound (Echo-method)

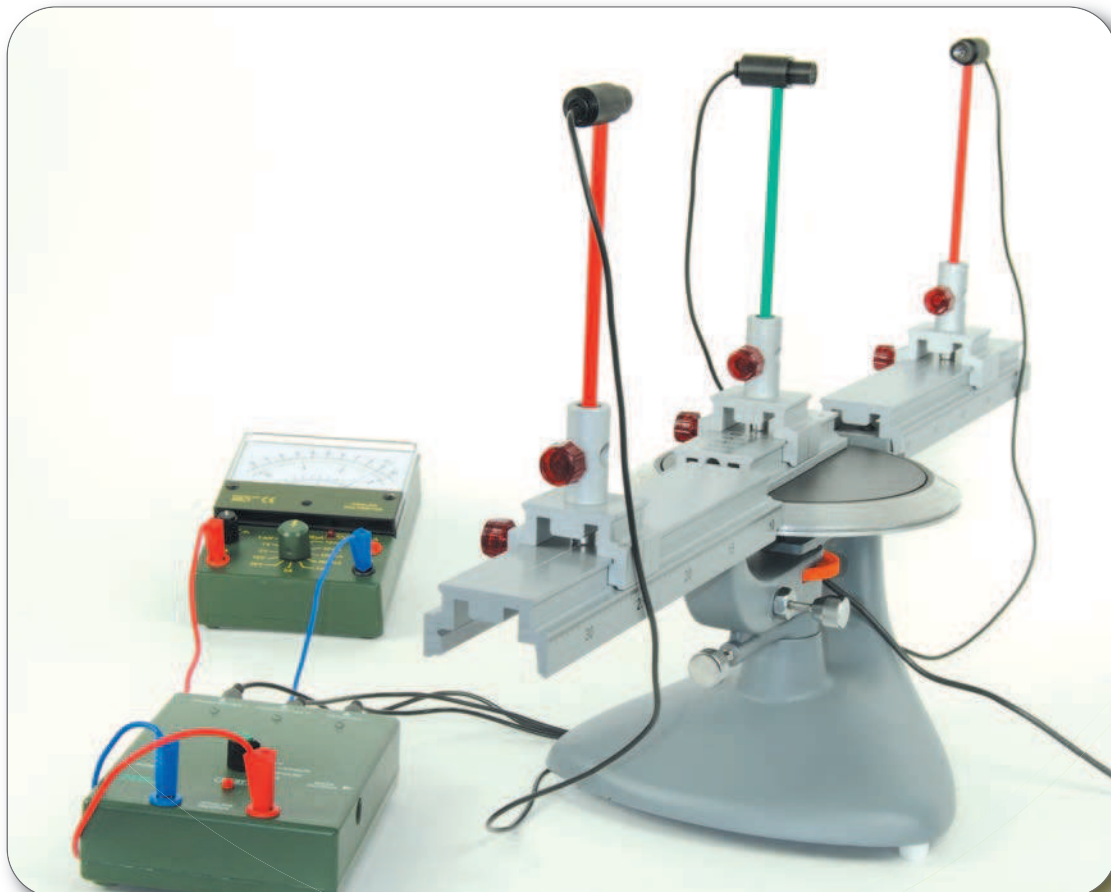
Ordering information

P9901-4U SEK Ultrasonics
 P9160-4U Experiment manual Ultrasonic



Experiments

- | | | | |
|-------|--|-------|---|
| US 01 | Transmitter – radiation characteristics | US 11 | Diffraction at a simple slit |
| US 02 | Receiver – characteristics | US 12 | Diffraction at a double slit |
| US 03 | Bundling of waves – effect of a parabolic mirror | US 13 | Diffraction at a circular aperture (round hole) |
| US 04 | The parabolic mirror as transmitter | US 14 | Diffraction at a circular plate |
| US 05 | Ambient noise | US 15 | Diffraction at Fresnel lenses |
| US 06 | Superposition principle | US 16 | Interference through two transmitters |
| US 07 | Reflection | US 17 | Lloyd experiment |
| US 08 | Absorption | US 18 | Stationary waves through two transmitters |
| US 09 | Absorption of sound in air | US 19 | Stationary waves through reflection |
| US 10 | Diffraction at a barrier | US 20 | Wave length – speed of sound |



US 18 Stationary waves through two transmitters

Kit consisting of:

Qty	Item no.	Description
1	P1860-1B	Ultrasonic control unit
2	P1860-1S	Ultrasonic transmitter
1	P1860-1E	Ultrasonic receiver
1	P1860-1G	Ultrasonic goniometer
3	P1861-1R	Slider with clamping post 40 mm
1	P1865-BS	Ultrasonics screens, set, with bracket
1	P1865-BR	Ultrasonics screen frame for absorption experiments
1	P1865-1P	Ultrasonics parabolic mirror

Storage:

1	P7906-4U	Box insert Ultrasonics
1	P7806-1G	Storage box II large, with cover Box insert plan with 2 labels

P1860-1S Ultrasonic transmitter

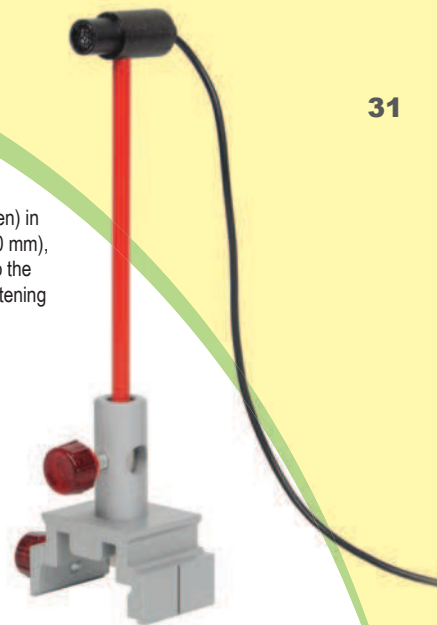
P1860-1E Ultrasonic receiver

Ultrasonic transmitter (red) and –receiver (green) in housing with painted metal stand rod (D = 6/10 mm), shielded cable with RCA plug for connection to the control unit. NTL sliders are required when fastening to the arms of the goniometer.

Operating frequency: 40 kHz (typ.)

Max. operating voltage: 20 Vpp

Axis height: 180 mm



P1860-1B Ultrasonic control unit

Electronic control unit consisting of a quartz-controlled transmitter (40 kHz) with two output ports as well as one input port with amplifier and commutator.

Modes:

- **CONTINUE:** Output signal is continuously transmitted (for diffraction, superposition and absorption experiments)
 - **IMPULSE:** Output signal is transmitted as a pulsation (for distance measurement, sonar principle etc., in conjunction with an oscilloscope)
 - **SHOT:** Non-recurring pulsation transmission when button is pushed (for time and distance measurements, in conjunction with an oscilloscope)
- Output and input ports have LEDs to indicate when a signal is transmitted or received as well as to indicate the battery status or overmodulation status of the receiver.
- Analogue output via two 4-mm safety jacks
 - Data output for oscilloscope, counter or computer

Voltage supply:

Battery-powered (9 V battery included) or external supply via mains transformer P3130-1P

Dimensions: approx. 160 x 120 x 40 mm; weight: approx. 310 g



P1860-1G Ultrasonic goniometer

- Solid and durable metal base with one permanently mounted arm
- Second arm rotatable on low-friction metal axis, with setting and fine-adjustment screw
- Both arms with special NTL profile and mm-scale for the accurate positioning of sliders
- Angular scale, D = 170 mm, rotatable and fixable independent of the arm, vernier readings; usable angle: 70.0 ... 310.0° min
- Angular scale-plate with special NTL profile for mounting screens or sliding saddles

Dimensions: approx. 68 x 22 x 19 cm

Weight: approx. 4130 g

An integrated gear-driven potentiometer enables evaluation of the angular position using a PC and suitable software (e.g. Coach 6)



P1865-BR Ultrasonics screen frame

For absorption experiments

Metal frame for mounting various materials for experiments involving absorption or reflection, for materials with a maximum size of 297 x 297 x 28 mm

For mounting onto the angular scale of the goniometer



P1865-BS Ultrasonics screens, set, with bracket

Acrylic screens, 30 x 30 cm:

- Full screen
- Screen with double slit
- Screen with single slit
- Half screen
- 2 Fresnel apertures
- Screen with hole
- Circular screen on support

The bracket is required for mounting on the angular scale (not shown).



US 12 Diffraction at a double slit



US 08 Absorption of sound waves by different materials

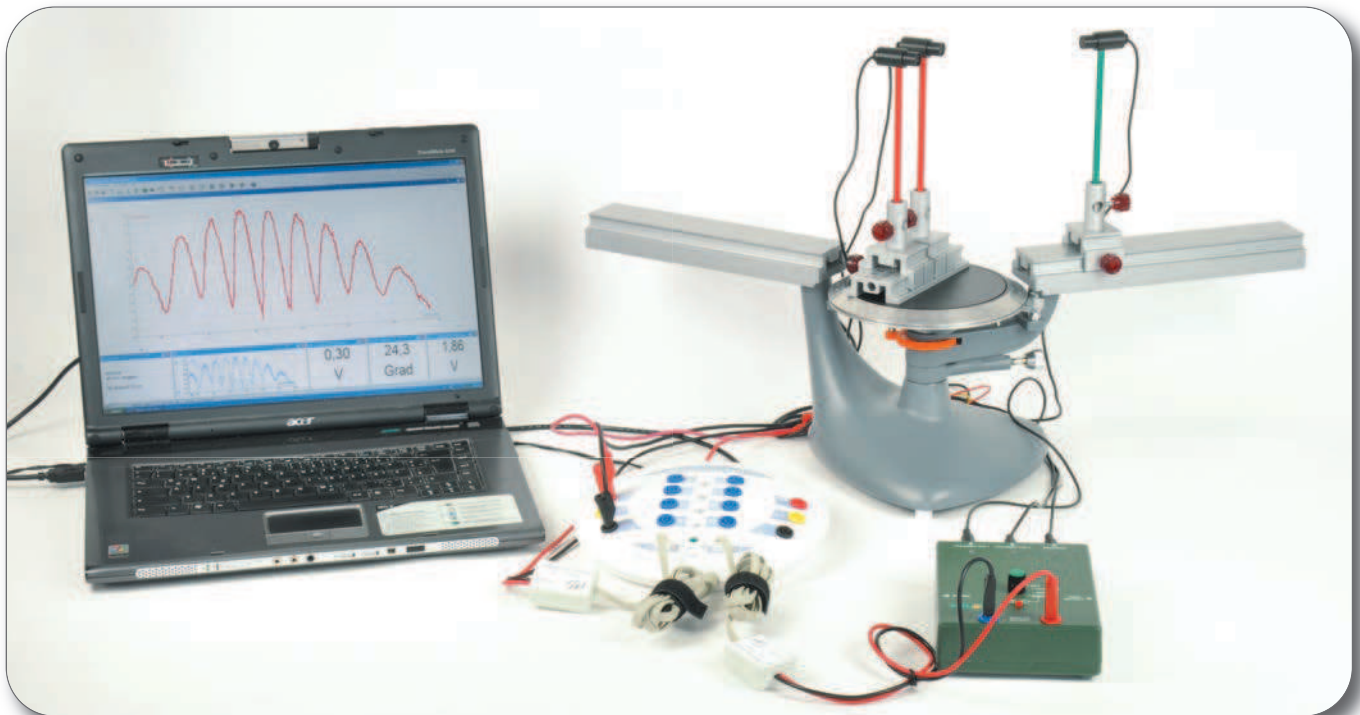
Computer-assisted data logging

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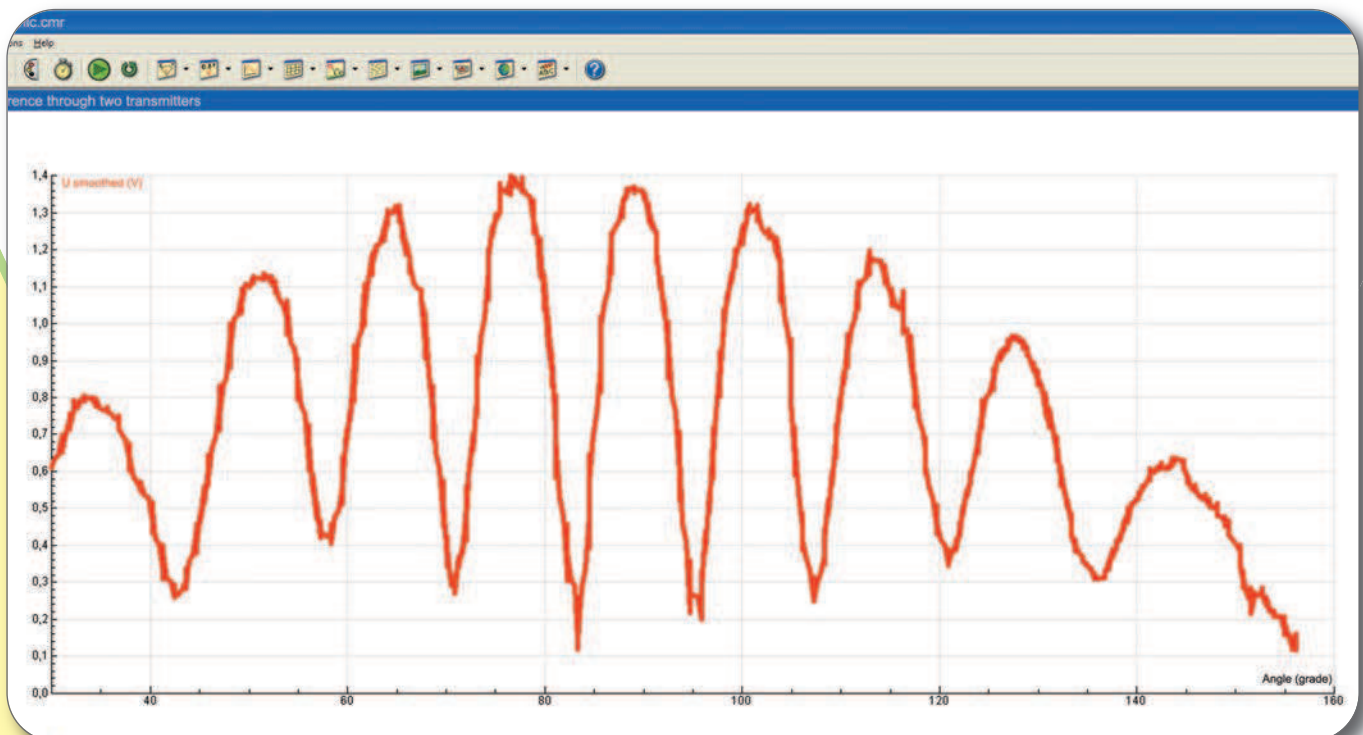
Supplement for the Ultrasonics module:

Ordering information

- P4910-1C CoachLab II+ interface, USB, incl. Coach 6 Lite
P4210-2S Sensor differential voltage, -10 .. +10 V



US 16 Interference by two transmitters



Ordering information

P9901-4A	SEK Stand rail material
P9902-4C	SEK Heat 1
P9160-4C	Experiment manual Heat 1



Experiments

1. THERMAL EXPANSION:

TDS 1.1	Model of a thermometer
TDS 1.2	Calibration of thermometer scales
TDS 1.3	Bimetal
TDS 1.4	Linear expansion of solid materials
TDS 1.5	Volume change of liquids
TDS 1.6	Volume change of air at constant pressure
TDS 1.7	Pressure change of air at constant volume
TDS 1.8	Thermal conduction
TDS 1.9	Heat flow
TDS 1.10	Heat radiation
TDS 1.11	Thermal protection

2. CHANGE OF AGGREGATE STATES:

TDS 2.1	Mixing temperature
TDS 2.3	Specific heat of solid materials
TDS 2.3.1	Calculation of the specific heat of solid materials
TDS 2.4	Melting temperature
TDS 2.4.1	Melting heat
TDS 2.5	Freezing mixture
TDS 2.6	Solidification heat
TDS 2.7	Boiling temperature
TDS 2.7.1	Evaporation heat
TDS 2.8	Distillation



TDS 2.8 Distillation



TDS 2.7 Boiling temperature



TDS 1.4 Linear expansion of solid materials



TDS 1.10 Heat radiation

Kit consisting of:

Qty	Item no.	Description
1	P7400-4A	Graduated cylinder, plastic, 100 ml
1	P2620-3B	Bodies for heat radiation, set of 2 White and black
1	P2420-1A	Bimetal strip, SE
1	P7090-2A	Wax crayon
2	P7132-1A	Tubing, plastic, 100 cm, transparent
2	P7400-1C	Manometer tube, acrylic, D = 8 mm, L = 200 mm, for manometer
1	P2610-2A	Needle, steel, right-angled
1	P2610-2B	Spirals for heat radiation, set
1	P7230-4H	Holder for dynamometers and test tubes, SE
1	P2600-5C	Wax straps
1	P7422-2B	Glass tube, straight, L = 80 mm



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- 1 P7250-1T **Support rings SE, set of 3**
 D = 102 mm: bracket for wire gauze
 D = 62 mm: bracket for the beaker
 D = 35 mm: bracket for Erlenmeyer flask
 These 3 support rings ensure the highest standard of safety when working with hot liquids



- 1 P7125-1B Wire gauze with ceramic centre, 150x150 mm
 1 C1010-1D Beaker glass, 250 ml, tall form, Boro
 1 C3020-4B Erlenmeyer flask, glass, 100 ml, SB 19

- 1 P2400-1A **Tube for heat expansion, aluminium**
 1 P2400-1B **Tube for heat expansion, iron**
 2 P2400-1C **Pointer with plug, for heat expansion**
 1 P2400-2F **Slider with setting for heat expansion**
 1 P5310-3F **Slider for pointers for heat expansion**



- 2 C1050-1C Test tube, glass, 16x160 mm, borosilicate glass
 1 P7030-2A Petroleum, scented, 50 ml
 1 P7020-4A Sodium thiosulfate, 200 g
 1 P7050-1A Powder dye, red
 2 C7320-1D Stopper, silicone, 12/18/27 mm, 1 hole
 1 C7320-2B Stopper, silicone, 17/22/25 mm, 1 hole, SB 19
 1 C7320-2C Stopper, silicone, 17/22/25 mm, 2 holes, SB 19
 1 P1120-3A Aluminium block
 1 P1120-3D Iron block with hook, small
 1 P2700-3D Insulating flask with lid
 Consisting of 2 aluminium beakers (volumes: 150 and 700 ml), insulating beaker, transparent lid, stoppers for supporting thermometers and stirrers
 1 P7240-1G Support rod, round, L = 500 mm, D = 10 mm

- 2 P2220-1A **Thermometer -10...+110/1 °C, graduated**
 1°C increments, filled with alcohol
 1 P2220-9A **Thermometer -10...+110/1 °C, non-graduated**
 filled with alcohol



Storage:

- 1 P7906-4C Box insert Heat 1, SE
 1 P7806-1G Storage box II large, with cover
 Box insert plan with 2 labels

P9902-4C SEK Heat 1



NTL support rings ensure safety

Thermometer and stirring thermometer
 With triangular markers, prevent rolling



Simultaneous demonstration of heat expansion in an aluminium and an iron tube



Accessories



C7414-2B Hot plate small, 500 W
 Hot plate, electric, D = 93 mm, with continuously variable heat regulation and protection against overheating
 Input voltage: 230 V / 50 ... 60 Hz
 Dimensions: approx. 135 x 65 mm
 Weight: approx. 0.7 kg

P2110-1A Gas cartridge burner
 Bunsen burner for use with pierced gas cartridges or with valve connector, includes needle valve and air regulator (supplied without cartridge)
 D = 114 mm, H = 185 mm

P2110-1C Gas cartridge

P2110-1V Gas cartridge with valve
 210 g, propane-butane mixture in a safety tank in acc. with the EN417 standard



C4350-1A Thermometer SE, digital, 200 °C
 Digital precision thermometer, metal sensor, L = 125 mm, incl. protective cap; 6-mm LC display
 Measuring range: -40 ... +200 °C (-40 ... +392 °F); accuracy: +/-1 °C; resolution: 0.1 °C
 Functions: hold, maximum and minimum temperature, battery-powered, automatic shutdown



Ordering information

P9902-5C SEK Heat 2
P9160-5C Experiment manual Heat 2



Experiments

2. CHANGE OF AGGREGATE STATES

TDS 2.2 Specific heat of water

3. MEASURING HEAT QUANTITATIVELY

TDS 3.1 Thermal expansion of gases in quantitative terms
Gay-Lussac law (absolute zero point)

TDS 3.2 Thermal conduction of solids in quantitative terms

TDS 3.3 Thermal radiation in quantitative terms

TDS 3.4 Thermal absorption in quantitative terms

4. WORK AND POWER

ELS 4.2.1 Heat emission and amperage

ELS 4.2.2 Electrical thermal equivalent

ELS 4.3 Water equivalent

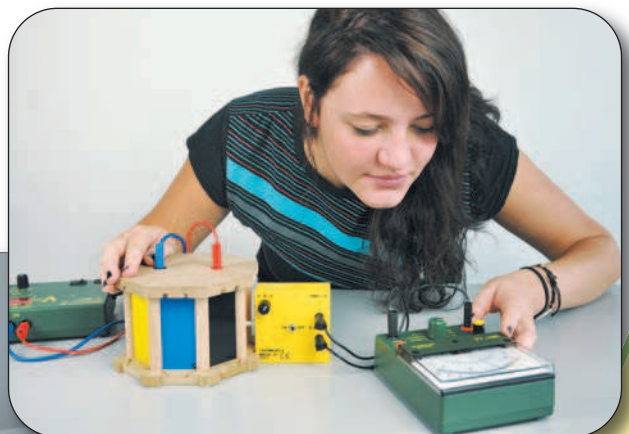
5. CONVERSION OF ENERGY

TDS 5.1 Conversion of heat into
electrical energy

TDS 5.2 Thermoelectrical cooling,
"Peltier effect"



TDS 2.2 Specific heat of water



TDS 3.3 Thermal radiation in quantitative terms (Leslie-Cube)



TDS 5.2 Thermoelectrical cooling, "Peltier effect"

Kit consisting of:

Qty Item no. Description

- | | | |
|---|----------|---|
| 1 | P2700-2D | Joule's calorimeter, universal
2 aluminium beakers, volume: 150 and 700 ml
separated by an insulating beaker,
transparent lid with immersion heater
cascade: 2 / 4 / 6 ohms;
power supply: 6 V / 2 A; stopper
for thermometer, stirrer included |
| 1 | P2700-2E | Lid with stoppers for calorimeter
Acrylic, with 4 stoppers,
D = approx. 108 mm |
| 1 | P2714-1S | Rods for thermal conduction, set of 4
Rods with front hole for supporting
thermometers, with silicone stopper, for
inserting in lid P2700-2E;
Material: Al, Fe, Cu, glass;
Dimensions: 150 x 8 mm each |
| 1 | P2712-1K | Sphere for Gay-Lussac experiment
Hollow metal sphere, D = 60 mm, with threaded hole |
| 1 | P2712-1M | Manometer for Gay-Lussac experiment
For attaching to hollow metal ball P2712-1K;
barometer absolute, 800 ... 1300 hPa, D = approx. 65 mm |
| 1 | P2720-1L | Thermo - octagon
The coloured surfaces are turned outward for thermal
radiation experiments and turned inward for absorption;
hollow body with 8 surfaces, partially laminated, in
various colours;
Heat source mounted on the cover: light bulb 12 V/20 W;
Surfaces: white, black, blue, yellow, red,
matte white, natural polished, matte natural
Dimensions: approx. 150 x 150 x 105 mm |
| 1 | MB241-2T | Thermopile "compact"
Thermopile with amplifier, for converting light energy into
electricity; may be used with a measuring device with a max. power
rating of 10 V or 10 mA as a radiation pyrometer; output voltage
(max. +/-14 V) at two 4-mm output jacks, output with short-circuit
protection; control for zero setting, ON-OFF switch, LED shows
operating mode; voltage supply: 9 V battery (included) or external
6-12 V power supply (e.g. P3120-6N); case: ABS plastic;
Dimensions: 84 x 84 x 39 mm |
| 1 | P2725-1T | Thermal generator with clamp
For conversion of thermal energy into electrical energy or
vice versa; acrylic housing with centrally arranged
Peltier element between two cubic aluminium containers,
fixed upright section with 2 safety jacks
and holders for thermometers, clamp for fastening the
aluminum containers to the Peltier element
Peltier element: max. 15 V / 3.5 A; aluminum container: 50 ml each
Dimensions: approx. 85 x 55 x 80 mm |
| 2 | P2220-1A | Laboratory thermometer -10...+110/1 °C,
graduated increments: 1° C, alcohol filled |

Storage:

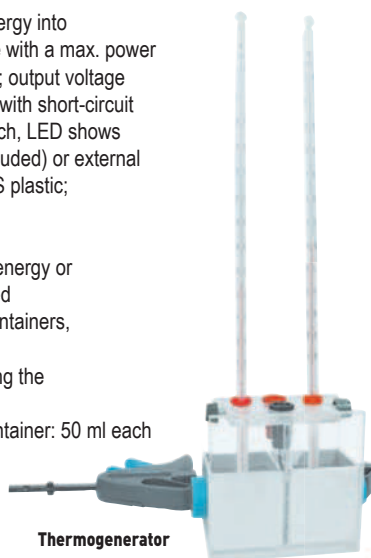
- | | | |
|---|----------|---|
| 1 | P7906-5C | Box insert Heat 2, SE |
| 1 | P7806-1G | Storage box II large, with cover
Box insert plan with 2 labels |



P9902-5C SEK Heat 2



Joule-Calorimeter, universal



Thermogenerator



Thermo-octagon



Accessories



P3130-3D power supply
Please refer to page
57 for details



P3210-1P Multimeter
Please refer to page 58
for details



**P1150-1D Handheld stopwatch,
digital, SE**
Ranges: 1 / 100 sec. to 30 min.,
1 sec. to 24 h, with alarm, battery included

Ordering information

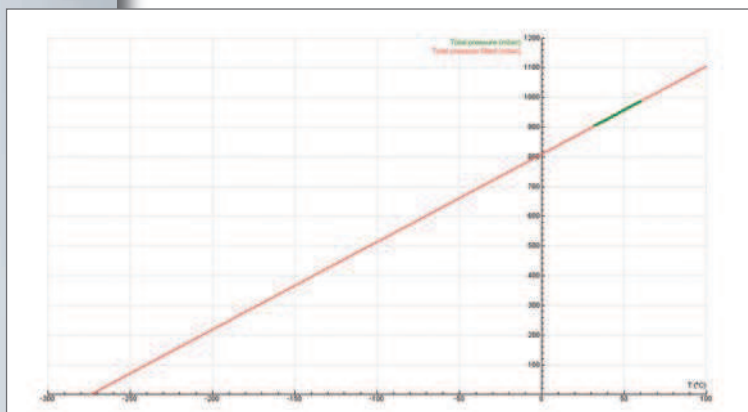
P4910-1U	ULAB datalogger, USB, serial incl. Coach 6 Lite
P4210-3T	Sensor temperature, with handle, -20 .. 125 °C
P4210-1D	Sensor pressure, 0 .. 700 kPa

(Note: additional sensors are required for specific experiments)

In contrast to conventional temperature-recording methods, i.e. using a thermometer and then plotting readings in a chart, readings are recorded several times a second. A sensor reacts faster than a liquid thermometer. The results can then be represented in graphic form or, if required, exported to a chart for further processing.



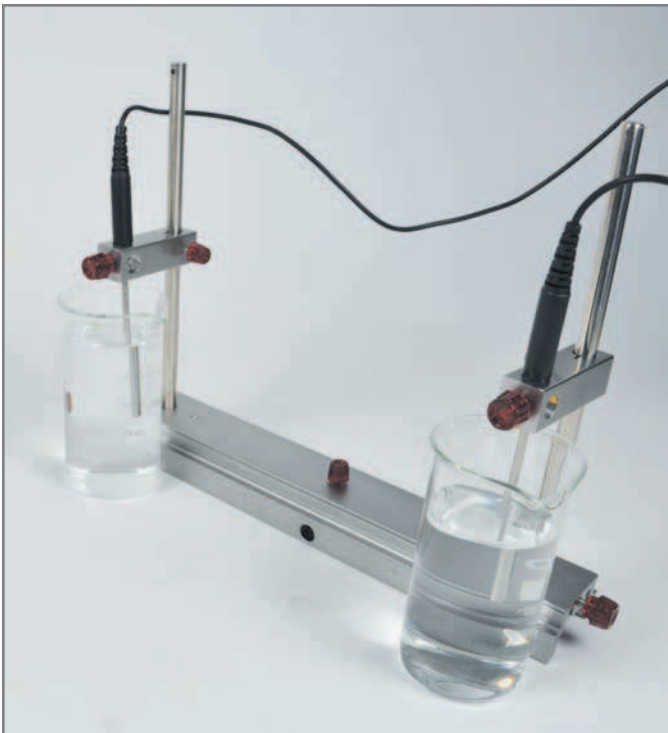
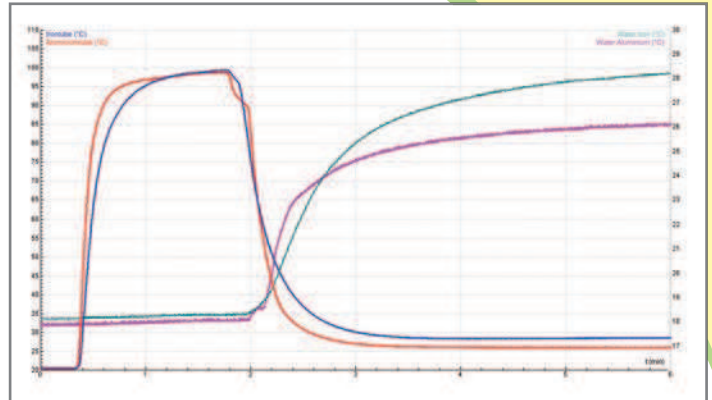
Supplement for the modules Heat 1 and Heat 2:



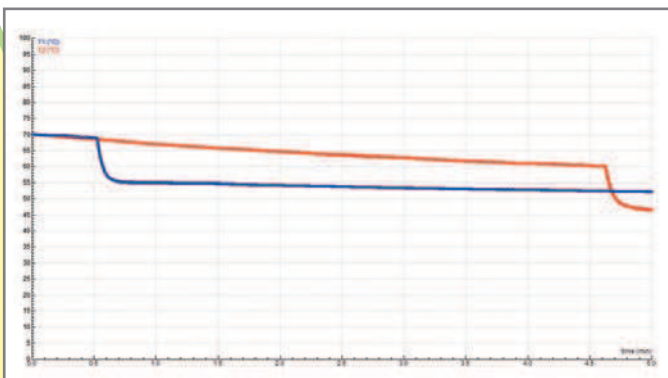
The absolute zero point can be calculated by recording temperature and pressure changes.

Estimating the absolute zero point - Gay-Lussac Law

Graphic representation of heating and cooling curves for an aluminium and an iron block of equal volume.



Specific heat of solids



Cold milk is poured at two different points in time into two cups of coffee with the same temperature.
Which one is colder after waiting 5 minutes?



Cold coffee

Ordering information

P9902-4W SEK Alternative energy conversion
 P9160-4W Experiment manual
 Alternative energy conversion



Experiments

1. COMBUSTION ENGINES:

AES 1.1 Combustion process in a gasoline engine
 AES 1.2 Combustion process in a diesel engine

2. ENERGY MADE PERCEPTIBLE:

AES 2.1 Energy demand of a light bulb
 AES 2.1.1 Energy demand of a light bulb (quantitatively)
 AES 2.1.2 Energy demand of home appliances
 AES 2.2 Energy demand of a small electric car
 AES 2.2.1 Additional experiments with the electric car
 AES 2.2.2 Electric car – practical cross references
 AES 2.3 Energy demand of a propeller
 AES 2.3.1 Additional experiments with the propeller

3. WIND POWER:

AES 3.1 Wind power station
 AES 3.1.1 Wind power – continuative experiments

4. WATER POWER:

AES 4.1 The hydropower station
 AES 4.1.1 Water power - continuative experiments

5. THERMAL POWER (caloric force):

AES 5.1 Principle of thermal power plants
 AES 5.1.1 Thermal power – continuative experiments

6. SUN POWER - PHOTOVOLTAICS:

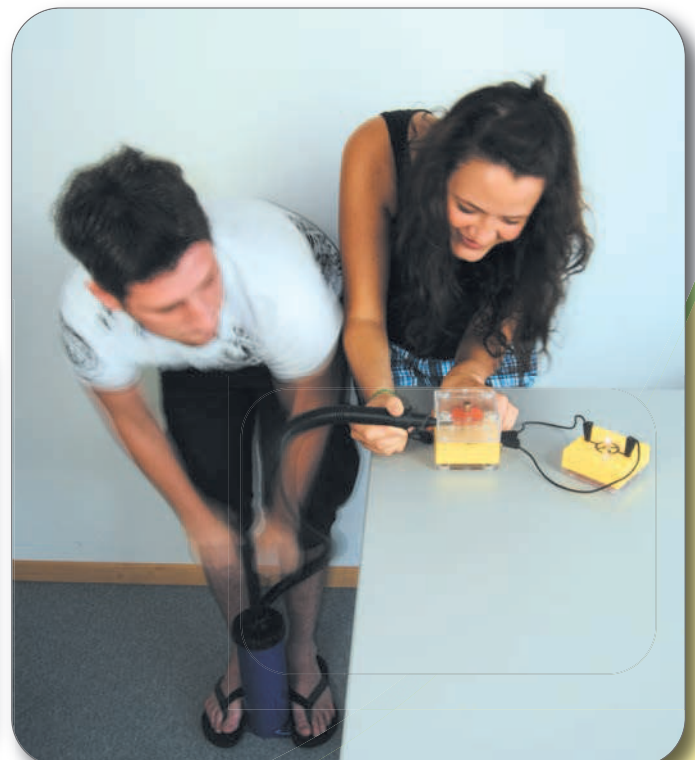
AES 6.1 Voltage metering and incidence angle (qualitatively)
 AES 6.2 Series connection of solar cells
 AES 6.3 Parallel connection of solar cells
 AES 6.3.1 Voltage metering and incidence angle (quantitatively)
 AES 6.4 Motor with propeller driven by a solar cell
 AES 6.5 Electric car driven by a solar cell

7. ENERGY STORAGE:

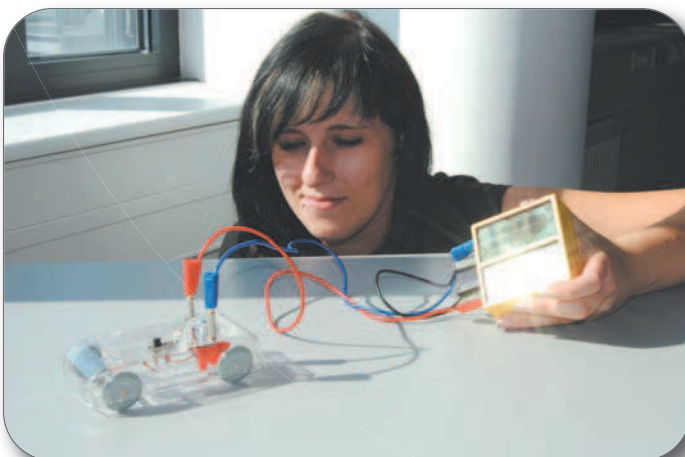
AES 7.1 Quick charging of the short – time energy storage
 AES 7.2 The short – time energy storage as energy source
 AES 7.3 Charging facilities of the short – time energy storage



Blowing on a wind vane (wind energy) operates a light bulb



Principle of a thermal power station: gas jet drives turbine and generator



Solar car

Kit consisting of:

Qty	Item no.	Description
1	P2890-1D	Fire piston A small amount of cotton batten is ignited as a result of high compression (diesel engine) Solid acrylic cylinder, piston rod with pressure plate, cotton and spare gaskets Stroke length: approx. 90 mm
1	P2890-1Z	Ignition cylinder Ignition of a petrol-air mixture (gasoline engine); acrylic cylinder with soft cover (as projectile), supplied with lighter
1	P3600-2A	MBC double solar cell, SE 2 solar cells in housing with magnet base with 4 safety jacks
1	P3601-2A	Clinometer for double solar cell SE Acrylic frame with angular scale on both sides, rotatable metal plate for mounting solar cell SE
1	P1314-1M	Electric car, model Trolley with motor, selection switch for battery or external power supply
1	P3610-1T	Turbine in case, SE Turbine in transparent housing, can be plugged into the MBC motor/generator
1	P3610-1M	MBC motor/generator, SE For connection to the Pelton turbine or the propeller
1	P3610-1P	Propeller, SE Can be plugged onto the MBC motor/generator
1	P3820-1G	Hand generator SE Manually cranked DC motor with gear drive in transparent housing, with durable drive crank, terminals for output voltage
1	P3620-1S	MBC energy storage, SE 10 F capacitor with analogue display for charge state
1	P3710-2A	MBC lamp socket E 10
5	P3320-1A	Light bulb, 1.5 V/50 mA, E10
1	P3310-1S	Set of 6 cables, SE 1 x 75 cm red, 1 x 75 cm blue, 1 x 50 cm red 1 x 50 cm blue, 2 x 25 cm black
Storage:		
1	P7906-4W	Box insert Alternative energy conversion
1	P7806-1G	Storage box II large, with cover Box insert plan with 2 labels



P9902-4W SEK Alternative energy - conversion



Energy storage with display (principle of hybrid engines)



Water power is converted into electrical energy

Accessories



DT105-1T Air pump

Solid double-stroke pump for generating overpressure and underpressure; flexible tube and connecting piece included; stroke volume: approx. 3 litres

DT105-1T Table lamp

Lamp with base, integrated on/off switch, flexible gooseneck; light: spotlight 60 W



Ordering information

P9902-4S SEK Hot water
P9160-5W Experiment manual Hot water

Kit consisting of:

Qty	Item no.	Description
1	P2750-1S	Solar collector SE Flat collector for converting solar energy into thermal energy; copper tube coil on copper plate, length approx. 220 cm, black laminated, with removable transparent housing; port with silicone stopper for measuring inside temperature Tube D = 6 mm; dimensions: 172 x 127 x 50 mm
1	P2750-1W	Heat exchanger SE For the transmission of energy from a primary to a secondary water cycle; copper tube coil in transparent plastic tank, length approx. 120 cm, removable cover with silicone stopper for inserting thermometer Tube D = 6 mm; dimensions: 80 x 80 x 100 mm
1	P2751-1T	Temperature measurement chamber For measuring the temperature in a water cycle; acrylic cylinder with two metal tube connectors, silicone stopper for inserting a thermometer, magnetic base with rubber caps
1	P2750-1T	Membrane circulation pump - Self-priming - Low noise level - Minimal power consumption - Small housing - Little vibration Power supply: 2 ... 12 VDC Max. power consumption: 20 ... 150 mA Free flow rate: 150 ml / min Max. pressure: 6.0 m (water) Max. suction lifting height: - 3.0 m (water) 2 tube connectors D (ext.) = 4.8 mm
3	P2220-1A	Laboratory thermometer -10...+110/1 °C, graduated in 1°C increments, filled with alcohol
4	C7445-3ST	Tubing, silicone, D = 3/6 mm, L = 24 cm
1	C6100-2A	Syringe, 120 ml, plastic

Storage:

1	P7906-5W	Box insert Hot water
1	P7806-1K	Storage box II small, with cover Box insert plan with 2 labels



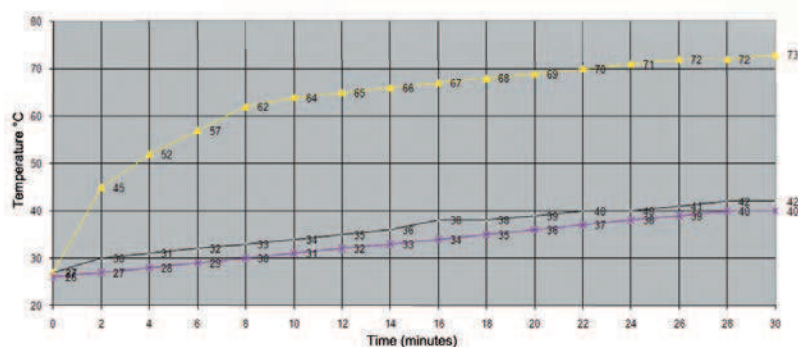
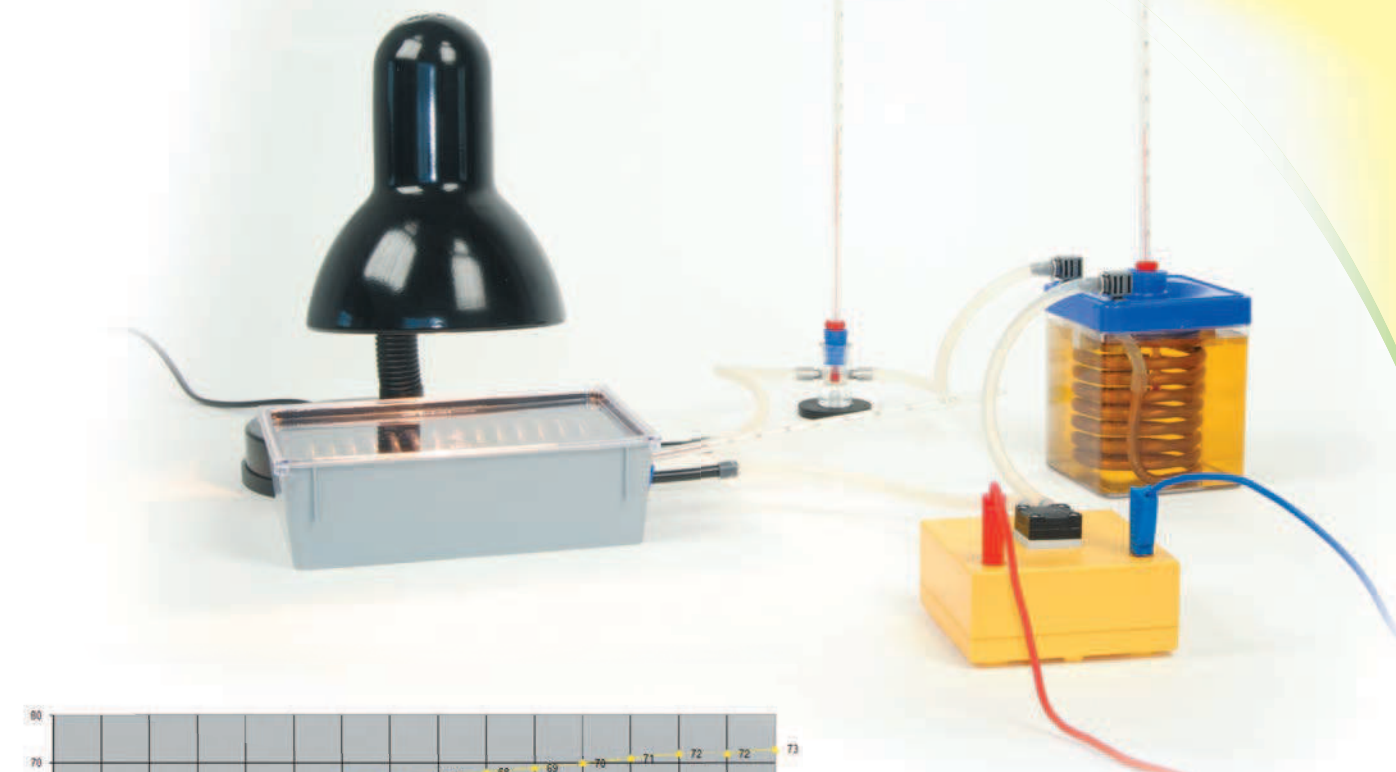
High-quality membrane pump!

- Self-priming, can also be operated using solar cells due to minimal power consumption
- System-independent: can be integrated in existing systems



Model of a solar collector

43



Temperature-time diagram

- in collector
- in water cycle (primary)
- in heat exchanger (secondary)

Accessories



DT105-1T Table lamp
Lamp with base, integrated on/off switch, flexible gooseneck; light: spotlight 60 W



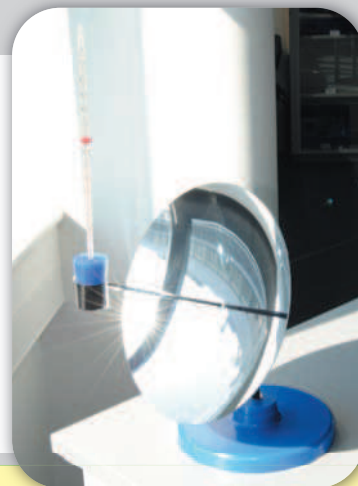
C4350-1A Thermometer SE, digital, 200 °C
Digital precision thermometer, metal sensor, L = 125 mm, incl. protective cap; 6-mm LC display
Measuring range: -40 ... +200 °C (-40 ... +392 °F); accuracy: ± 1 °C; resolution: 0.1 °C
Functions: hold, maximum and minimum temperature, battery-powered, automatic shutdown

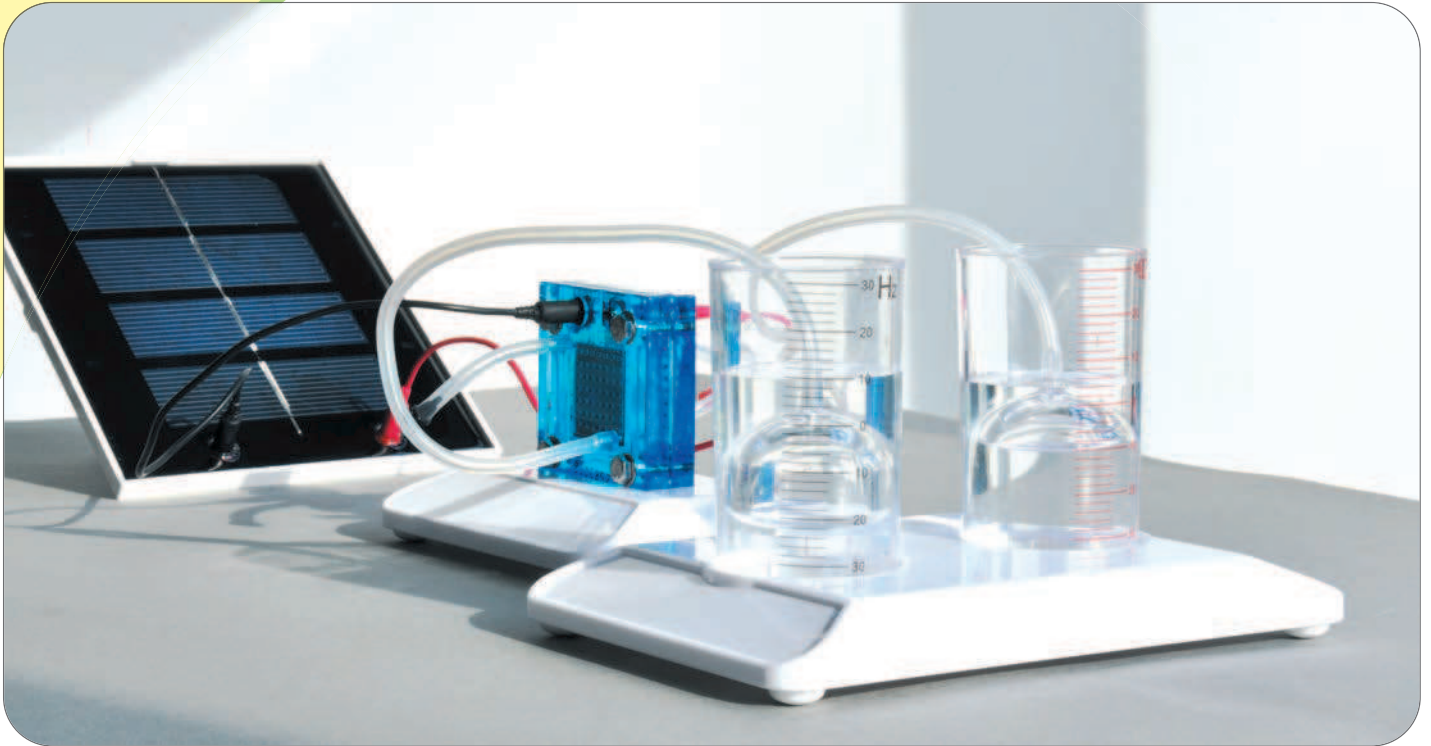
Supplement



P2885-1P Parabolic mirror with stand
High temperatures in the focal point of the mirror can be generated by bundling heat radiation; parabolic mirror made of plastic, small metal container mounted in the focal point for heating up various materials, large base plate and holder with adjustable pivot bearing for optimum setting of the angle of incidence.

The sun as water boiler or popcorn-cooker





P2820-1S Hydrogen education kit

Complete set for demonstrating the principles of energy storage and energy conversion using a fuel cell; consisting of:

- Fuel cell, reversible
- Gas storage unit
- Solar panel
- Motor with propeller
- Battery compartment with switch
- Small parts required for operation
- Instruction sheet



Energy for hydrogen production is supplied by the solar panel or the battery unit. The motor then can be driven by the fuel cell using the produced hydrogen. Please refer to item no. P2823-1R (Fuel cell, reversible) for technical details. This set can be combined with the module "Alternative energy - conversion".

P2840-1W Wind generator, professional model

Large working model of a wind turbine, conversion of wind energy into electrical energy;

- Generator with hub mounting rotor blades of different shapes
 - sets of 3 rotor blades in 4 different shapes each, can be varied individually as well as the angle
 - Stable base with metal insert
 - LED voltage indicator included, along with music module as energy consumer (not shown);
- Hub height: approx. 285 mm
Total height incl. rotor blades: approx. 440 mm

The wind turbine can be combined with the articles in the "Alternative energy - conversion" module or with those of the fuel cell kit.



P2821-1R Hydrogen racing car and station, set

The car engine of the future, demonstration of the complete process:

- Generation of hydrogen using solar power
- Hydrogen storage (filling station)
- Refuelling the car with hydrogen from a fuel cell
- Operating the car using hydrogen from a fuel cell
- Operation of the car by remote control

Set consisting of:

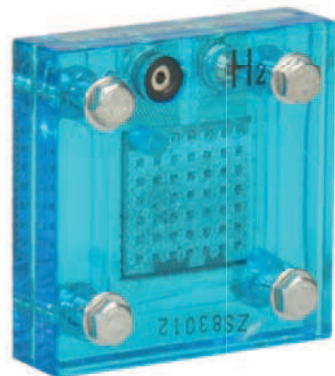
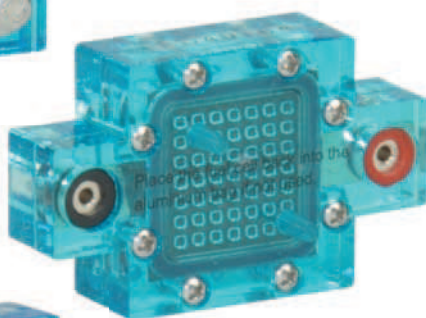
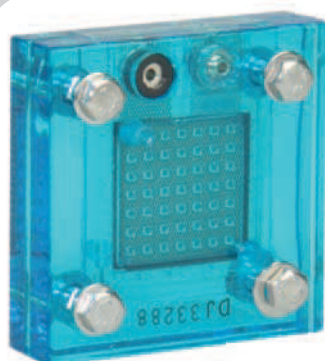
- Solar cell
- Hydrogen filling station
- Hydrogen car
- Remote control
- Small parts required for initial operation
- Instruction sheet

Dimensions (car):

approx. 155 x 70 x 40 mm



Individual components for individualists



P2823-1E PEM* Electrolyser, SE

Unit for the production of oxygen and hydrogen from distilled water by adding energy; energy can be supplied by a solar cell, wind turbine, hand generator or a mains power supply; the gases produced can be collected in the gas storage unit.

Technical data:

Power supply: 1.7 ... 3 V DC, 0 ... 1 A

H₂ production: max. 7 ml / min.

Dimensions: approx. 54 x 54 x 17 mm

P2823-1B PEM* Fuel cell, SE

Unit for the production of electrical energy by supplying hydrogen (and oxygen from the ambient air); hydrogen is supplied by the gas storage unit or a gas pressure bottle; energy output via two 2 mm jacks.

Technical data: 0 ... 0.6 V DC, 0 ... 0.4 A (max. 240 mW)

Dimensions: approx. 32 x 32 x 10 mm

P2823-1R PEM* Fuel cell, reversible, SE

This unit combines the functions of the electrolyser and the fuel cell SE; electrical energy is supplied to produce gases from distilled water, or hydrogen is supplied to allow the output of electrical energy.

Technical data:

Electrolyser functions:

Power supply: 1.7 ... 3 V DC, 0 ... 0.7 A

H₂ production: max. 5 ml / min.

Fuel cell functions:

Power output: 0 ... 0.6 V DC, 0 ... 0.3 A (max. 180 mW)

Dimensions: approx. 54 x 54 x 17 mm

P2823-1S Gas storage unit SE

For decomposing distilled water and for collecting the resulting gases (hydrogen and oxygen); may be operated together with the electrolyser or to supply fuel cell SE; two graduated acrylic cylinders with gas collecting unit; volume: approx. 30 ml each; on base plate, silicone tube with mini stoppers and syringe included; dimensions with base plate: approx. 152 x 108 x 83 mm

*PEM = proton exchange membrane

Ordering information

P9901-4D SEK Electricity 1
P9160-4D Experiment manual Electricity 1



Experiments

1. FUNDAMENTAL PRINCIPLES

ELS 1.1	The electrical circuit
ELS 1.2	Double-throw switch
ELS 1.3	Voltage
ELS 1.4	Serial connection of voltage sources
ELS 1.5	Parallel connection of voltage sources
ELS 1.6	Current intensity
ELS 1.7	Conductors and nonconductors
ELS 1.8	Do liquids conduct electrical current?

2. ELECTRICAL RESISTANCE

ELS 2.1	Ohm's Law
ELS 2.1.1	Series of measurements for Ohm's Law
ELS 2.2	Application of Ohm's Law
ELS 2.3	Wires and their amount of resistance
ELS 2.3.1	Specific resistance of wires
ELS 2.4	Ohmic resistor
ELS 2.5	An incandescent lamp is not an ohmic resistor
ELS 2.6	Serial connection of incandescent lamps
ELS 2.7	Serial connection of ohmic resistors
ELS 2.8	Voltage division
ELS 2.8.1	* Sliding resistor
ELS 2.9	Parallel connection of incandescent lamps
ELS 2.10	Parallel connection of ohmic resistors
ELS 2.11	Resistors in parallel/series circuits
ELS 2.12	Why are voltage sources connected in parallel?
ELS 2.13	Model of a potentiometer
ELS 2.13.1	* Dimming by means of a potentiometer
ELS 2.13.2	* Unloaded potentiometer
ELS 2.13.3	* Loaded potentiometer
ELS 2.14	Internal resistance of voltage sources (terminal voltage)
ELS 2.15	* Internal resistance of a voltmeter
ELS 2.16	Internal resistance of an ammeter
ELS 2.17	* Expansion of the measuring range of a voltmeter
ELS 2.18	* Expansion of the measuring range of an ammeter
ELS 2.19	Wheatstone's bridge connection

3. THERMAL ENERGY DERIVED FROM ELECTRICAL ENERGY

ELS 3.1	Electrical energy is converted into thermal energy
ELS 3.2	Electrical energy is converted into light energy
ELS 3.3	Conducting wires and resistor wires
ELS 3.4	Development of heat with different cross sections of wire
ELS 3.5	Safety fuse

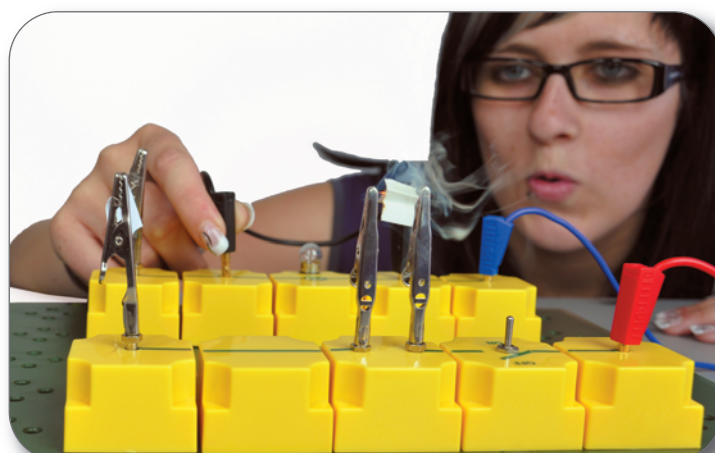
4. WORK AND POWER

ELS 4.1	The power of incandescent lamps
ELS 4.2	Electrical work

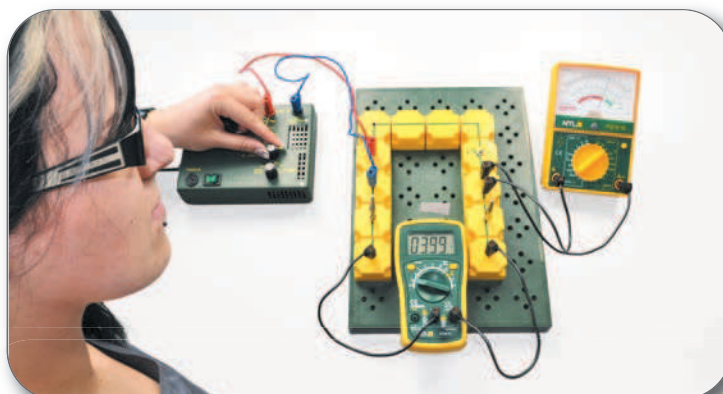
5. ELECTROCHEMISTRY

ELS 5.1	An electrochemical element
ELS 5.1.1	Volta cell
ELS 5.2	Electrolysis
ELS 5.3	Electroplating
ELS 5.4	Model of a lead accumulator
ELS 5.5	Contact series

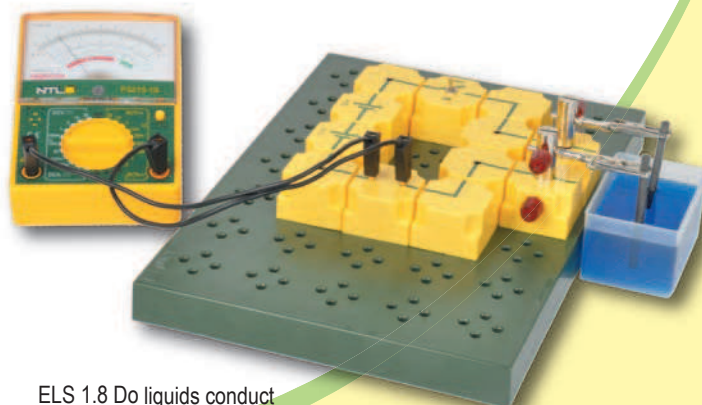
For experiments marked with *, items from the SEK Electronics supplement are additionally required..



ELS 3.5 Safety fuse



ELS 2.1 Ohm's law

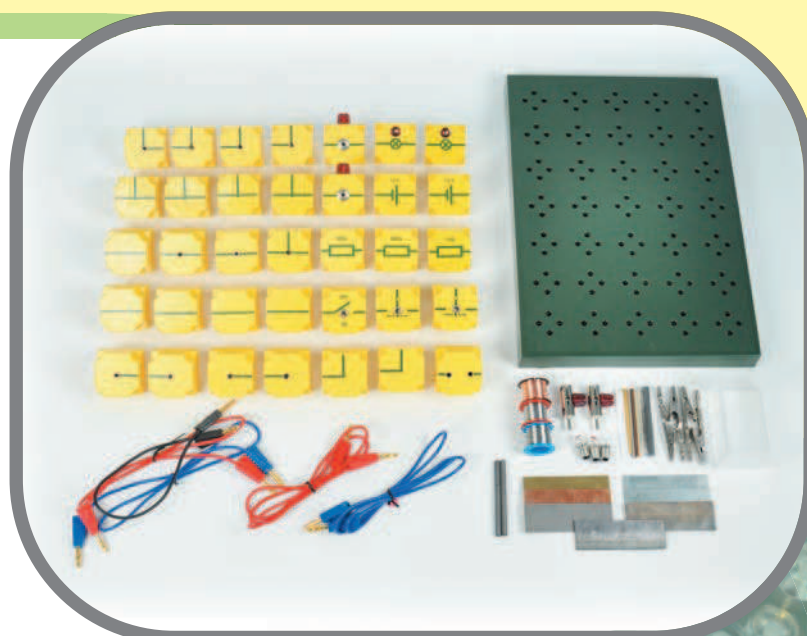


ELS 1.8 Do liquids conduct electrical current?

Kit consisting of:

Qty	Item no.	Description
1	P3910-1A	Plug-in panel, small
2	P3310-2E	Connecting lead, 25 cm, black, SE
1	P3310-3A	Connecting lead, 50 cm, red, SE
1	P3310-3B	Connecting lead, 50 cm, blue, SE
1	P3310-4A	Connecting lead, 75 cm, red, SE
1	P3310-4B	Connecting lead, 75 cm, blue, SE
4	P3910-1B	PIB connector
5	P3910-1C	PIB wire, straight
2	P3910-1D	PIB wire, straight, with socket
1	P3910-1F	PIB wire, T-shaped, with socket
4	P3910-1E	PIB wire, T-shaped
4	P3910-1H	PIB wire, angled, with socket
2	P3910-1G	PIB wire, angled
1	P3910-1J	PIB wire, interrupted, with sockets
1	P3910-2R	PIB switch, ON/OFF
2	P3910-2T	PIB two-way switch
1	P3910-3G	PIB resistor 100 Ohm
1	P3910-3M	PIB resistor 500 Ohm
1	P3910-3O	PIB resistor 1 kOhm
2	P3910-2K	PIB battery (accu) 1.2V
2	P3911-3B	PIB with adapter bush
2	P3910-2A	PIB lamp socket E 10
1	P3325-2C	Electrolysis tank
1	P3325-1A	Conductors and nonconductors, set
1	P3325-2A	Electrodes, set of
2	P3320-1B	Light bulb, 2.5 V/0.2 A, E10
2	P3320-1I	Light bulb, 10 V/50 mA, E10
1	P3314-1A	Fuse wire, D = 0.1 mm, spool, red
1	P3316-1C	Resistance wire, D = 0.2 mm, spool, blue
1	P3316-1B	Copper wire, D = 0.2 mm, spool, black
4	P3911-3D	Crocodile clip with plug
2	P3911-3A	Holder with slit and hole, SE
Storage:		
1	P7906-4D	Box insert Electricity 1, SE
1	P7806-1K	Storage box II small, with cover Box insert plan with 2 labels

The NTL plug-in block system is very durable and thus very reliable, and the transparent assembly makes for very good visibility. Students in particular will be pleased to discover how quickly experiments can be set up and disassembled once again.



P9901-4D SEK Electricity 1

NTL plug-in block system
"the yellow original"



Circuit board for 7 x 5 plug-in blocks. Green housing of moulded plastic and with removable, transparent base. The board has built-in flat springs made of brass, ensuring good conductivity even at very low voltages.

NTL plug-in blocks consist of a moulded ABS plastic housing (in NTL yellow) and a transparent base, allowing the inside parts to be viewed and also replaced easily. A symbol for the electronic component inside is printed on the upper surface of the housing.

Accessories



Power supply:

Please refer to page 57 for details



Meters:

Please refer to page 58 + 59 for details

P3120-3B Battery charging board

For recharging the P3910-2K 1.2-V rechargeable battery modules included in the Electricity 1 kit (up to 18 may be recharged at one time).



Mains transformer for the battery charging board:

P3120-3A Battery charger, power supply for P3120-3B

Ordering information

P9902-5M SEK Magnetism

P9160-5M Experiment manual Magnetism



Experiments

1. INTERACTION OF MAGNETS

- MAS 1.1 Magnets and magnet poles
- MAS 1.2 Interaction among magnet poles
- MAS 1.3 Magnetic attraction
- MAS 1.4 Magnetic force over distance
- MAS 1.5 Shielding a magnetic field
- MAS 1.6 Floating magnet

2. MAGNETIC INDUCTION

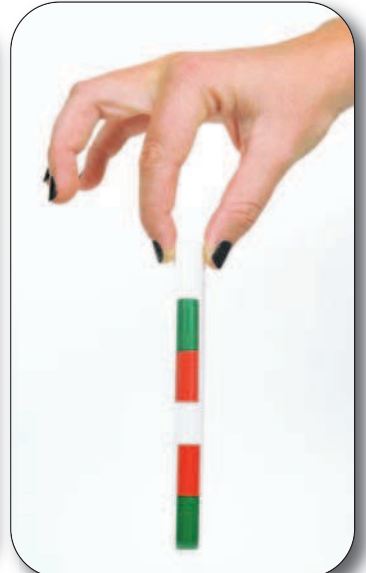
- MAS 2.1 Magnetic induction
- MAS 2.2 Creating a magnet
- MAS 2.3 The interior of a bar magnet
- MAS 2.4 Elementary magnets

3. MAGNETIC FIELDS

- MAS 3.1 The magnetic field of a bar magnet
- MAS 3.2 Magnetic field lines
- MAS 3.3 Field lines around a bar magnet
- MAS 3.4 Magnetic field between magnet poles
- MAS 3.4.1 Magnetic field lines around an u-magnet
- MAS 3.5 The earth's magnetic field
- MAS 3.6 The magnet as a compass
- MAS 3.7 Methods of magnetising

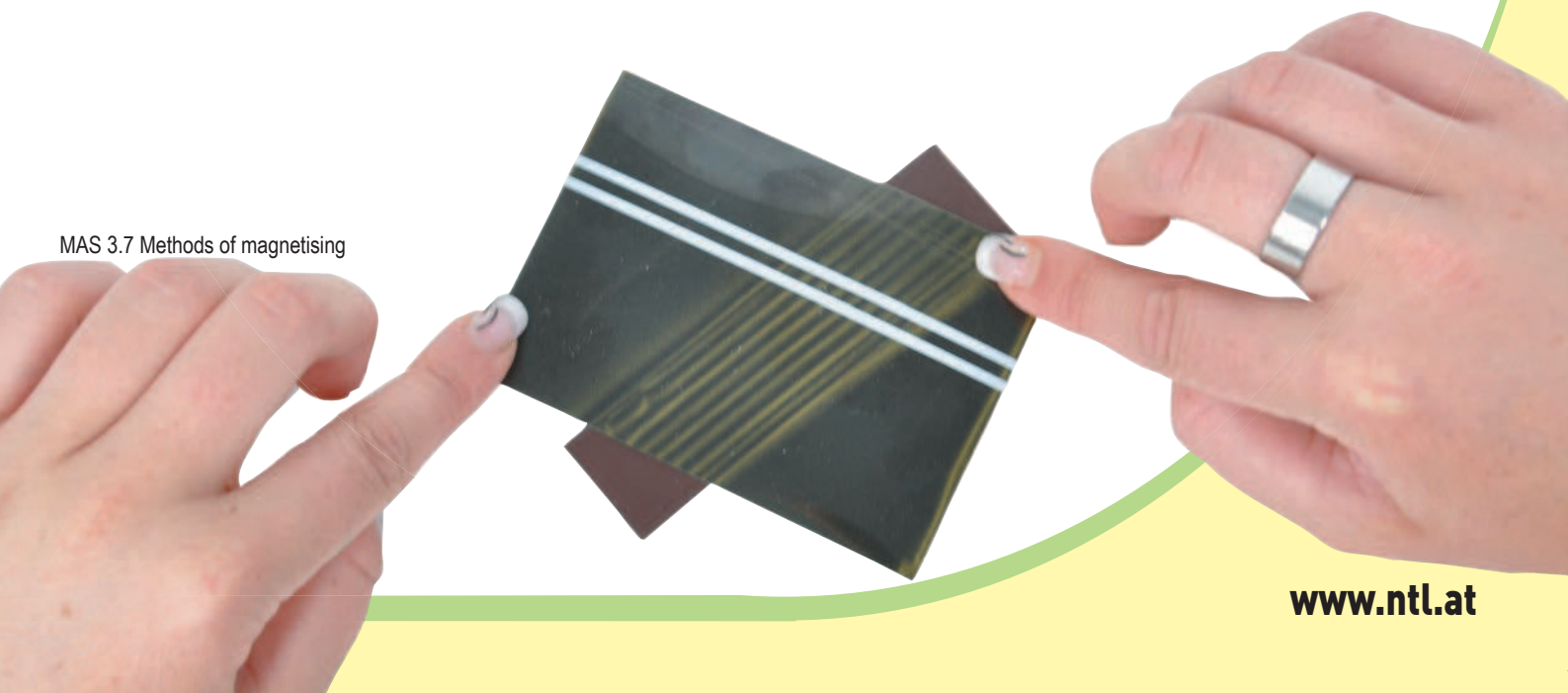


MAS 3.5 The earth's magnet field



MAS 1.6 Schwebender Magnet

MAS 3.7 Methods of magnetising



Kit consisting of:

Qty	Item no.	Description
2	P3410-1K	Bar Magnet, AlNiCo, D=10 mm, L=50 mm painted red and green
1	P3410-2F	Iron filings in box
1	P3410-5M	Pocket compass
1	P3410-2A	Earth-model for magnetic field of earth D = 56 mm Labelled, with support
1	P3410-2K	Magnetic field sensor, large
1	P3911-3F	Plug-in pin with needle, used as needle bearing for friction rods and magnets
2	P3410-1L	Support plate for bar magnets
4	P3410-2E	Threaded bolts, steel, L=40 mm Able to be magnetised, screwed together, for experiments in magnetism
1	P3911-3H	Insulating block with socket
1	P3410-2M	Bearing bush for cylindrical magnets For connecting 2 bar magnets 50 x 10 mm

- 1 P3413-1P **Magnetic field plate "compact"**
For displaying magnetic field lines around permanent magnets
Dimensions: approx. 155 x 90 x 10 mm



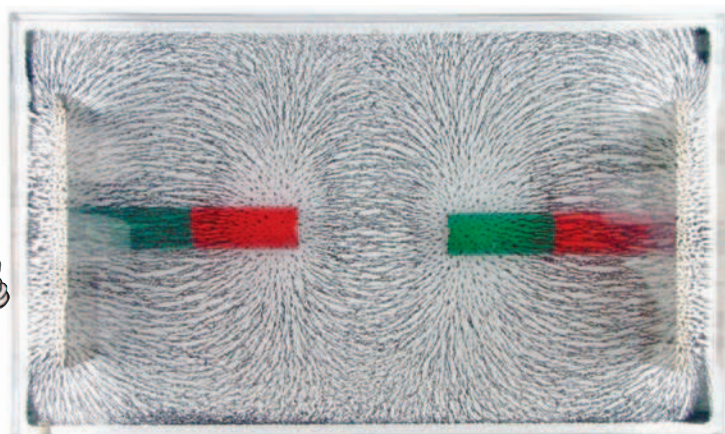
- 2 P3911-1L Pole plate SE, 60 x 25 mm
1 P3430-1C Paper clips in container, set of 10
1 P3430-1B Paper clip with string
1 P3308-2P Test tube, 16x150 mm, plastic
1 P3417-1F Magnetic field sheet
For displaying the magnetic field direction of magnetised objects
Dimensions: approx. 100 x 70 mm
1 P3417-1G Rubber pad, magnetic
Dimensions: approx. 100 x 25 mm
1 P3410-1W Soft iron ring, SE
1 P3410-1N Iron nails, in box, SE

Storage:

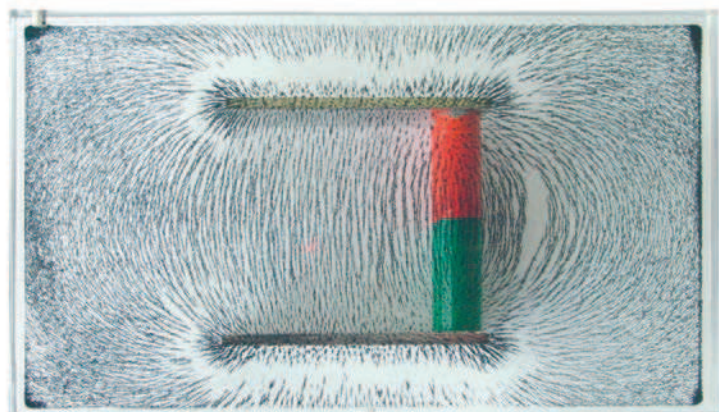
- 1 P7906-5M Box insert Magnetism, SE
1 P7806-1K Storage box II small, with cover
Box insert plan with 2 labels



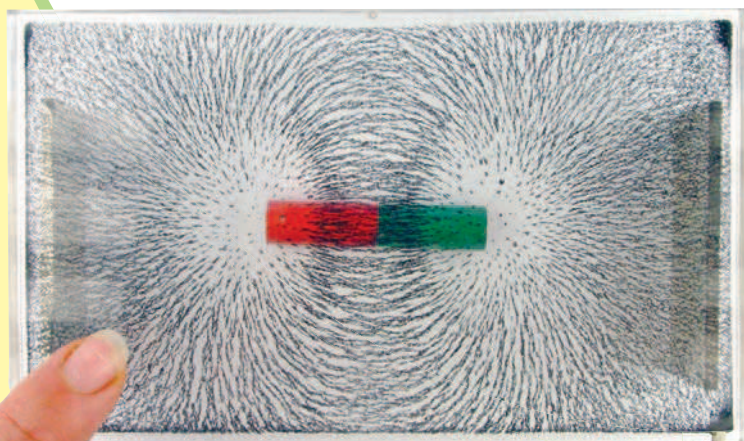
P9902-5M SEK Magnetism



MAS 3.4a Magnetic field between two different poles



MAS 3.4.1 Magnetic field lines around an u-magnet



MAS 3.3 Magnetic field lines

Iron fillings in a sealed cuvette in combination with a transparent, viscous medium allow "clean" experiments!



Ordering information

P9901-4D	SEK Electricity 1
P9902-5M	SEK Magnetism
P9902-5P	SEK Electromagnetism
P9160-4P	Experiment manual Electromagnetism

Experiments

3. THERMAL ENERGY FROM ELECTRICAL ENERGY

ELS 3.6	Bimetal fuse
ELS 3.7	Bimetallic thermostat
ELS 3.8	Bimetallic fire alarm

4. WORK AND POWER

ELS 4.1.1	The power of an electric motor
ELS 4.4	Mechanical work and the power of electricity

6. ELECTROMAGNETISM

ELS 6.1	Electrical current generates a magnetic field
ELS 6.2	The magnetic field of a coil
ELS 6.3	A magnetically manipulated switch
ELS 6.4	A relay
ELS 6.5	Relay with operating point and normal contact
ELS 6.6	Self-opening switches
ELS 6.7	An AC buzzer
ELS 6.8	Model of a magnetic fuse

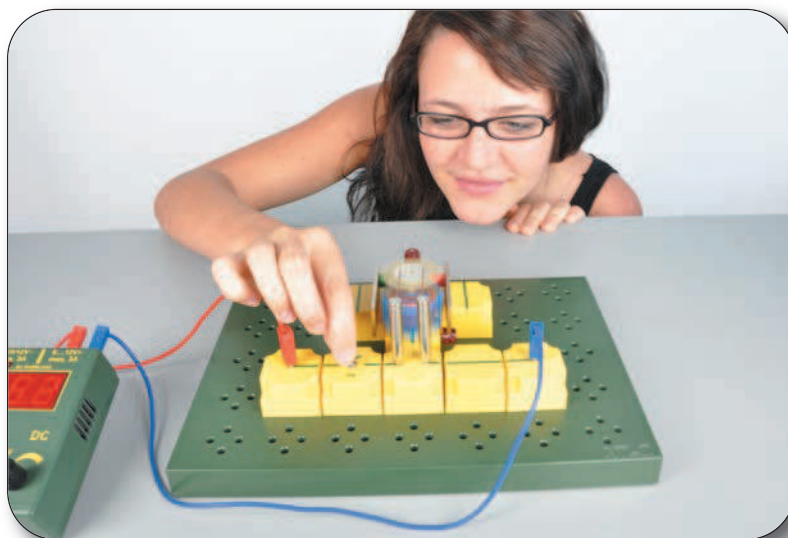
7. KINETIC ENERGY FROM ELECTRIC ENERGY

ELS 7.1	Electricity used to generate motion
ELS 7.1.1	Lorentz force
ELS 7.2	Principle of the electric motor
ELS 7.3	Model of the electric motor
ELS 7.3.1	Direct current motor
ELS 7.4	Wound series electric motor
ELS 7.5	Shunt-wound motor
ELS 7.6	Model of a moving iron measuring instrument

8. ELECTROMAGNETIC INDUCTION

ELS 8.1	Induction
ELS 8.1.1	Induced electromotive force
ELS 8.2	Principle of a generator
ELS 8.3	The AC generator (internal pole generator)
ELS 8.4	The AC generator (external pole generator)
ELS 8.5	The DC generator
ELS 8.6	Generators with electromagnets
ELS 8.6.1	Internal pole generator with electromagnet
ELS 8.7	Induction by DC

ELS 8.8	Transformer
ELS 8.9	Transformer 1:1
ELS 8.10	Transformer not under load
ELS 8.11	Current intensity is also transformed
ELS 8.12	Coils under DC
ELS 8.13	Cut-out peaks due to self-induction
ELS 8.13.1	Lenz's Law
ELS 8.13.2	Braking effect due to self-induction
ELS 8.14	Coils under AC
ELS 8.15	AC resistance of a coil
ELS 8.16	Resistance and inductance in AC



ELS 7.3 Model of the electric motor

Kit consisting of:

Qty	Item no.	Description
1	P3911-3J	PIB with heating coil
1	P3910-2C	PIB glow lamp
1	P3910-2S	PIB pushbutton
1	P3911-1K	Iron core, solid, L=50 mm
1	P3911-3E	Contact pin SE
2	P3911-1L	Pole plate SE, 60 x 25 mm
2	P3911-1N	Commutator brush, SE
1	P3911-1Q	Magnet holder, revoluble
1	P3911-1O	Commutator disc
1	P3911-1R	Collecting ring disc
1	P2420-1A	Bimetallic strip, SE
1	P1810-1A	Flat spring, steel, 0.2 mm
1	P1810-1B	Flat spring, brass
1	P3911-1T	PIB motor
		0.5 ... 4 V DC, axis with cord spool
1	P3911-2J	PIB for coil with 800 turns
1	P3911-2K	PIB for coil with 2 x 800 turns
1	P3911-2R	Coil with 800 turns, SE, blue
1	P3911-2S	Coil with 2 x 800 turns SE, red
1	P3911-1J	Iron core, laminated, U and I-shaped core with clamp strap
2	P3911-1P	Bearing pin, SE

Storage:

1	P7906-5E	Box insert Electromagnetism, SE
1	P7806-1K	Storage box II small, with cover Box insert plan with 2 labels



P9902-5P SEK Electromagnetism



ELS 8.8 Transformer

Supplements (independent of individual systems)



P3805-1M Motor model, construction set

An easy-to-operate working model with a permanent magnet and an electromagnet – can be consequently driven using DC or AC (may be also used as a series or shunt-wound motor)

Power supply in DC mode: 1.5 ... 5 V; AC mode: 6 ... 9 V

Dimensions (assembled model) : 140 x 90 x 100 mm

Ordering information:

P3805-1M Motor model, kit

P3805-1MG Motor model, kit, 4 or more units



P3820-1G Hand generator SE

An ideal, easy-to-operate working model for student experiments. DC motor with gear and crank handle in transparent housing. Built-in light bulb socket and terminals for external power supply.

Ordering information:

P3820-1G Hand generator

P3820-1GG Hand generator, 4 or more units

Ordering information

P9901-4D	SEK Electricity 1
P9902-5T	SEK Electrodynamics
P9160-4T	Experiment manual Electrodynamics



Experiments

MAGNETIC FIELD OF A COIL

EMS 1.1	The magnetic field in a current-carrying coil
EMS 1.2	Vector diagram
EMS 1.3	Schematic illustration of field lines
EMS 1.4	What causes the current in a coil to flow in a certain direction?
EMS 1.5	Relation between amperage and the tangent of the deflection angle

THE EARTH'S MAGNETIC FIELD

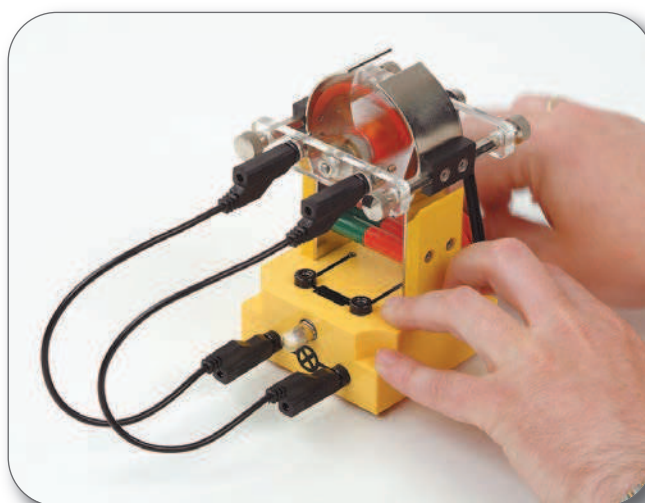
EMS 2.1	Schematic diagram of the earth's magnetic field and its vectors
EMS 2.2	Determining the magnetic field force of a coil and of the earth
EMS 2.3	Relation between the magnetic field force of a coil and of the earth
EMS 2.4	SI unit of magnetic field force and the Oersted

KINETIC ENERGY FROM ELECTRIC ENERGY

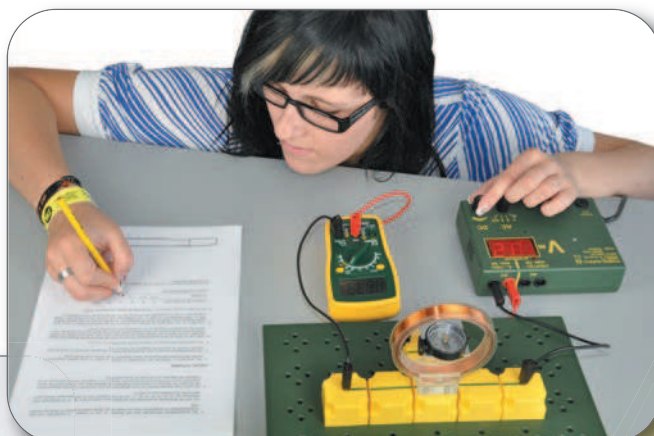
EMS 3.1	Current flow and deflection of a current-carrying conductor in a magnetic field ("right-hand rule")
EMS 3.2	Coil in a magnetic field (rotating-coil device)

MOTOR / GENERATOR (COMPACT MODEL)

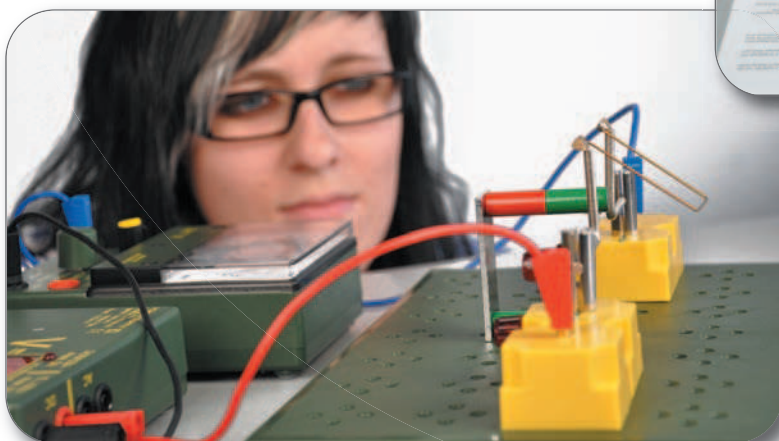
EMS 4.1	Simple DC motor
EMS 4.2	Series motor
EMS 4.3	Shunt-wound motor
EMS 4.4	DC generator
EMS 4.5	External pole generator
EMS 4.6	Internal pole generator



EMS 4.4 DC generator



EMS 1.5 Relation between amperage and the tangent of the deflection angle



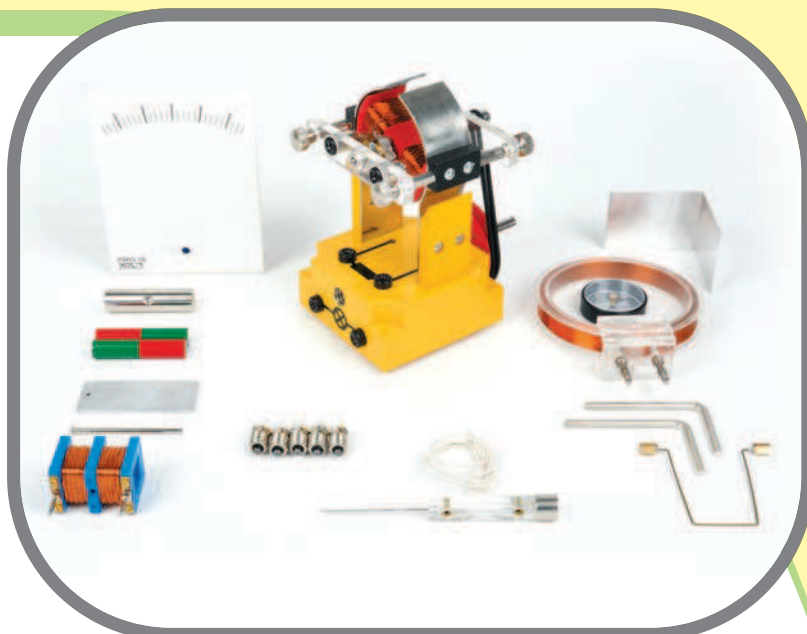
EMS 3.1 Current flow and deflection of a current-carrying conductor in a magnetic field ("right-hand-rule")

Kit consisting of:

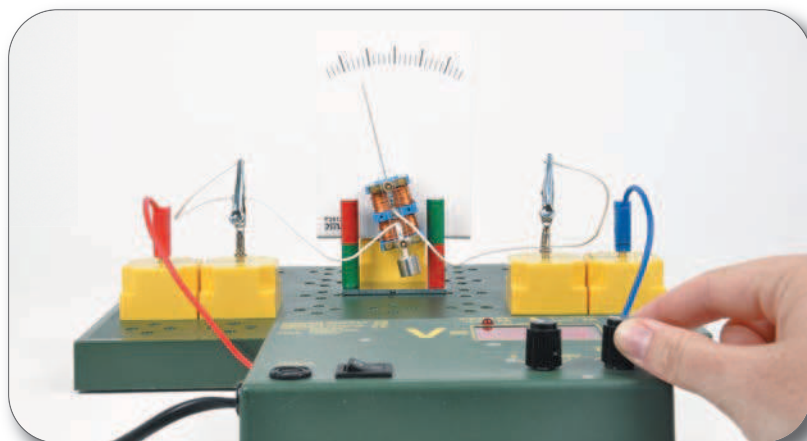
Qty	Item no.	Description
1	P3911-2T	Axis for moving coil, SE
1	P3911-2U	Pointer for moving coil
1	P3911-1L	Pole plate SE, 60 x 25 mm
1	P3800-1A	Motor/generator model
2	P3410-1K	Bar Magnet, AlNiCo, D=10 mm, L=50 mm
5	DE309-4A	Light bulb, 4 V/40 mA, E10
1	P3911-2V	Moving coil with hole, blue, SE
1	P3911-1K	Iron core solid, L=50 mm
1	P3912-2A	Electromagnetic swing, SE
2	P3560-1B	Electrode, right-angled
1	P3410-5O	Holder for pocket compass
1	P3912-1A	Induction coil, SE
1	P3410-5M	Pocket compass
1	P3913-1S	Scale for moving coil, SE

Storage:

1	P7906-4T	Box insert Electrodynamics, SE
1	P7806-1K	Storage box II small, with cover Box insert plan with 2 labels



P9902-5T SEK Electrodynamics



EMS 3.2 Coil in a magnetic field (rotating-coil device)

Supplements (independent of individual systems)

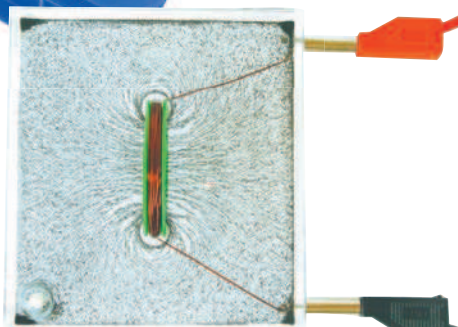
P9902-5U SEK Magnetic field of current

Kit consisting of:

Qty	Item no.	Description
1	P3413-1L	Magnetic field conductor models, set of 3 Conductor models (straight, loop and coil) mounted in temperature-resistant nylon profiles, iron fillings in a viscous medium in a sealed acrylic cuvette Dimensions of the cuvette: 107 x 96 mm
1	DG133-1B	Battery (rechargeable), 6 V / 1 Ah, with 2 cables and safety plugs
8	DE420-1XE	Plotting compass, D=20 mm
1	P7906-5U	Box insert Magnetic field of current, SE
1	P7806-1S	Storage box II mini, with cover Box insert plan with 2 labels

Experiments

- EMS 5.1 Magnetic field lines around a straight, current-carrying conductor
- EMS 5.2 Magnetic field lines around a conductor loop
- EMS 5.3 Magnetic field lines around a coil



simple - fast - safe

Ordering information

P9901-4D	SEK Electricity 1
P9901-4F	SEK Electronics supplement
P9160-4F	Experiment manual Electronics



Experiments

1. SEMICONDUCTORS:

EOS 1.1	PTC resistor
EOS 1.2	NTC resistor
EOS 1.3	Light-dependent resistor (LDR)
EOS 1.4	Measuring luminous intensity
EOS 1.5	VDR resistor
EOS 1.6	Solar cell

2. DIODES:

EOS 2.1	Silicon diode
EOS 2.2	Forward voltage of a silicon diode
EOS 2.2.1	Characteristic lines of semiconductor diodes
EOS 2.3	Diodes protect meters
EOS 2.4	Light-emitting diode (LED)
EOS 2.4.1	Forward voltage of an LED
EOS 2.5	Polarity indicators
EOS 2.5.1	Polarity indicators under variable frequency AC
EOS 2.6	Zener diodes
EOS 2.7	Stabilising voltage

3. TRANSISTORS:

EOS 3.1	Does a transistor consist of two diodes?
EOS 3.1.1	Response of a PNP transistor
EOS 3.2	Base current enables collector current (NPN transistor)
EOS 3.2.1	Base current enables collector current (PNP transistor)
EOS 3.3	The transistor as an amplifier
EOS 3.3.1	Base circuit (current amplification)
EOS 3.3.2	Base circuit (voltage amplification)
EOS 3.3.3	Collector circuit (current amplification)
EOS 3.3.4	Collector circuit (voltage amplification)
EOS 3.3.5	Emitter circuit (current amplification)
EOS 3.3.6	Transfer characteristic of an NPN transistor
EOS 3.3.7	Transfer characteristic of a PNP transistor
EOS 3.3.8	Adjusting the operating point
EOS 3.3.9	Distortion-free amplification through quiescent base current
EOS 3.4	Light-triggered alarm
EOS 3.5	Base voltage divider
EOS 3.6	Burglar alarm using trip wire
EOS 3.7	Automatic lighting
EOS 3.8	Alarm triggered by a light barrier
EOS 3.9	Fire alarm
EOS 3.10	Electric thermometer

4. CAPACITORS:

EOS 4.1	Electric charge storage
EOS 4.2	A capacitor supplies base current
EOS 4.3	Capacitance
EOS 4.3.1	Time switch
EOS 4.4	A capacitor blocks DC
EOS 4.5	Half-wave rectification
EOS 4.6	Smoother rectified voltage
EOS 4.7	Capacitors as AC resistors

EOS 4.7.1	Capacitive resistance at 50 Hz AC
EOS 4.7.2	Capacitive resistance
EOS 4.8	Charged condensers connected in series
EOS 4.9	Capacitors connected in series (determining capacitance)
EOS 4.10	Capacitors connected in parallel
EOS 4.11	AC resistors connected in series
EOS 4.12 *	Ohmic resistors, coil and capacitor in an AC circuit
EOS 4.13 *	Filter

5. RECTIFICATION

EOS 5.1	Principle of full-wave rectification (mid-point tapping)
EOS 5.2	Application of full-wave rectification
EOS 5.3 *	Bridge circuit
EOS 5.3.1	AC bridge circuit (variable frequency)

6. MULTIVIBRATOR:

EOS 6.1	Bistable multivibrator
EOS 6.2	Capacitor discharge
EOS 6.3	A capacitor prevents base current
EOS 6.4	Monostable multivibrator
EOS 6.5	Flashing circuit
EOS 6.6	Multivibrator music
EOS 6.7	Music controlled by light
EOS 6.7.1	Music controlled by temperature

7. RESONANT CIRCUIT

EOS 7.1 *	Principle of a resonant circuit
EOS 7.1.1 *	Parallel resonant circuit
EOS 7.1.2 *	Acceptor circuit
EOS 7.2 *	Continuous oscillation
EOS 7.3 *	LC music

8. AMPLIFIER CIRCUITS

EOS 8.1	The resistance in the human body
EOS 8.1.1	A transistor step controls a second step
EOS 8.1.2	Alarm on heating failure
EOS 8.2	Automatic level measurement
EOS 8.3	Lie detector
EOS 8.4	Microphone amplifier
EOS 8.5	Sum and difference amplifier
EOS 8.6 *	A motor armature signals its position
EOS 8.7 *	Direct current motor without commutator

9. LOGIC CIRCUITS

EOS 9.1 *	Logical AND
EOS 9.2 *	Logical OR
EOS 9.3	Logical NOT
EOS 9.4	AND circuit
EOS 9.5	OR circuit
EOS 9.6	NOT circuit
EOS 9.7	NAND circuit
EOS 9.8	NOR circuit

For experiments marked with *, items from the SEK for electromagnetism are additionally required

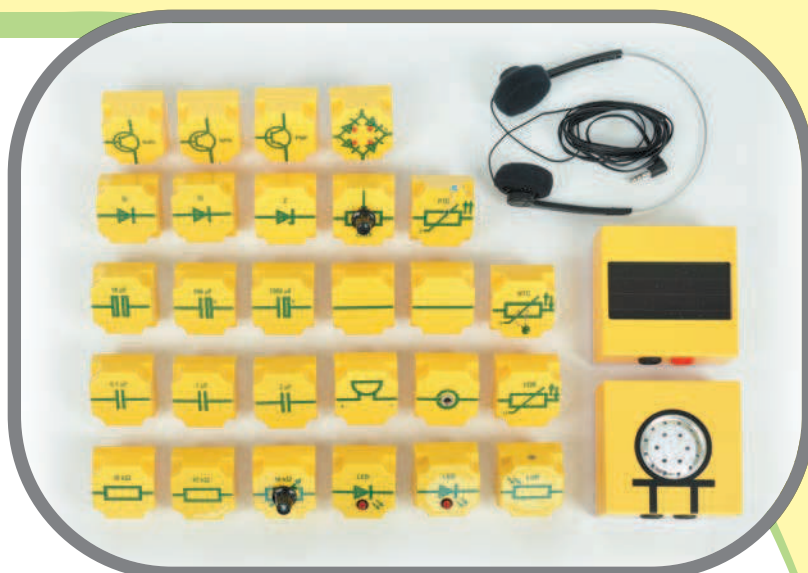


Kit consisting of:

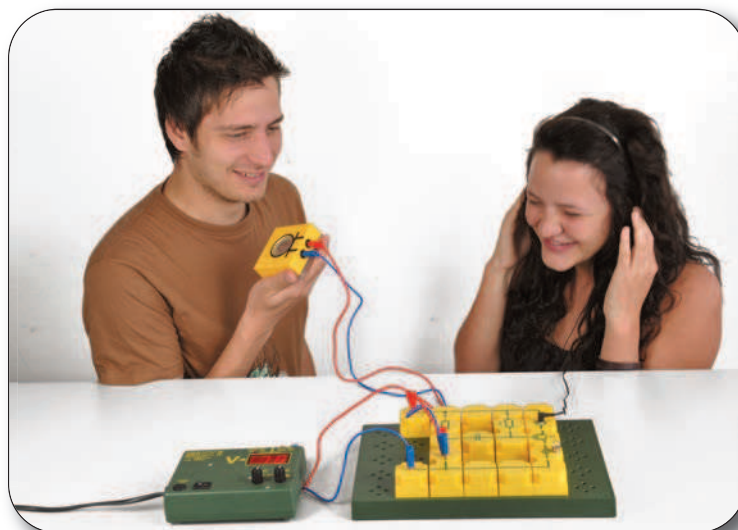
Qty	Item no.	Description
1	P3910-3R	PIB resistor 10 kOhm
1	P3910-3S	PIB resistor 47 kOhm
1	P3910-5A	PIB rheostat 10 kOhm
2	P3910-1C	PIB wire, straight
1	P3910-4J	PIB photo resistor (LDR)
1	P3910-4K	PIB varistor (VDR)
1	P3910-4A	PIB NTC resistor
1	P3910-4E	PIB PTC resistor
1	P3911-2C	Headphone, SE
1	P3910-6D	PIB capacitor 0.1 μ F
1	P3910-6G	PIB capacitor 1 μ F
1	P3910-6H	PIB capacitor 2 μ F
1	P3910-6J	PIB capacitor 10 μ F
1	P3910-6N	PIB capacitor 100 μ F
1	P3910-6Q	PIB capacitor 1000 μ F
1	P3600-1A	Solar cell, in plastic housing
1	P3910-7T	PIB bridge rectifier
1	P3910-5F	PIB potentiometer 470 Ohm
1	P3910-1K	PIB wire with jack bush
1	P3911-2A	PIB buzzer
1	P3910-7E	PIB Zener diode 4.7 V
2	P3910-7A	PIB Si diode
1	P3910-8B	PIB transistor NPN, base right
1	P3910-8A	PIB transistor NPN, base left
1	P3910-8C	PIB transistor PNP, base left
1	P3721-2C	MBC microphone
2	P3910-7K	PIB LED red

Storage:

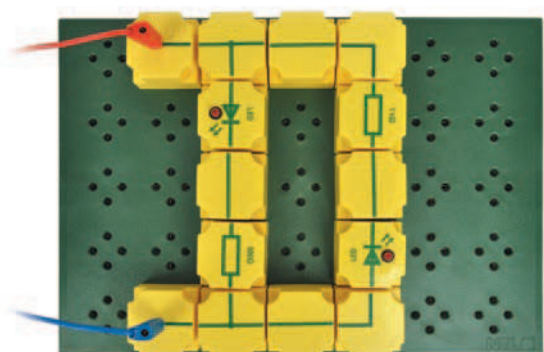
1	P7806-4F	Box insert Electronics, plastic
1	P7806-1K	Storage box II small, with cover Box insert plan with 2 labels



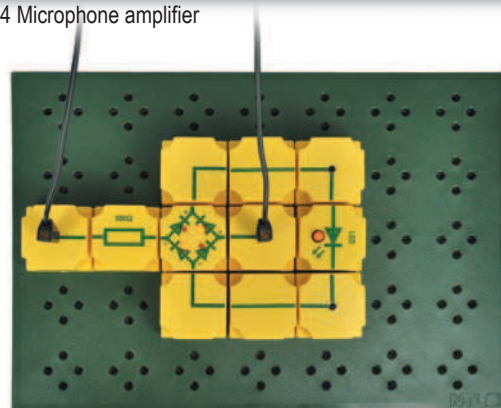
P9901-4F SEK Electronics supplement



EOS 8.4 Microphone amplifier



Circuit diagram clearly identifiable



Bridge rectifier with LEDs

Accessories



Power supply

Please refer to page 57 for further details



Meters

Please refer to pages 58 + 59 for further details

Ordering information

P9901-4M SEK Electronics – complete
P9160-4F Experiment manual Electronics

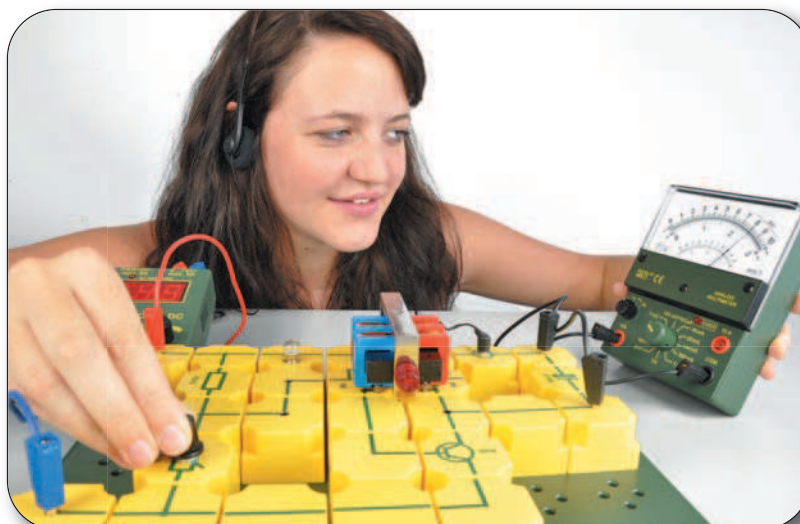
This collection contains all articles required for performing the student experiments in electronics (please refer to the previous page for the list of experiments). We provide this set in response to our customers' needs for a complete solution for student experiments in electronics. One box with all required items, easy to prepare, easy to gather in and easy to keep track of.



Kit consisting of:

Qty Item no. Description

1	P3910-1A	Plug-in panel, small
2	P3310-2E	Connecting lead, 25 cm, black, SE
1	P3310-3A	Connecting lead, 50 cm, red, SE
1	P3310-3B	Connecting lead, 50 cm, blue, SE
1	P3310-4A	Connecting lead, 75 cm, red, SE
1	P3310-4B	Connecting lead, 75 cm, blue, SE
1	P3600-1A	Solar cell, in plastic housing
1	P3921-2C	Microphone module
4	P3910-1B	PIB connector
5	P3910-1C	PIB wire, straight
3	P3910-1D	PIB wire, straight, with socket
4	P3910-1E	PIB wire, T-shaped
1	P3910-1F	PIB wire, T-shaped, with socket
2	P3910-1G	PIB wire, angled
4	P3910-1H	PIB wire, angled, with socket
1	P3910-1J	PIB wire, interrupted, with sockets
2	P3910-2A	PIB lamp socket, E10
2	P3910-2R	PIB switch, ON/OFF
1	P3910-2K	PIB battery (rechargeable) 1.2V
1	P3910-1K	PIB wire with jack bush
1	P3910-3G	PIB resistor 100 Ohm
1	P3910-3M	PIB resistor 500 Ohm
1	P3910-3O	PIB resistor 1 kOhm
1	P3910-3R	PIB resistor 10 kOhm
1	P3910-3S	PIB resistor 47 kOhm
1	P3910-5A	PIB rheostat 10 kOhm
1	P3910-5F	PIB potentiometer 470 Ohm
1	P3910-4A	PIB NTC resistor
1	P3910-4E	PIB PTC resistor
1	P3910-4J	PIB photo resistor (LDR)
1	P3910-4K	PIB varistor (VDR)
1	P3910-6D	PIB capacitor 0.1 μ F
1	P3910-6G	PIB capacitor 1 μ F
1	P3910-6H	PIB capacitor 2 μ F
1	P3910-6J	PIB capacitor 10 μ F
1	P3910-6N	PIB capacitor 100 μ F
1	P3910-6Q	PIB capacitor 1000 μ F
2	P3910-7A	PIB Si diode
1	P3910-7B	PIB Ge diode
1	P3910-7E	PIB Zener diode 4.7 V
2	P3910-7K	PIB LED red



EOS 7.2 Continuous oscillation

1	P3910-7T	PIB bridge rectifier
1	P3910-8A	PIB transistor NPN, base left
1	P3910-8B	PIB transistor NPN, base right
1	P3910-8C	PIB transistor PNP, base left
1	P3911-2J	PIB for coil with 800 turns
1	P3911-2K	PIB for coil with 2 x 800 turns
1	P3911-2A	PIB buzzer
1	P3911-2B	Earphone, SE
1	P3911-2R	Coil with 800 turns SE, blue
1	P3911-2S	Coil with 2 x 800 turns SE, red
1	P3911-1J	Iron core, laminated, U and I-shaped core with clamp strap
2	P3320-1I	Light bulb, 10 V/50 mA, E10
1	P3410-2M	Bearing bush for cylindrical magnets
2	P3410-1K	Bar magnet, AlNiCo, D=10 mm, L=50 mm
1	P3911-1K	Iron core, solid, L=50 mm
1	P3911-3F	Plug-in pin with needle
2	P3310-1A	Crocodile clip, plain metal
2	P3911-3D	Crocodile clip with plug

Storage

1	P7806-4M	Box insert Electronics – complete, SE
1	P7806-1G	Storage box II large, with cover
		Box insert plan with 2 labels

Power supplies

57

P3130-3D Low-voltage power supply with digital display

Continuously variable, stabilised DC voltage, level displayed on 20-mm digital display, and selectable AC voltage, with electronic overload protection;

Output terminals:

0 ... 12 V DC, stabilised, continuously variable, max. 3 A;
and 3, 6, 9 or 12 V AC, variably selectable, max. 3 A

Galvanic separation from mains source; output voltage provided through 4-mm safety jacks; ON-OFF switch; LED indicator for overloads and short circuits;
 T 630 mA fine-wire fuse (primary)

Voltage source: 230 V AC/50...60 Hz
 Green ABS plastic case with yellow labelling
 Dimensions: approx. 160x120x45 mm
 Weight: approx. 1200 g



P3120-3N Low-voltage power supply "inno"

Continuously variable, stabilised DC voltage and selectable AC voltage, with electronic overload protection; 10 strong neodymium magnets in the rear panel for mounting the device magnetically

Output terminals:

0 ... 12 V DC, stabilised, continuously variable, max. 3 A;
and 3, 6, 9 or 12 V AC, variably selectable, max. 3 A

Galvanic separation from mains source; output voltage provided through 4-mm safety jacks;
 ON-OFF switch with indicator lamp;
 T 400 mA fine-wire fuse (primary)

Voltage source: 230 V AC/50...60 Hz
 Green ABS plastic case with yellow labelling
 Dimensions: approx. 160x120x45 mm
 Weight: approx. 1225 g



P3120-3F Function generator SE

Output signals: sine, triangle and square
Frequency range: 0.1 Hz ... 100 kHz,
adjusted using variable controls (coarse, fine)

Output voltage: 0...4 V_{eff}, max. 4 watts, from 4-mm safety jacks;
 suitable for powering sources of sound as well as motors (2 A max.)
 thanks to high power output; with short-circuit and backlash
 potential protection

Input voltage: 12 V AC, provided e.g. by mains transformer
 P3130-7A (12V AC) or student mains transformer P3130-3D

Green ABS plastic case
 Dimensions: approx. 160x120x45 mm
 Weight: approx. 400 g



Meter displayed in original size



P3210-1P Multi-Multimeter analogue, automatic fuse

Moving-coil instrument with automatic overload protection. Meter for measuring voltage and current, can be used as galvanometer as well!

AC/DC voltage ranges: 1 mV, 100 mV ... 30 V

AC/DC current ranges: 100 μ A ... 3 A and 10 A

Arc scale length approx. 90 mm

Dimensions: ca. 120 x 160 x 50 mm

Weight: approx. 480 g

- Electronic overload protection with indicator light (no more melting fuses)
- Large, easy-to-read mirrored scale with clear labelling
- Extremely accurate, typically 1.5%
- Minimum power consumption – need not be shut down
- Durable selection switch
- 10 A range with separate input jack
- All measuring ranges (even for low current!) available in AC
- Exceptional frequency response (typically -1.5 db at 20 kHz) allowing direct measurement of all kinds of resonant circuits

- 1 mV upper value range for measuring thermal voltage or induction without a preamplifier!
- Zero at midpoint may be selected by switch



P3215-1S Multimeter, analogue 08, SE

Analogue hand multimeter specially designed to be handled by students. Pointer mid-point setting for particularly easy recognition of magnetic induction. Options for testing 1.5 and 9 V batteries and transistors make this multimeter truly unique.

Measuring ranges:

VDC: 100mV / 1 / 3 / 10 / 30 V

VAC: 3 / 10 / 30 V

ADC: 10 / 30 / 100 / 300 mA / 1 / 3 A

AAC: 10 / 30 / 100 / 300 mA / 1 / 3 A

Accuracy: approx. +/- 3 %

Battery testing: 1.5 V and 9 V

Transistor testing

Included:

2 test leads, technical instruction manual,

powered by 2 x 1.5 V batteries (included)

Overload protection: fine-wire fuse 3A/250V

Weight: approx. 300 g

Dimensions: 150 x 100 x 38 mm



Ordering information:

P3215-1S Multimeter, analogue 08, SE

P3215-1SG Multimeter, analogue 08, SE, 8 and more units

P3245-1T Hand multimeter, digital 07, auto-range

An ideal multimeter for student experiments.

Auto-range, data hold function, automatic shutdown, temperature, frequency and capacitance measurement, handy, large LCD display, support bracket, sheath

	Measuring ranges	Max. resolution:
VDC:	400 mV ... 600 V	0.1 mV
ACV:	4... 600 V	1 mV
ADC:	400 µA... 10 A	0.1 µA
AAC:	400 µA... 10 A	0.1 µA
Accuracy:	min. +/- 1.5 %	
Resistance:	400 Ohm ... 20 MOhm	0.1 Ohm
Frequency:	10 Hz ... 5 MHz	0.01 Hz
Capacitance:	4 nF ... 100 µF	10 pF
Temperature:	- 20 ... + 750 °C	1 °C
Conductance testing		
Diode testing		

Included: 2 test leads, temperature sensor, sheath, technical instruction manual

Powered by 2 x 1.5 V batteries (included)

Overload protection: fine-wire fuse 250mA/250V

Weight: approx. 153 g

Dimensions: 138 x 72 x 38 mm



Ordering information:

P3245-1T Hand multimeter, digital 07, auto-range

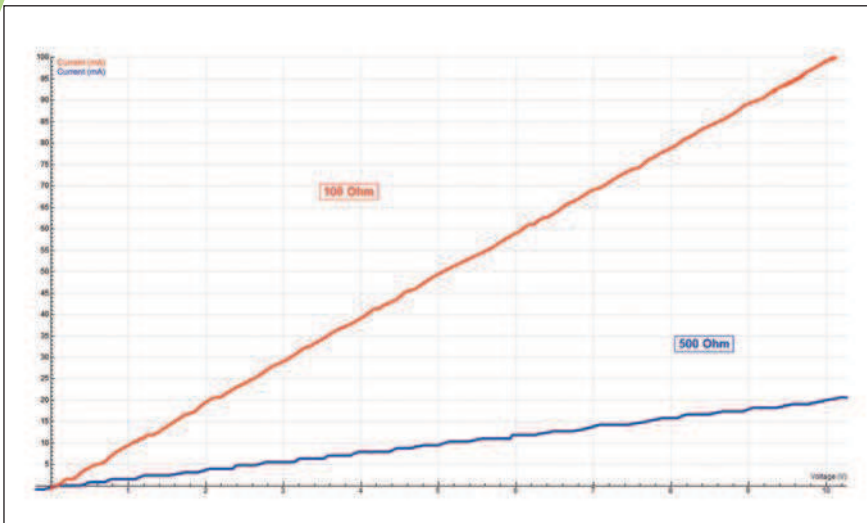
P3245-1TG Hand multimeter, digital 07, 8 units or more

Ordering information

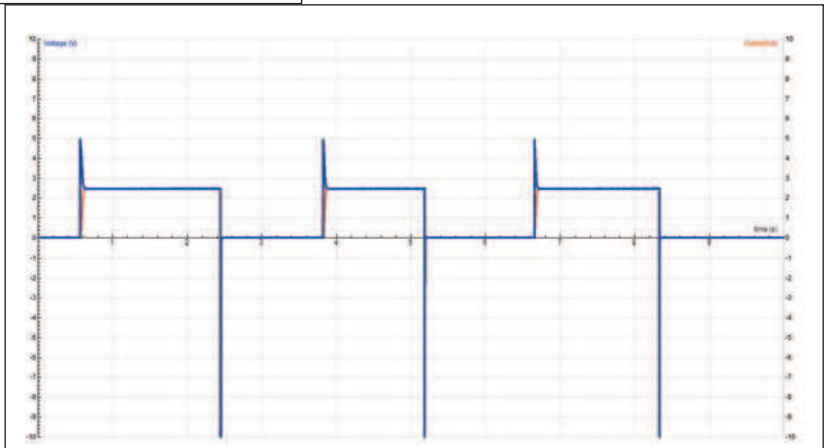
P4910-1U	ULAB datalogger, USB, serial, incl.Coach 6 Lite
P4210-2S	Sensor differential voltage, -10 .. +10 V
P4210-5S	Sensor current, -500 .. +500 mA

Supplement for the Electricity, Electromagnetism and Electronics modules

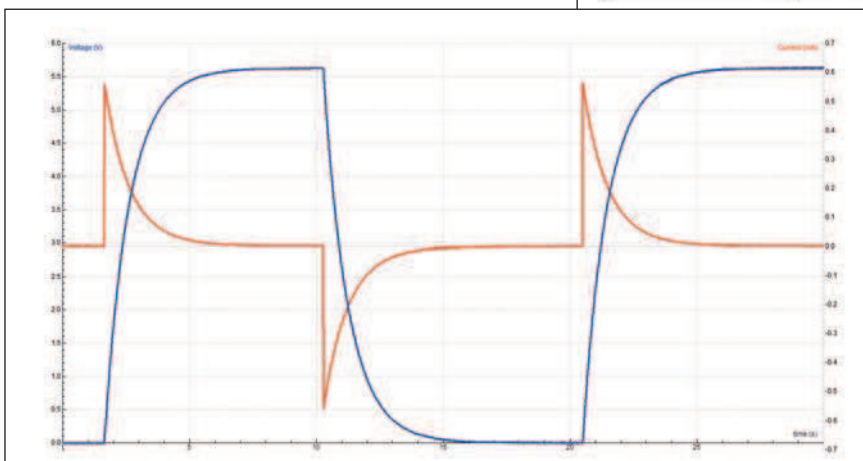
In contrast to conventional measurement methods with multimeters, this system allows voltage or current changes to be displayed in graphic form or, if required, exported to a chart for further processing.



Ohm's law



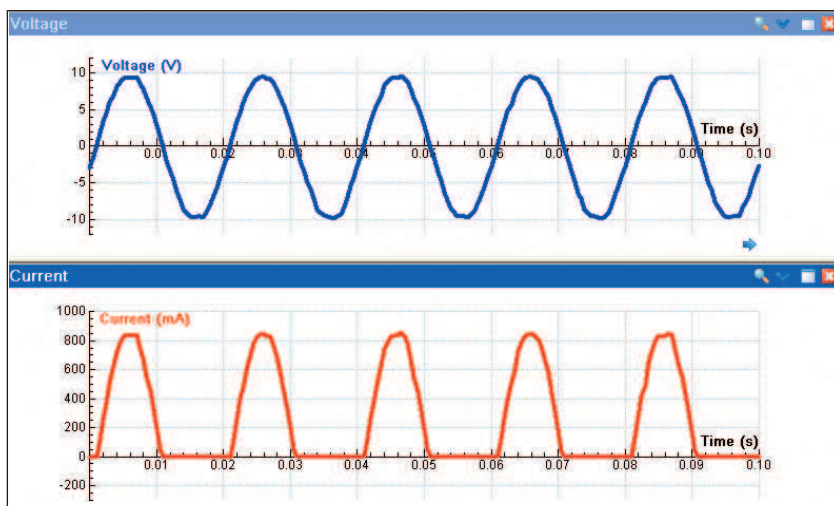
Response of a coil when power is switched on and off



Graph showing charge and discharge response of a capacitor

data logging

61



Half-wave rectification

An interface and sensors eliminate the need for an oscilloscope or a measuring amplifier!



Task

Electromagnetic Induction

Advice

A picture of the interface gets displayed through clicking on the symbol "announce interface" in the tool bar above.

The elected sensors get displayed at the appropriate space on the display of the interface and the instantly imported measured value gets indicated (controlling opportunity).

The indication of the measured value gets already done BEFORE the measurement gets started!

When clicking on the symbol again, the measuring interface gets faded out.

Assembly

The coil 800 wdg. (4) gets plugged in its associated module (3), switched as shown on the picture and connected with the voltage sensor (1).

The voltage sensor (1) gets connected at the 1st analogue input.

Experiments

1. The measurement gets started. With its northpole ahead, the bar magnet gets dropped from a low height through the coil.

Material

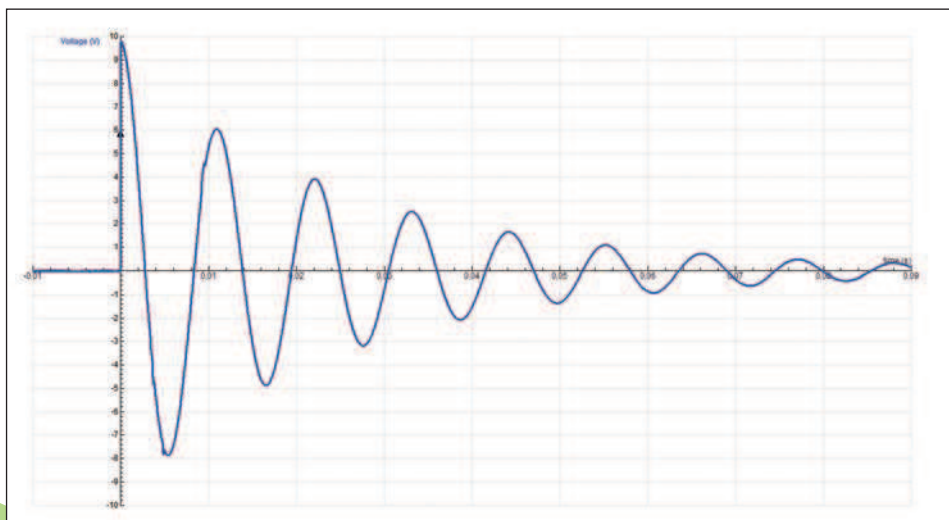
1	P4210-1S	1	Voltage sensor -10...+10 V
2	P3910-1A	1	Plug-in panel, small
3	P3911-2J	1	PIB for coil 800 turns
4	P3911-2R	1	Coil 800 turns SE, blue
5	P3911-2K	1	PIB for coil 2 x 800 turns
6	P3911-2S	1	Coil 2 x 800 turns SE, red
7	P3910-1H	2	PIB wire, angled, with socket
8	P3910-1B	2	PIB connector
9	P3410-1K	1	Bar Magnet, AlNiCo, D=10 mm, L=50 mm
			1 interface

CH1 : Voltage sensor (differential)

CH1 : Voltage sensor (differential) [Standard]

V
0,0
V

Electromagnetic induction



Voltage at a capacitor within a resonant circuit

Ordering information

P9902-5S SEK Electrostatics
 P9160-5S Experiment manual Electrostatics



Experiments

1. CONTACT ELECTRICITY

- ESS 1.1 Plastic bar and acrylic bar under friction
- ESS 1.2 Discharge via a neon lamp
- ESS 1.3 Polarity of electrical charges
- ESS 1.4 Conductors – nonconductors

2. ELECTROSTATIC INTERACTION

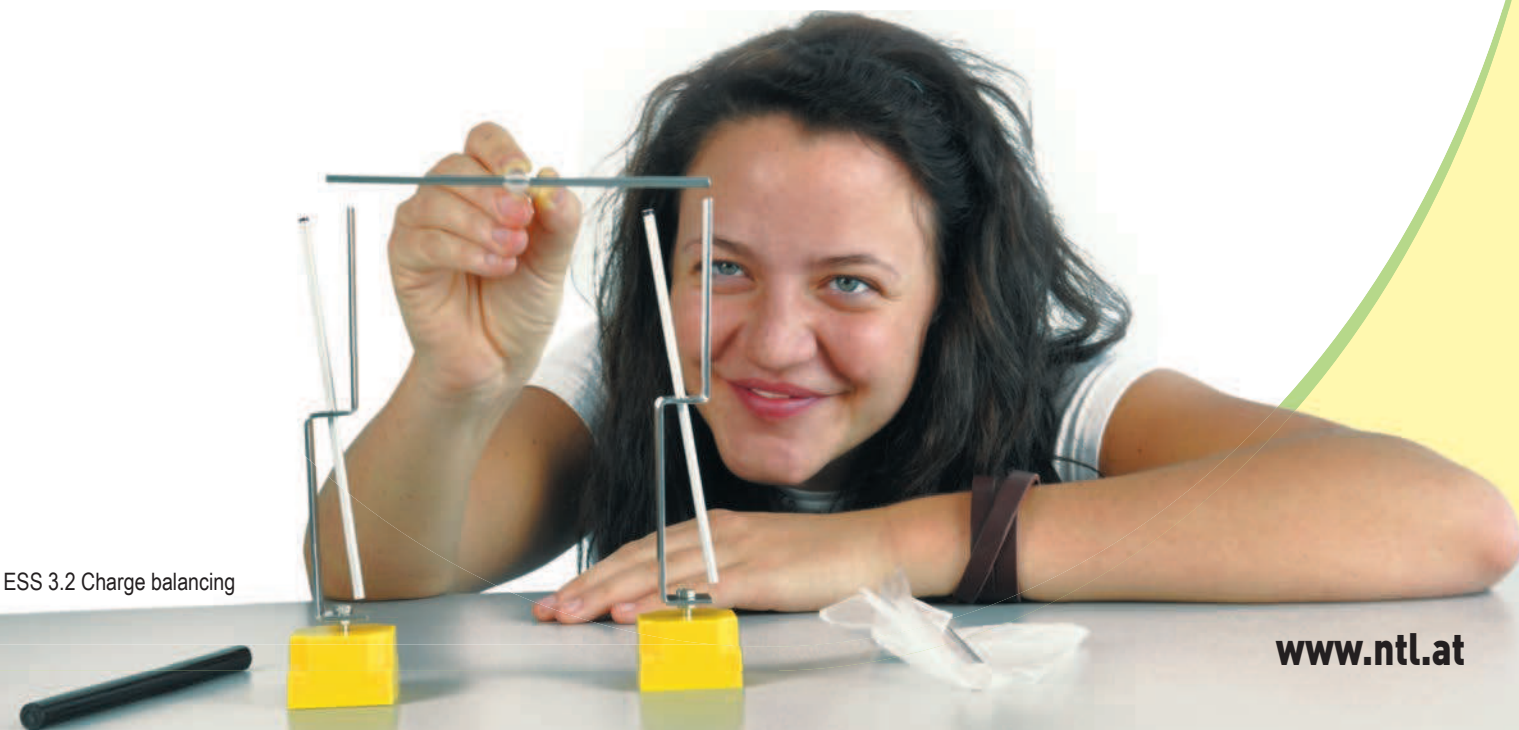
- ESS 2.1 Electrostatic interaction between charged bodies
- ESS 2.2 Model of the electroscope
- ESS 2.3 Electroscope

3. ELECTROSTATIC INDUCTION AND POLARISATION

- ESS 3.1 Electroscopes in electrical fields
- ESS 3.2 Charge balancing
- ESS 3.3 Charge separation of charge through electrostatic induction and neutralisation
- ESS 3.4 Faraday cage
- ESS 3.5 Isolators in electrical fields – polarisation



ESS 3.4 Faraday cage



ESS 3.2 Charge balancing

Kit consisting of:

Qty	Item no.	Description
2	P3520-1A	Electroscope SE Aluminium profile with 4-mm-plug, for mounting on isolated stand base, solid aluminium pointer, L = 140 mm, low-friction bearing
1	P3520-2A	Acrylic bar, 150x10 mm Drilled holes for the aluminium rod, D = 4 mm
1	P3520-2D	Plastic bar, 150x10 mm
1	P3520-2M	Plastic bar, 150x10 mm, with drilled hole
1	P3520-2E	Polyethylene rubber pad
1	P3520-2H	Aluminium bar, 150x4mm, to be used together with P3520-2L as discharger
1	P3520-2L	Acrylic bar, with drilled hole
1	P3320-9B	Fluorescent lamp SE
2	P3911-3H	Insulating block with socket
1	P3911-3F	Plug pin with needle
2	P3520-1D	Aluminium strip, SE (simple electroscope)
1	P3523-1F	Faraday cup, SE
1	C1000-1C	Beaker glass, 150 ml, small, Boro

Storage:

1	P7906-5S	Box insert Electrostatics, SE
1	P7806-1S	Storage box II mini, with cover Box insert plan with 2 labels

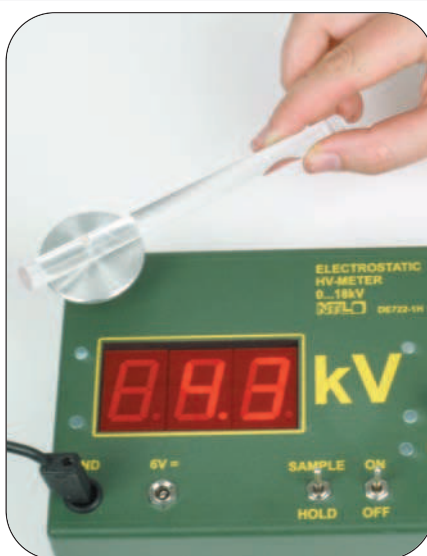


P9902-5S SEK Electrostatics

The electroscope has a pointer made of durable round aluminium tube, making it ideal for handling by students.



Accessories



- Display of accurate quantities
- Indication of Polarity



DE722-1H Static voltmeter "inno"

Meter for demonstration measurements of high electrostatic voltages; in contrast to mechanical electroscopes, this instrument delivers exact and clear quantitative readings, in addition to displaying the polarity of the charge; the value measured can be frozen using the hold switch; this instrument is easy to transport and can be mounted magnetically; the 26-mm LED display allows measurements to be read even from a distance

TECHNICAL DATA:

Display:	2 1/2-digit LED display;
Digit height:	26 mm
	Measurement input provided by means of special insulated 4-mm safety jack, 4-mm safety jack for ground connection
Measuring range:	0 ... 18.0 kV, reset button for resetting instrument to zero
Accuracy:	better than 2 % for 0 ... 10 kV
Throw switch:	ON/OFF
Throw switch:	measure sample
	freeze measured value (hold)
Power supply:	4 x 1.5 V mignon cells (included) or 5.5 mm hollow DC jack for 6 V/500 mA external power supply P3120-6N
Case:	green ABS plastic with yellow labelling
Dimensions:	approx. 160x120x45 mm;
Weight:	approx. 483g

Ordering information

P9901-4L	SEK Optics 1, 20 W Halogen
P9160-5G	Experiment manual Optics 1
P3130-7A	Fixed-voltage power supply 12 V / 20 W AC



Experiments

1. PROPAGATION OF LIGHT:

- OPS 1.1 Light propagates rectilinearly
- OPS 1.2 Shadows

2. MIRRORS:

- OPS 2.1 Reflection in a plane mirror
- OPS 2.2 Images in a plane mirror
- OPS 2.3 Reflection in a concave mirror
- OPS 2.4 Construction of images for a concave mirror
- OPS 2.5 Representation of a point by a concave mirror
- OPS 2.6 Reflection in a convex mirror
- OPS 2.7 Construction of images for a convex mirror
- OPS 2.8 Representation of a point by a convex mirror

3. REFRACTION:

- OPS 3.1 Refraction in a plane-parallel plate
- OPS 3.2 Refraction coefficient of glass
- OPS 3.3 Refraction at the transition from air to water
- OPS 3.4 Angle of incidence and angle of refraction
- OPS 3.4.1 Index of refraction of solid matter
- OPS 3.4.2 Calculation of parallel displacement in a plane-parallel plate
- OPS 3.5 Transition from glass to air
- OPS 3.6 Deflecting prism and reversing prism
- OPS 3.7 Refraction in a prism

4. LENSES:

- OPS 4.1 Refraction in convex lenses
- OPS 4.2 Marginal rays
- OPS 4.3 Construction of convex lens images
- OPS 4.4 Representation of a point by a convex lens
- OPS 4.5 Refraction in concave lenses
- OPS 4.6 Construction of images in a concave lens
- OPS 4.7 Representation of a point by a concave lens

5. COLOURS:

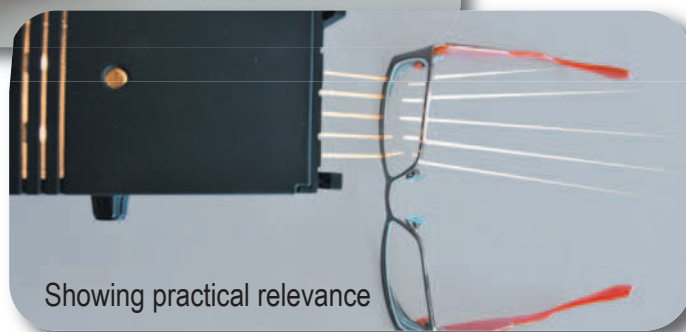
- OPS 5.1 Colour dispersion

6. THE EYE:

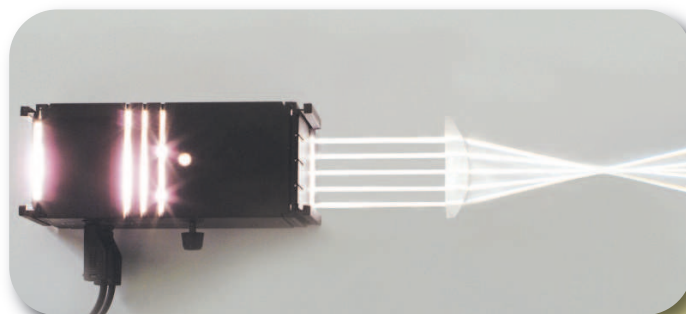
- OPS 6.1 Normal vision
- OPS 6.2 Near-sightedness (myopia)
- OPS 6.3 Far-sightedness (hyperopia)
- OPS 6.4 Presbyopia



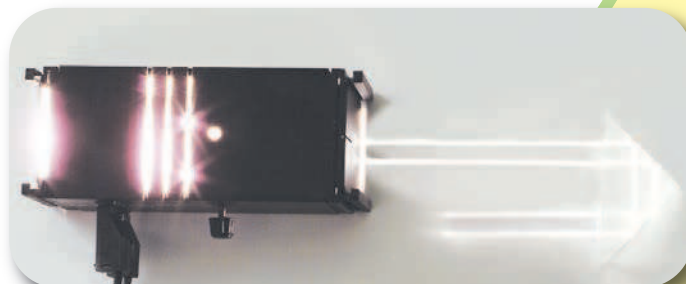
OPS 4.5 Refraction at a concave lens



Showing practical relevance



OPS 4.1 Refraction in convex lenses



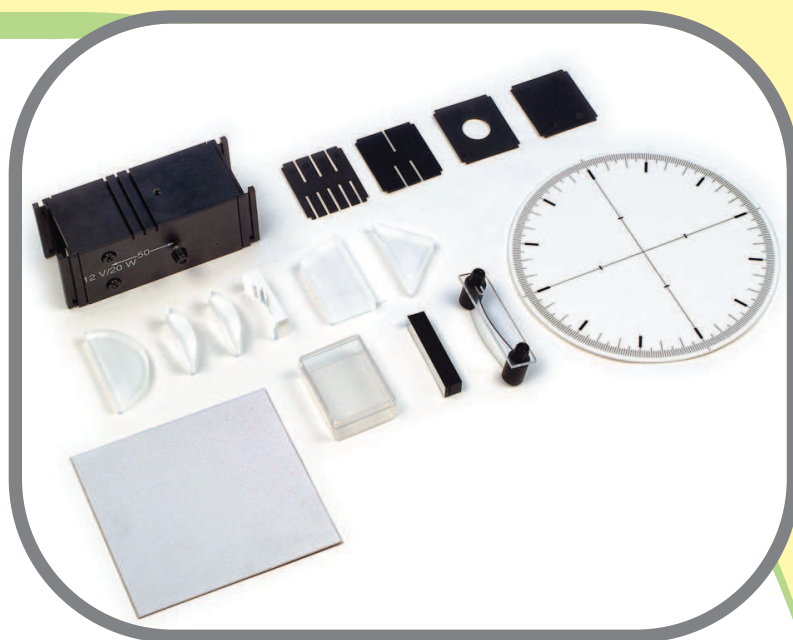
OPS 3.6 Deflecting prism and reversing

Kit consisting of:

Qty	Item no.	Description
1	P5110-1G	Light source, 20 W halogen, SE 12 V / 20 W halogen lamp For use directly on the desk or at an optical bench with built-in condenser lens, aluminium case with plastic rails for mounting screens
		Model bodies of high-gloss polished acrylic glass, coated white, 70 mm in length each
1	P5520-1F	Prismbody, acrylic, trapezoid, SE
1	P5520-1A	Lensbody, acrylic, semicircle, SE
1	P5520-1E	Prismbody, acrylic, 90° angle, SE
		Model bodies as above, each 51 mm in length
2	P5520-1B	Lensbody, acrylic, plano-convex, SE
1	P5520-1C	Lensbody, acrylic, plano-concave, SE
1	P5620-1A	Optical disk, with graduation, SE
1	P5610-5C	Screen white, SE
1	P5600-5A	Mirror plane, SE
1	P5600-5B	Mirror concave/convex, adjustable, SE, can also be used as parabolic mirror
1	P5405-1A	Shutter with 1 and 2 slits
1	P5405-1B	Shutter with 3 and 5 slits
1	P5710-1B	Plastic tank, transparent 65 x 47 mm with white base and cover

Storage:

1	P7906-4G	Box insert Optics 1, SE
1	P7806-1K	Storage box II small, with cover Box insert plan with 2 labels

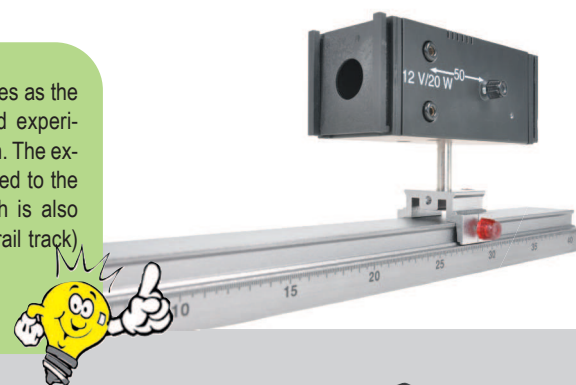


P9901-4L SEK Optics 1



Optics set for experiments "on the desk" with halogen lamp 12 V / 20 W

The Optics 1 kit also serves as the basis for more advanced experiments at the optical bench. The experimental lamp is attached to the optical bench (e.g. which is also used in mechanics as a rail track) using a rod.



Accessories

P5205-1A Colour mixing set for optics

for additive and subtractive colour mixing in combination with SEK Optics 1.

Set contains:
1 three-colour slide with additive colours,
3 deflective mirrors and
3 subtractive colour filters
made of plastic



Replacement lamp for experimental lamp SE

P3320-1R Halogen lamp, 12 V / 20W,
for G4 socket



P3130-7A Fixed-voltage power supply 12 V / 20 W AC

For supplying power to the halogen light source used in Optics 1



Ordering information

P9901-4L	SEK Optics 1
P9902-4H	SEK Optics 2
P9902-4K	SEK Optics 3, supplement
P9160-6G	Experiment manual Optics 2+3
P3130-7A	Fixed-voltage transformer 12V



Experiments

1. PROPAGATION OF LIGHT:

OPS 1.3	Light and shadow
OPS 1.4	Core shadow, half shadow
OPS 1.5	Lunar phases
OPS 1.6	Solar and lunar eclipse
OPS 1.7	Pinhole camera
OPS 1.8	Photometer

2. MIRRORS:

OPS 2.5.1	Images in a concave mirror
OPS 2.8.1	Images in a convex mirror

4. LENSES:

OPS 4.2.1	Determination of the focal length of convex lenses
OPS 4.4.1	Images in a convex lens
OPS 4.4.2	Law for images in convex lenses
OPS 4.5.1	Determination of the focal length of concave lenses
OPS 4.7.1	Images with a concave lens
OPS 4.8 *	Spherical lens aberrations
OPS 4.9 *	Chromatic lens aberrations

5. COLOURS:

OPS 5.2	Splitting light into colours using a prism and consequent recombination
OPS 5.3	Additive mixing of colours
OPS 5.4	Subtractive mixing of colours
OPS 5.5	Body colours

6. THE EYE:

OPS 6.1.1	Model of the human eye
OPS 6.5	Eye defects and their correction

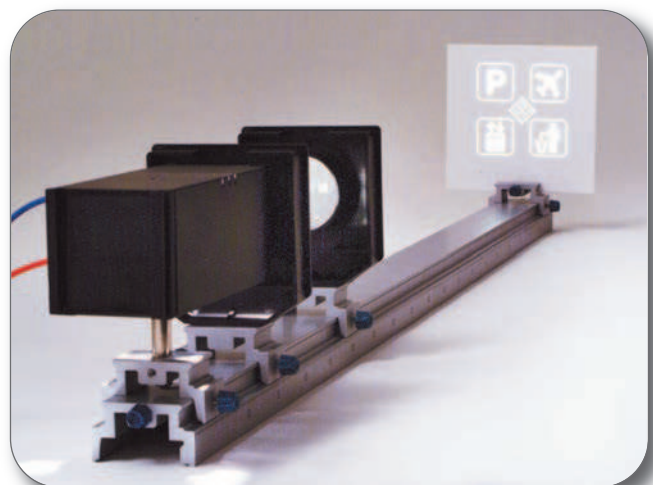
7. OPTICAL INSTRUMENTS:

OPS 7.1	Magnifying glass
OPS 7.2	Slide projector
OPS 7.3	Microscope
OPS 7.4	Telescope
OPS 7.5	Camera

8. WAVE OPTICS:

OPS 8.1 *	Diffraction through a grating
OPS 8.2 *	Determination of the wavelength
OPS 8.3 *	Polarisation using filters
OPS 8.4 *	Rotation of the plane of polarisation by inserting solid materials
OPS 8.5 *	Model of a saccharimeter
OPS 8.6 *	Photoelasticity

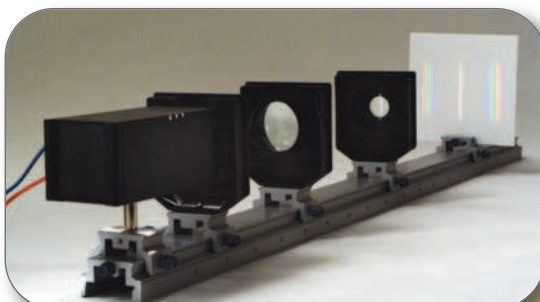
* These experiments can only be executed together with Optics 3, supplement



OPS 7.2 Slide projector



OPS 7.4 Telescope



OPS 8.2 Determination of wavelength

Optics 2 - Kit consisting of:

Qty	Item no.	Description
1	P5510-2A	Lens glass, in holder, $f_l = +50$ mm
1	P5510-2L	Lens glass, in holder, $f_l = -100$ mm
1	P5510-3C	Lens glass, in mount, $f_l = +300$ mm
1	P5510-3B	Lens glass, in mount, $f_l = +100$ mm
1	P5600-3B	Concave mirror in mount
1	P5600-3C	Convex mirror in mount
3	P5310-2A	Holder for lenses and screens
2	P5310-2B	Holder for slides and screens, slip-on type
1	P5400-1K	Round screens, set of 3 $D = 1, 3$ and 8 mm
1	P5400-1E	Slide with "L"
1	P5400-1F	Slide with 4 drawings
1	P5400-1A	Slide with 1 slit
1	P5490-1A	Earth-moon model Support axis curved at 23° , $D = 56$ mm Moon is moveable for illustration of moon phases
1	P5610-5A	Screen, translucent, in holder
1	P5115-1A	Diode lamps for additive colour mixing, with power supply module ($4.5 \dots 15$ V DC) as well as connecting cables
1	P5210-2A	Colour filter set, subtractive, SE
3	P5310-1E	Sliding saddle for optical bench
1	P5310-1H	Sliding saddle with set screw
1	P5550-1A	Prism, equilateral, glass, $s = 25$ mm
1	P5610-8A	Prism table, SE

Storage:

1	P7907-4H	Box insert Optics 2+3, SE
1	P7806-1G	Storage box II large, with cover Box insert plan with 2 labels

SEK P9901-4A Stand rail material is required for the Optics 2 module. The kit is a supplement to SEK P9901-4L Optics 1 for the secondary level. The list of experiments which can be performed using Optics 2 can be found on the previous page.

Optics 3 - Kit consisting of:

Qty	Item no.	Description
1	P5310-1B	Track and optical bench, 2×50 cm NTL aluminium rail profile, anodised, very thick and solid, with screen-printed millimetre scale, can be assembled to a 1-m rail using a rail connector, drill holes on the face for mounting pulleys or a rod to incline the track in any position/angle
1	P5310-1S	Rail connector SE, universal
1	P7240-1A	Support rod with pivot pin, $L = 100$ mm, $D = 10$ mm
1	P5410-1H	Circular disk in mount, $D = 34$ mm
1	P5410-1G	Circular screen in mount, $D = 20$ mm
1	P5310-2A	Holder for lenses and screens
1	P5820-1B	Diffraction grating, 300 lines/mm
1	P5420-2A	Quartz, polarisation material Right-shifting quartz, $D = 10$ mm For shifting the polarisation level
1	P5710-1A	Cell SE, $85 \times 45 \times 43$ mm
2	P5420-1A	Polarising filter, $D = 50$ mm, in mount
2	P5420-1B	Holder for polarising filters, with graduation
1	P5310-1E	Sliding saddle for optical bench
1	P5310-1H	Sliding saddle with set screw
1	P5310-1F	Sliding saddle for screens, springs and pointers
1	P5420-3A	Object for photoelastics

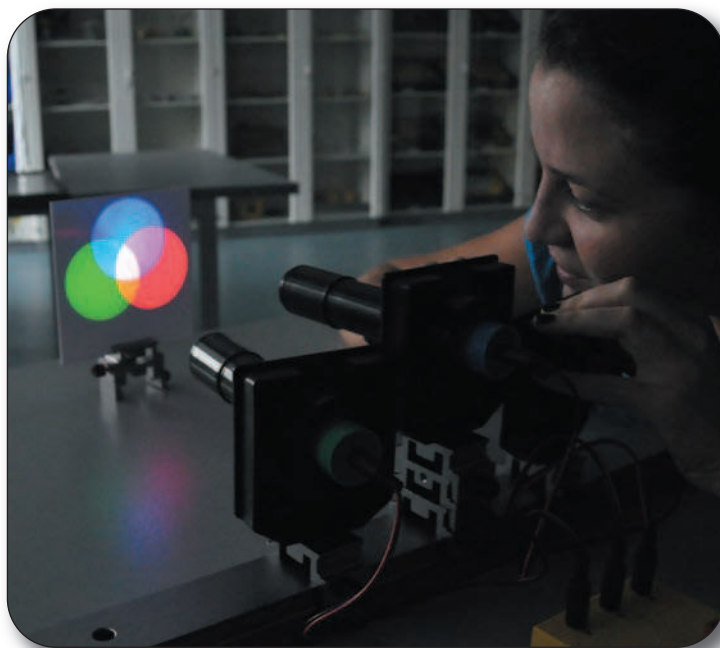
Storage:

Items can be placed in the box insert and box of SEK Optics 2



P9902-4H SEK Optics 2

Additive colour mixing with three separate lamps (ultra-bright diode lamps) with condenser lens. A flexible objective rod with integrated image lens enables adjustment to create a sharp and clear image within a distance of 15 to 90 cm!



OPS 5.3 Additive mixing of colours



P9902-4K SEK Optics 3, supplement

Ordering information

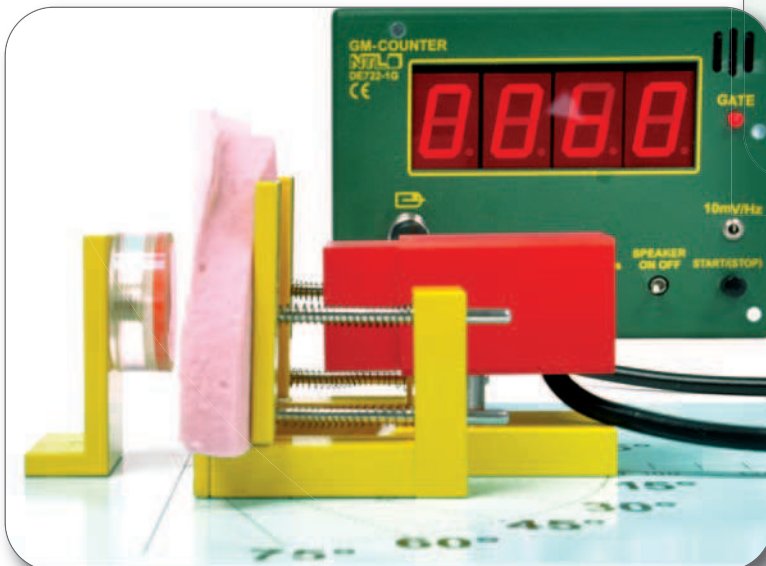
P9901-6R	SEK Nuclear science
DE722-1G	Geiger-Mueller counter, "inno"
DR291-1Z	Geiger-Mueller tube on magnetic base
P9160-6R	Experiment manual Radioactivity

Experiments

- | | |
|---------|---|
| RAI 1.1 | Measuring blank value |
| RAI 1.2 | Identifying a radioactive source (natural radioactive substances) |
| | |
| RAI 2.1 | Alpha radiation: identifying alpha radiation |
| RAI 2.2 | Range of alpha radiation in air |
| RAI 2.3 | Absorption of alpha radiation |
| | |
| RAI 3.1 | Beta radiation |
| RAI 3.2 | Behaviour of beta radiation in a magnetic field |
| RAI 3.3 | Range of beta radiation in air |
| RAI 3.4 | Absorption of beta radiation |
| RAI 3.5 | Measuring the thickness of transparent plastic |
| RAI 3.6 | External exposure to beta radiation |
| RAI 3.7 | Beta radiation backscatter |
| | |
| RAI 4.0 | General notes on gamma radiation |
| RAI 4.1 | Range of gamma radiation in air: the inverse square law |
| RAI 4.2 | Gamma radiation not deflected in a magnetic field |
| RAI 4.3 | Gamma dosimetry |
| RAI 4.4 | Absorption of gamma radiation |
| RAI 4.5 | Detecting levels |



RAI 3.2 Behaviour of beta radiation in a magnetic field



RAI 4.3 Gamma dosimetry

Kit consisting of:

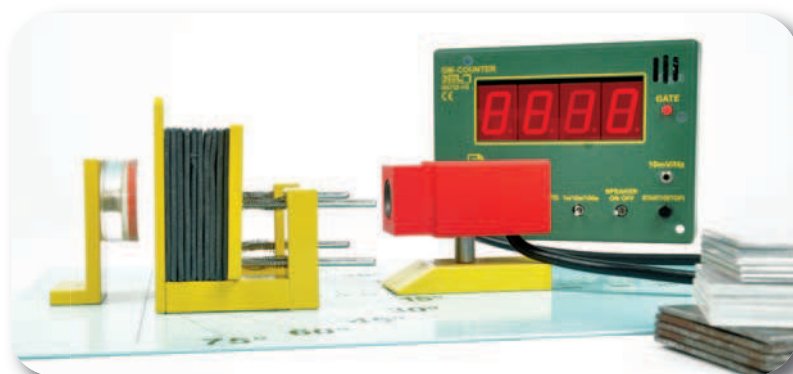
Qty	Item no.	Description
1	DR212-1H	Absorption plate mount, magnetic For vertically mounting absorption plates or other objects either magnetically, on a metal panel, or directly on a lab table
1	DR213-1A	Adapter for deflection in radioactive substances
1	DE407-1A	Magnets, button type, pair
1	DR250-1A	Radiation absorption plates, set of 25 pcs. 5 x Alu, 5 x Fe, 5 x Acrylic, 10 x Lead Dim: 80 x 50 x 2 mm
1	C3551-2T	Test tube, graduated
1	DM115-1A	Lead (tare) weights, 250 g For use as absorption mass
1	DR200-BK	Blue fertilizer, 250 g
1	DR200-KC	Potassium chloride, 250 g
1	DM810-1H1	Container with lid, plastic, 50 x 50 x 30 mm
1	C7418-2A	Knife for laboratory use, steel
1	DR201-1R	Radioactive preparation mount, magnetic
1	DR210-1P	Scale for radioactivity, metal Metal plate with imprinted angle scale and distance scale increments in mm and cm Dimensions: 300 x 210 mm

Storage:

1	P7906-1R	Box insert Radioactivity, plastic
1	P7806-1K	Storage box II small, with cover Box insert plan with 2 labels



P9901-6R SEK Nuclear science



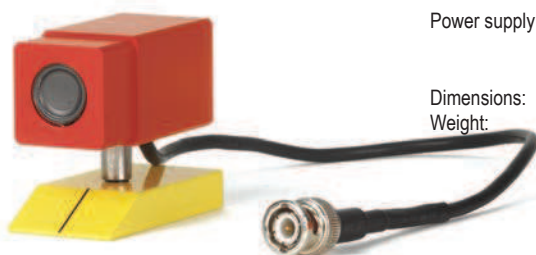
RAI 4.4 Absorption of gamma radiation

Required accessories



DR291-1Z Geiger-Mueller tube on magnetic base

For detecting the presence of alpha, beta and gamma rays
Gas filling: Ne & halogen
End window made of mica, 9.1 mm in diameter
Plateau voltage: approx. 500 V



DE722-1G MBI Geiger-Mueller counter, "inno"

Demonstration instrument for measuring ionising radiation; very easy to transport and magnetically mountable; the 26-mm LED display allows precise readings to be taken even at a great distance

TECHNICAL DATA:

Display:	4-digit LED display; digit height 26 mm
Switch:	ON-OFF
MODE switch:	
IMP setting:	manual start and manual stop
MAN setting:	manual start, one measurement is taken during the interval set on the TIME switch
AUTO setting:	measurement cycle is repeated for the interval set on the TIME switch
TIME switch:	for the MAN and AUTO modes a valid measurement interval of 1, 10 or 100 seconds may be selected
SPEAKER switch:	switches the speaker on or off
START switch:	starts and stops measurement in IMP mode and starts measurement in MAN mode
GATE LED:	indicates counter gate state
	Analogue output through a 3.5 mm phone jack (10 mV/Hz)
	BNS jack for connecting tube DR291-1Z
Power supply:	4 x 1.5 V mignon cells (included) or 5.5-mm hollow DC jack for 6 V/500 mA ext. power supply
Dimensions:	approx. 160 x 120 x 45 mm;
Weight:	approx. 475 g

Radioactive preparations:

DR209-PO Po-210 preparation (alpha radiation)

Emits alpha radiation (polonium-210) with activity (A) = 3.7 kBq; half-life: 138.40 days; emits alpha particles with a maximum energy level of 5.305 MeV

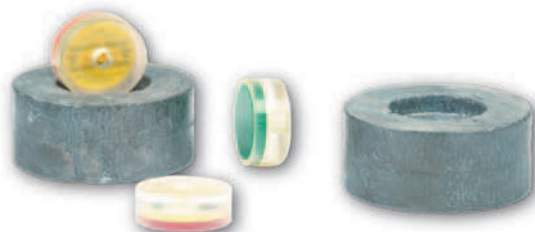
DR209-SR Sr-90 preparation (beta radiation)

Emits beta radiation (strontium-90) with activity (A) = 3.7 kBq; nuclide decays to its daughter particle yttrium-90 which emits beta particles with a maximum energy level of 2.27 MeV

DR209-CO Co-60 preparation (gamma radiation)

Emits gamma and beta radiation (cobalt-60) with activity (A) = 37 kBq; half-life: 5.258 years; in addition to beta radiation, which is absorbed by the radiation window, it emits gamma rays with an energy level of 1.17 and 1.33 MeV

This source is supplied with two lead cylinders for shielding against gamma radiation



Instructions and advice for the purchase of these preparations can be found in our general catalogue, or you may directly contact your authorised retailer

Ordering information

DR420-1P Planck's constant,
compact apparatus



A phenomenal piece of equipment:

With this device, **Planck's constant** can be easily determined to an error level around or better than 5%.

Electron affinity can be calculated as well.

The phenomenon is termed the **outer photoeffect**. Electromagnetic radiation results in the release of electrons from a metal surface.

The device has a built-in photodiode, and LEDs of various wavelengths are used as monochromatic light sources. The emitted light passes through the opening of the ring-shaped anode and contacts the surface of the cathode. In the photoeffect, a photon transfers its entire energy ($E = h \cdot f$) to an electron upon impact. Part of the energy is required to force the electron out of the metal surface (electron affinity). The remaining energy is then at the electron's disposal as kinetic energy.

$$E_{\text{kin}} = h \cdot f - \phi$$

The critical voltage for the five available wavelengths is measured within this experiment. All further calculations are based on this.

TECHNICAL SPECIFICATIONS		
Photocell	Material	Caesium (Cs)
Voltmeter	Display	3 1/2 digit, LCD
	Precision	0,5 % (typical)
Amperemeter	Display	3 1/2 digit, LCD
	Precision	1 % (typical)
Dimensions	WxHxD = 280 x 120 x 160 mm	
Weight	approx. 1000 g	

All required peripheral devices (voltmeter, nano-amperemeter) are integrated into the device.

The five light sources (LEDs with various precisely defined wavelengths) are supplied with power from the device.

Power supply through included fixed-voltage transformer.

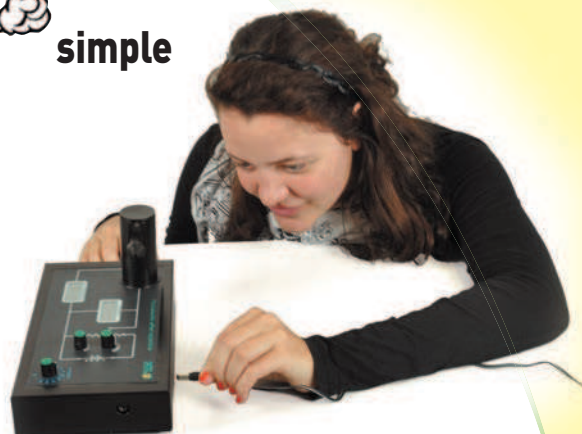
Supplied with experiment manual as well as evaluation spreadsheet (Excel).

The evaluation of the experiment can be easily done by entering the values measured for the critical voltage in the columns of the Excel spreadsheet included.



simple

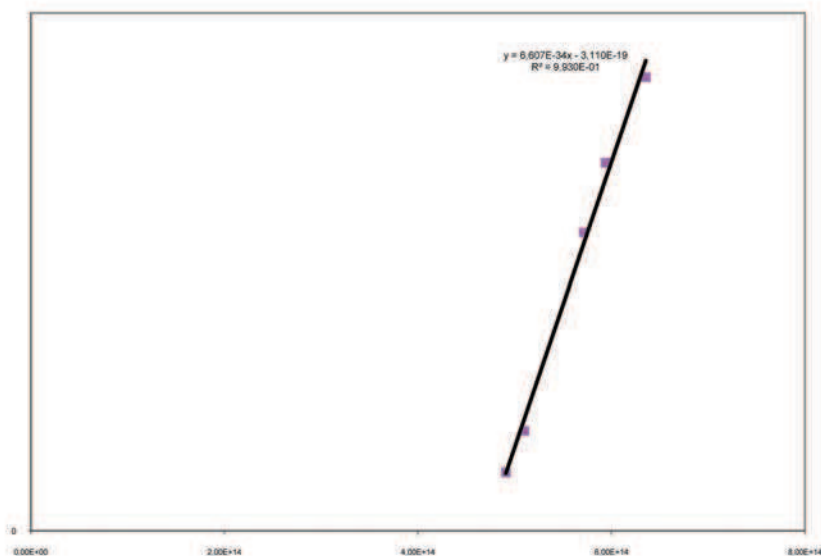
NAME	[m]	[V]	F [Hz]	$E_0 = U_0 \times e$ [J]	$E = h \times f - \phi$ [J]
SAMPLE	6,11E-07	0,085	4,91E+14	1,36E-20	1,334E-20
	5,88E-07	0,145	5,10E+14	2,32E-20	2,606E-20
	5,25E-07	0,432	5,71E+14	6,912E-20	6,663E-20
	5,05E-07	0,533	5,94E+14	8,528E-20	8,162E-20
	4,72E-07	0,657	6,36E+14	1,0512E-19	1,091E-19



Afterwards, the inclination h and the axis intercept ϕ can be read from the graph ...



fast



safe



.... and the program then automatically calculates the deviation (error) from the theoretical value.



EXPERIMENTAL RESULTS	PLANCK'S CONSTANT [J.s]	ELECTRON WORK FUNCTION [J]
THEORETICAL	6,626E-34	3,120E-19
MEASUREMENT	6,607E-34	3,110E-19
ERROR [%]	-0,29 %	-0,32 %

Of course, these parameters can be calculated manually as well, but this is much more time-consuming.

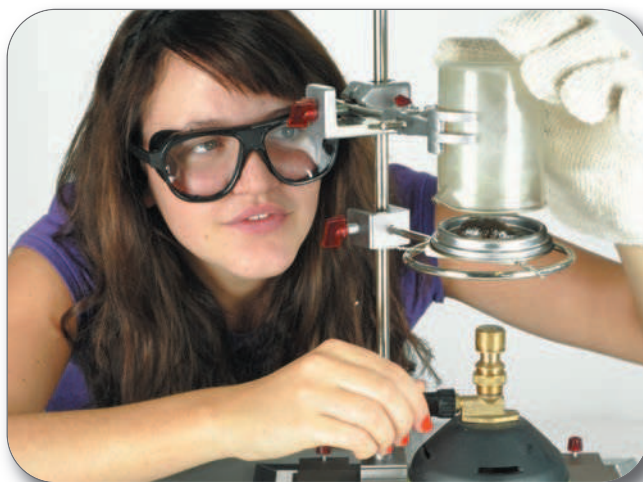
Ordering information

C9902-4A	SEK Chemie-Startkoffer
C9902-4B	SEK Chemie-Startkoffer
C9160-4A	Experimentierkoffer Chemie



Experiments

CHS 1.1	Pure substances are rarely found in nature	(13 experiments)
CHS 1.2	Electrical conduction and insulators	(4 experiments)
CHS 2.1	Chemistry: the world of substances	(6 experiments)
CHS 2.2	Water seen chemically	(14 experiments)
CHS 2.3	Chemicals in daily life – it all depends on the dosage	(6 experiments)
CHS 2.4	Acids and bases in daily life	(11 experiments)
CHS 2.5	Air: the life element	(12 experiments)
CHS 2.6	Natural substances and synthetic products	(6 experiments)
CHS 2.7	Substances in the working world	(15 experiments)
CHS 2.8	Chemistry – natural and industrial synthetics	(8 experiments)
CHS 2.9	Alcohol and carbonic acids	(9 experiments)
CHS 2.10	Foods – nutrients	(13 experiments)
CHS 2.11	Substances for cleaning and hygiene	(5 experiments)



CHS 2.10.2.1 What are diet killers made of?

More than 120 Experiments



CHS 1.1.1.5 Your own sewage treatment plant



CHS 2.2.2.1 Oxyhydrogen

C9902-4A SEK Chemistry stand

73

Qty Item no. Description

1	DS100-1H	Support base, L = 250 mm
2	DS400-2K	Bosshead, cross-pattern, SE
1	DS103-04	Sliding saddle, H = 40 mm
1	DS502-02	Support ring on support clamp, D = 102 mm
2	DS502-62	Support ring on support clamp, D = 62 mm
1	P7240-1G	Support rod, round, L = 500 mm, D = 10 mm
1	C7002-1A	Universal clamp, 0 - 80 mm
1	C7420-1S	Spatula spoon, steel, 150 x 18 mm
1	C7420-2S	Spatula double, flat, steel, 180 x 11 mm
1	C8020-1A	Mortar, D = 100 mm, ceramic
1	C8020-2A	Pestle, L = 110 mm, ceramic
1	C8000-3B	Crucible, 35 ml, tall, ceramic
1	C8010-1C	Evaporating dish, 75 ml, ceramic
1	C7415-2Z	Crucible tongs, stainless steel, L = 200 mm
1	C7205-1A	Test tube holder, wooden, 10 - 30 mm
1	C7418-2A	Knife for laboratory use, steel
1	C1570-1S	Pipette, measuring, 10 / 0.1 ml, graduated
1	C7223-1A	Triangular wire support, ceramic collar, 60 mm
1	P7125-1B	Wire gauze with ceramic centre, 150 x 150 mm
1	C7205-2A	Test tube rack, 12 holes, 6 sticks
1	C7418-1A	Forceps, pointed ends, steel, L = 115 mm
1	C6020-1C	Stirring rod, glass, 8 x 250 mm
1	C7600-1K	Protective gloves, cold/hot, pair
1	C7445-7G	Tubing rubber, D = 7/10 mm, L = 100 cm
1	C7413-1A	Deflagration spoon, L = 450 mm

Storage:

1	C7806-4A	Box insert Chemistry stand
1	P7806-1B	Storage box II large, with cover Box insert plan with 2 labels



The stand base, made of a special NTL anodised aluminium profile, is very solid and creates a relatively strong, stable stand area and is resistant to chemicals. Sliding saddles are able to be set and fixed in place easily.



C9902-4B SEK Chemistry glass

Qty. Item no. Description

1	C1000-1B	Beaker glass, 100 ml, low form, Boro
1	C1000-1C	Beaker glass, 150 ml, low form, Boro
1	C1000-1D	Beaker glass, 250 ml, low form, Boro
1	C1370-1B	Funnel, plastic, D = 75 mm
1	C3020-6D	Erlenmeyer flask, glass, 250 ml, SB 29
1	C1055-1H	Test tube, glass, 30 x 200 mm, with side arm, Boro
1	C1380-2A	Gas jar, glass, cylindrical, 200 x 52 mm, ground rim
1	C1064-1A	Funnel, separating, 50 ml, cylindrical, with stopper
1	C7520-1A	Cobalt glass filter, 50 x 50 mm
2	B7505-1A	Microscope slide, 76 x 25 x 1 mm
1	C1385-1A	Cover plate glass, D = 75 mm, one side ground
1	C6120-1C	Watch glass, D = 100 mm
1	C6030-1M	Glass tubes, set, nos. 1-7, D = 8/5 mm
12	C1050-1C	Test tube, glass, 16 x 160 mm, Boro
1	B7804-1A	Magnifier, 3x and 5x, plastic
2	C6150-2A	Pipette glass, with rubber bulb, 5 ml
1	C7530-1A	Brush for test tubes, D = 17 mm
1	C6510-6C	Thermometer -20...+110/1 °C, alc., graduated
4	C7320-1C	Stopper silicone, 12/18/27 mm
2	C7320-1D	Stopper silicone, 12/18/27 mm, 1 hole
1	C7320-4B	Stopper silicone, 26/32/30 mm, 1 hole, SB 29
1	C7320-5B	Stopper silicone, 31/38/35 mm, 1 hole
1	C6160-1S	Pipette pump, mechanical, 10 ml capacity

Storage:

1	C7806-4B	Box insert Chemistry glass
1	P7806-1G	Storage box II large, with cover Box insert plan with 2 labels



The support rings with boss-head ensure a safe and stable assembly.



Precasted, thick-walled glass-tubes enable a quick treatment of experiments.



All stoppers are made of silicone. This guarantees a long-term elasticity, high melting point, food safety and a high resistance against chemicals. It also ensures that stoppers can be inserted and removed easily.



Protection gloves for safe work



Ordering information

C9902-4A	SEK Chemistry stand
C9901-4E	SEK Electrochemistry
C9901-4C	SEK Chemistry - distillation (GL)
C9160-4A	Experiment manual Chemistry



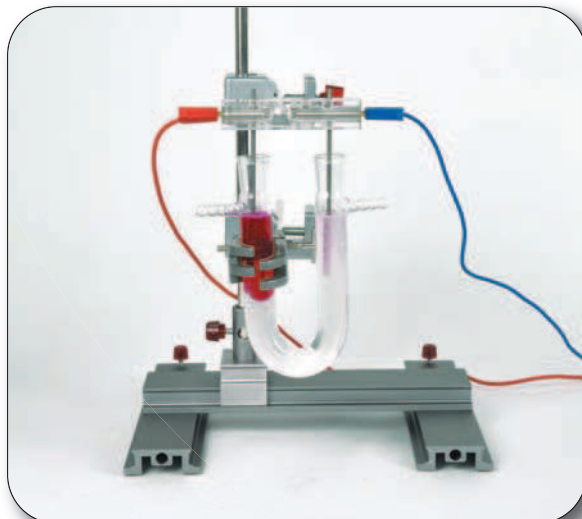
C9901-4E SEK Electrochemistry

Qty Item no. Description

1	DE921-3A	Holder with plug pin
1	C3082-4C	U-shaped tube, glass, with adapter, SB 19
1	C7118-2A	Electrode rod holder
1	P3310-1A	Crocodile clip, plain metal
1	C7118-2B	Electrode rod holder accessory
1	P3910-2B	PIB lamp socket E 10, plug-in component
1	C1000-1B	Beaker glass, 100 ml, small, Boro
1	P3320-1I	Light bulb, 10 V/50 mA, E10
1	P3310-3A	Connecting lead, 50 cm, red, SE
2	P3310-3B	Connecting lead, 50 cm, blue, SE
2	C7124-5A	Electrode rod, carbon
1	C7124-4A	Electrode rod, copper
2	C7124-6A	Electrode rod, nickel
2	C7320-2B	Stopper silicone, 17/22/25 mm, 1 hole, SB 19

Storage:

1	C7906-4E	Box insert Electrochemistry
1	P7806-1K	Storage box II small, with cover Box insert plan with 2 labels



Exchanging electrodes

With the SEK electrochemistry (C9901-4E), additional 13 experiments in "electrical chemistry" can be performed.



C9901-4C SEK Chemistry - distillation

Qty Item no. Description

1	C3601-01	Flask with round bottom, 100 ml
1	C3601-03	Adapter for distillation
1	C3601-06	Cooling tube, with screw-on lids and connectors
1	C3601-21	Gas discharge tube, curved
1	C6514-13	Thermometer, chemical, -10 ... +110 °C, alcohol-filled

Storage:

1	C7806-4C	Foam insert for SEK distillation (GL)
1	P7806-1K	Storage box II small, with cover Box insert plan with 2 labels

The SEK Distillation C9901-4C is a distillation apparatus with GL screw closures. The apparatus enables an accurate measurement of temperature and contains an efficient cooling apparatus.



Distillation with heating jacket

Chemistry accessories

75



P2110-1A Gas cartridge burner



P2110-1C Gas cartridge



or
P2110-1V Gas cartridge with valve

C7227-1B Protective shield, 500 x 330 mm, acrylic

DS102-12 Stand rail base, L = 125 mm

2 required

DS140-2R Slider stand, horizontal

2 required

C7225-1A Protective ceramic plate in metal frame,
500 x 330 mm

Ceramic fibre in zinc plate frame



C6005-1B Washing bottle, 500 ml, PE

C7605-1S Protective goggles with side
protection



C7447-1B Tray plastic,
260 x 160 x 100 mm approx.
Volume: approx. 2.5 l



Set of chemicals for student experiments:
the detailed content of this set can be requested from your authorised retailer



P3245-1T Hand multimeter, digital, small, autorange
Please refer to page 58 for technical data

**We attach great
importance to safety**



P3130-3D Low-voltage transformer with digital display
Please refer to page 57 for technical data



Ordering information

P4910-1U ULAB Datenlogger, USB, serial,
incl. Coach 6 Lite
(please see selection of sensors below)

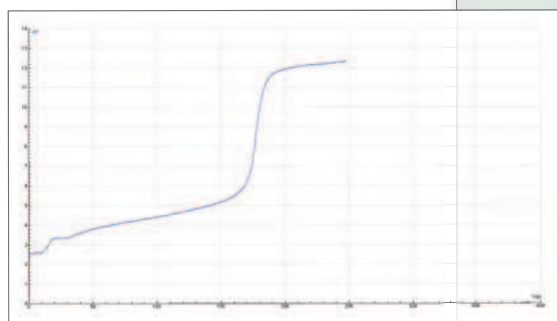
Supplement for Chemistry 1 module:

The use of one or more sensors and an interface is practically essential for recording changes in temperature or the progress of a reaction.

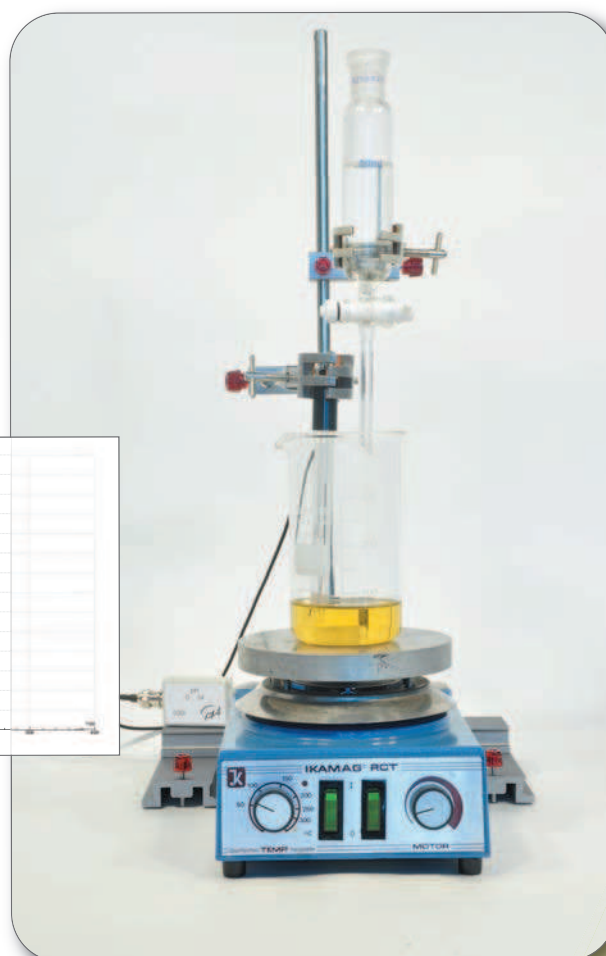


Sensors

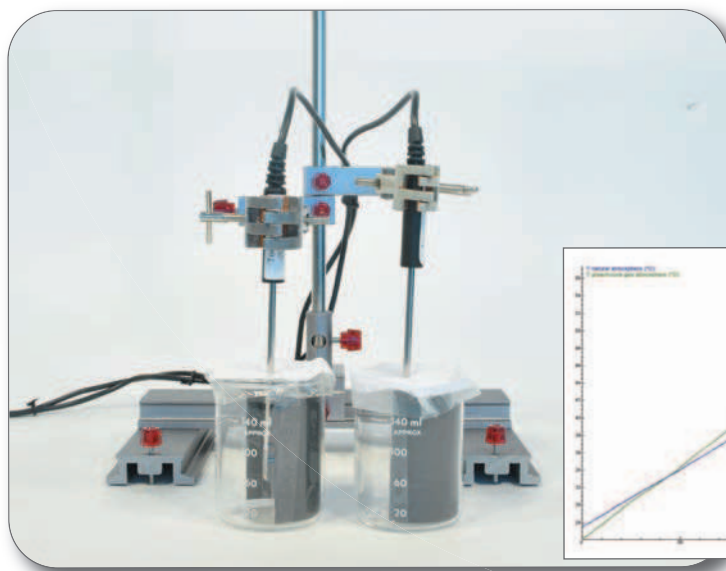
Qty	Item no.	Description
1	P4230-1A	Sensor Ammonium (NH_4^+)
1	P4230-1C	Sensor Chloride (Cl^-)
1	P4230-2C	Sensor CO_2 , 0 ... 5000 ppm
1	P4230-3C	Sensor CO_2 , 0 ... 100000 ppm
1	P4230-1K	Sensor Calcium (Ca^{2+})
1	P4230-1L	Sensor Conductivity, 0 ... 0.2 / 2 / 20 mS
1	P4230-1N	Sensor Nitrate (NO_3)
1	P4230-1P	pH amplifier (electrode not included)
1	P4230-2P	pH electrode (amplifier not included)
1	P4230-1F	Colorimeter (purple, blue, green, red)
1	P4230-1R	Sensor Redox, -450 ... +1100 mV
1	P4230-1S	Sensor Dissolved oxygen (for liquids), 0 ... 14 mg/l
1	P4230-2G	Sensor Oxygen gas, 0 ... 100 %
1	P4230-1T	Drop counter



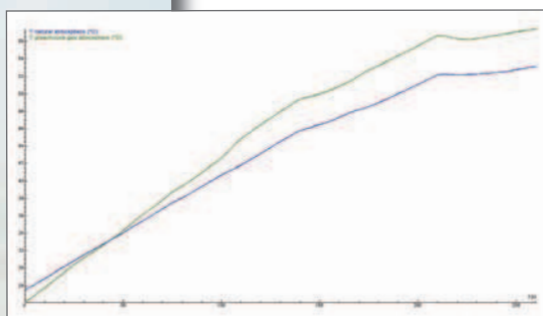
Titration diagram



"Sour affair" (titration)



Greenhouse effect in beaker



Greenhouse effect in beaker - diagram

data logging

For outdoor measurements:



Analysis of standing bodies of water

Measure, store and analyse data outdoors! The new ion-selective sensors have been developed especially for investigations of water. The parameters nitrate (NO_3^-), calcium (Ca^{2+}), chloride (Cl^-) and ammonium (NH_4^+) can be displayed quickly.



Analysis of flowing water



Analysis of groundwater (well)



Analysis of swimming pool water

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