



magnetostatics

NEODYMIUM - an extremely strong permanent magnet

A magnet's quality is measured by the maximum energy product (BH max). Here is a comparison of the maximum energy products of various magnet materials:

Plastic-bonded, anisotropic barium ferrite (Betaflex) =	18 kJ/m ³
Sintered, anisotropic hard ferrite (SrFe) =	27 kJ/m ³
AlNiCo 500 =	36 kJ/m ³
Plastic-bonded SmCo =	64 kJ/m ³
Plastic-bonded NdFeB =	80 kJ/m ³
Samarium cobalt (SmCo) =	180 - 225 kJ/m ³
Neodymium iron boron (NdFeB) =	385 kJ/m ³



DE407-1A Button magnets, pair

Material: neodymium; poles covered with red or green plastic cap; L=5 mm, D=13 mm

DE407-1C Round magnets, pair

Material: neodymium; poles covered with red or green plastic cap; L=12 mm, D=24 mm



DE410-1N Cylindrical bar magnet, with bearing cup

Material: neodymium; poles covered with red or green plastic cap; bearing cup allows virtually friction-free pivoting on base-mounted bearing pin DE300-1N; L=126 mm, D=24 mm

DE411-1N Cylindrical bar magnet, with tapped hole

Material: neodymium; poles covered with red or green plastic cap; tapped hole for inserting a c-hook (DS102-3S) in order to suspend it from a bead chain (DS412-2K) or from a cord; L=126 mm, D=24 mm

DE455-1N Pole plates with pins, pair

Nickel-plated iron yokes; Dimensions: 68x28 mm



Experiment:
Force of neodymium magnets

DE405-2R Tube for floating magnets

Acrylic tube (L=240 mm) with a slot; serves to guide two bar magnets (DE410/411-1N) when used as "floating magnets"; iron shield plate DE432-1E (D=80 mm) may be used as a base

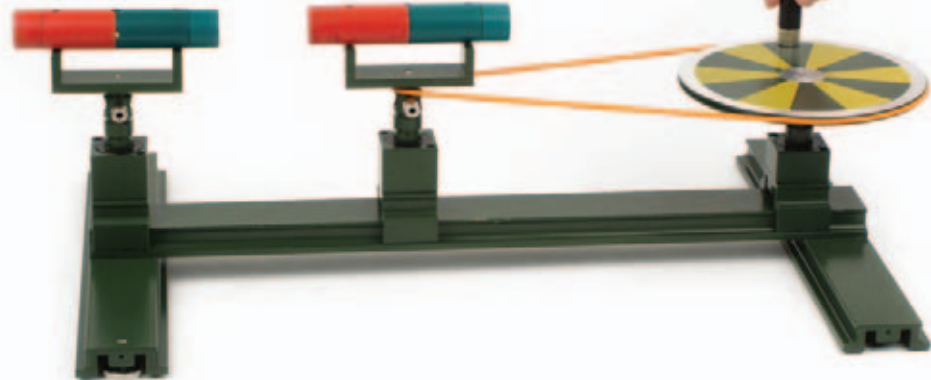


DP410-1E Cylindrical bar magnet

Material: Neodymium; poles covered with red or green plastic cap; tapped hole for inserting a c-hook (DS102-3S) in order to suspend it from a bead chain (DS412-2K), from a cord or from bearing sleeve P3410-2B; L=68 mm, D=24 mm

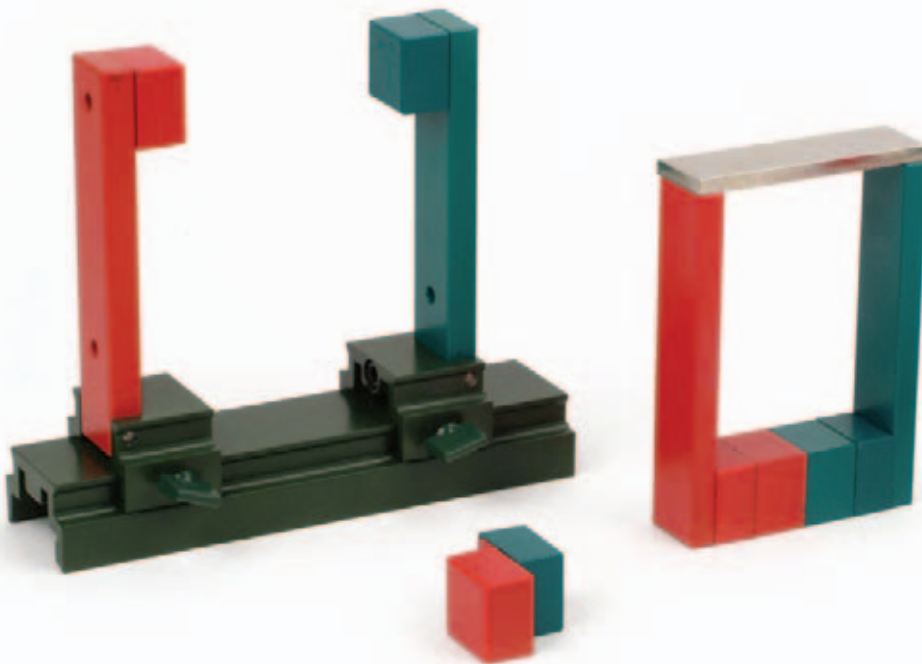
DP410-2S Cylindrical bar magnet, on support

Material: neodymium; poles covered with red or green plastic cap; L=68 mm, D=24 mm; permanently mounted support (L=35 mm, D=10 mm)



Experiment: Interaction of two magnets mounted to rotate

magnetostatics



U-magnet, variable, consisting of:

DS104-6G Stand rail, L=200 mm
DE456-1R Magnet holders, red-green, pair
DE412-1B Block magnets, pair

DE412-1B Block magnets, pair

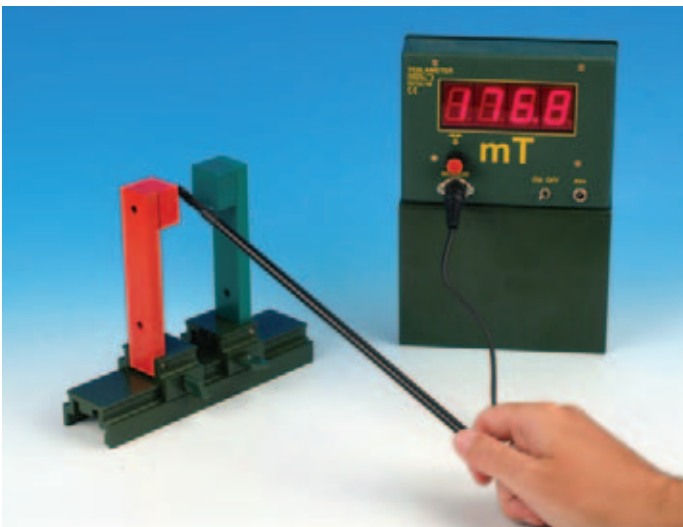
Material: neodymium; poles covered with red or green plastic cap; M6 tapping on the side; Dimensions: 28x28x18 mm

DE456-1R Magnet holders, red-green, pair

For assembling on stand rails a u-magnet with variably spaced arms; two metal holders, red-green powder-coated, on sliders; block magnets DE412-1B may also be secured in place using set screw DE452-3N

DE410-1U U-magnet, large

Material: neodymium, thus very strong; poles are labelled red or green; including iron yoke; **inside distance between poles: 74mm**; arm cross-section: 28x10 mm; free length of arms: 101 mm total length = 129 mm; Total width = 94 mm

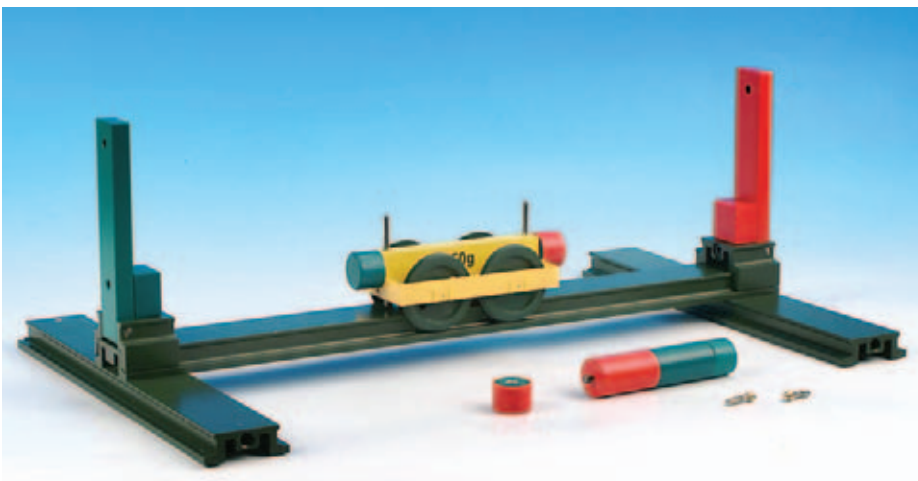


Use: Measuring the magnetic flux density of the variable u-magnet's field using teslameter DE722-1M



DE412-2S Plug-pins with M6 thread, pair

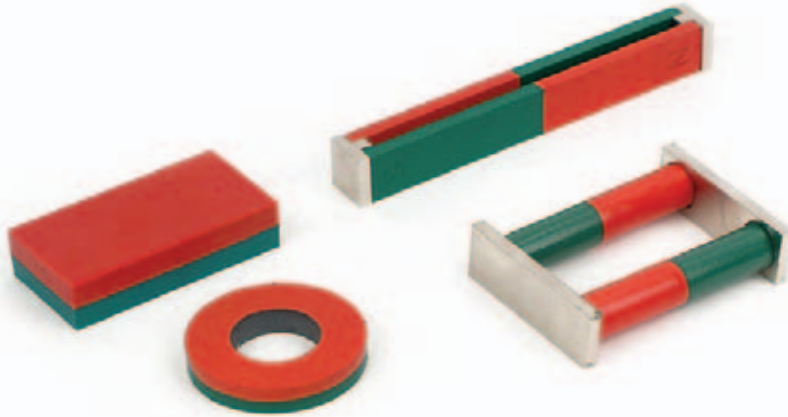
4-mm plugs which can be screwed onto any of bar magnets DE410/411-1N in order to obtain a magnet on a plug



Experiment: Conservation of momentum - using threaded plugs DE412-2S



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DE410-1M Cylindrical magnets, pair

Material: AlNiCo, poles labelled red or green, two iron yokes; D=15 mm, L=80 mm

DE410-1S Bar magnets, pair

Material: AlNiCo, poles labelled red or green, two iron yokes; Dimensions: 150x20 mm

DE460-1E Block magnet

Extremely strong ferrite magnet; embedded in a red-green plastic casing for identifying the poles and protecting against breakage; Dimensions: 82x42x17 mm

DE420-1E Ring magnet

Extremely strong ferrite magnet; embedded in a red-green plastic casing for identifying the poles and protecting against breakage; outside diameter = 63 mm, inside diameter = 30 mm



DE405-1H Base for floating magnets

Acrylic tube on a base; accepts ring magnets DE420-1E; Height: 180 mm (ring magnets not included)



DE300-1D Pivot bearing on base

For rotatable mounting of friction rods and bar magnets; plastic base with support mounted on low-friction needle bearing; Base diameter: 60 mm



Experiment: Interaction between magnets

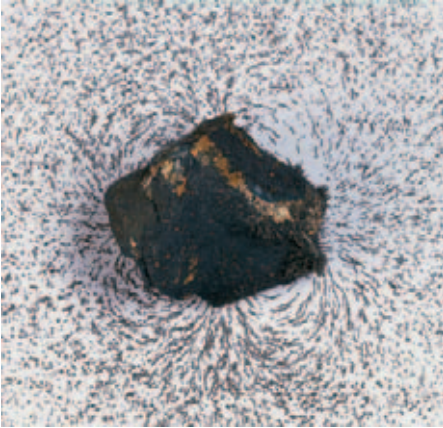


DE401-1M Magnetizer

For re-magnetizing u-magnets and bar magnets that have become partially or completely demagnetized; metal case with two openings for the north and south poles of the magnet; three soft iron yokes for confining the magnetic field of the bar magnet (included!)

Voltage source: 230 V/50...60 Hz

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DE400-1E Load stone

Unfinished natural magnet; weight: ca. 150 g (comparable to a nut)



DE420-1P Magnetic needle

With agate bearing; L=100 mm

DE420-1D Magnetic needle, demo

With cap and bent tips, red or green pole markings L=200 mm

DE300-1N Bearing pin on base

Steel needle mounted on an acrylic base; for rotatable mounting of magnetic needles or cylindrical bar magnets; Height: 55 mm

DE420-2W Compass rose

For use, in combination with the base-mounted bearing pin and a magnetic needle

or bar magnet, in setting up a demonstration compass; plastic disc (D=140 mm) showing degrees scale and compass rose

DE420-1Z Plotting compass

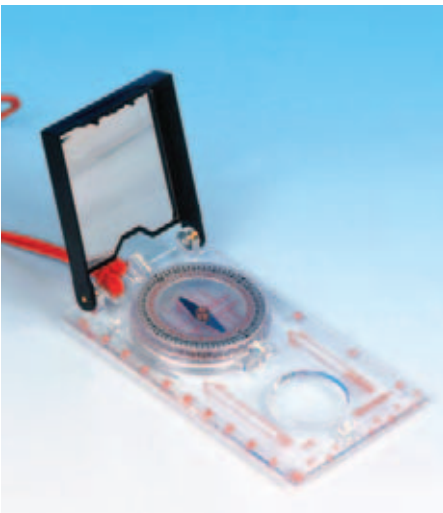
Pivot-mounted magnetic compass pointer, in a transparent case; for detecting magnetic field lines over small areas; D=20 mm

P3410-5M Pocket compass

Magnetic needle, mounted with very little friction, in a black plastic case; transparent cover; scale at bottom; D=40 mm

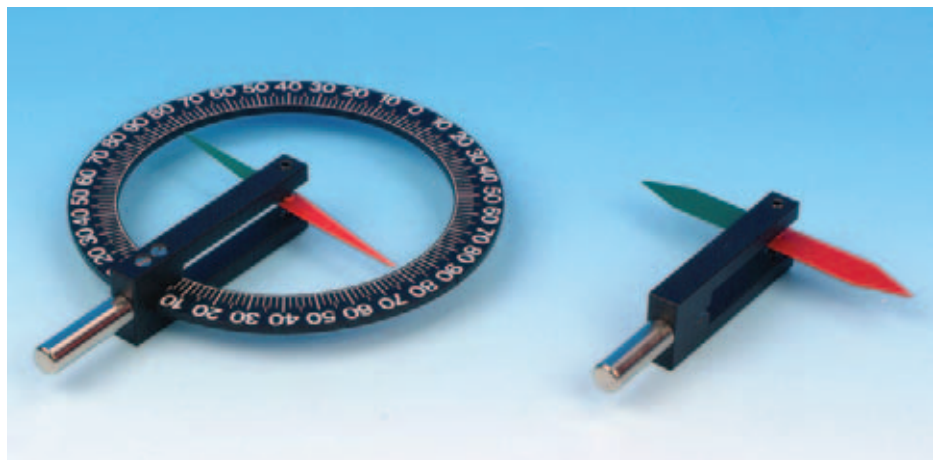


Set up: Magnetic compass



DE420-1K Compass

Simple field compass, oil-filled; includes a sighting device, mirror cover, transparent case and carrying cord; Dimensions: 110x70 mm



DE420-1I Dip needle, with scale

For determining the direction of the earth's magnetic field and for measuring magnetic inclination; magnetic needle, pivot-mounted in a bracket; with a graduated circular scale; on support (D=10 mm); Length of needle: 100 mm

DE421-1N Dip needle

For determining the direction of the earth's magnetic field and for measuring magnetic inclination; magnetic needle, pivot-mounted in a bracket; length of needle: 100 mm



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DE300-1S Iron filings

Plastic shaker with lid;
volume: approx. 250 g

DE430-1S Knitting needles, set

Material: nickel-plated iron; L=200 mm

DP410-1N Box of nails, nickel-plated

Transparent box with lid
Dimensions: 120x80x34 mm;
Volume: approx. 440 g

Detail:
Using the iron
filings collector



DE410-2E Iron filings collector

For easily collecting iron powder, filings or
nails with the aid of a strong ferrite magnet;
D=70 mm, H=180 mm



DE432-1E Shield plate, iron

Iron disc, D=80 mm

DE432-2A Shield plate, aluminium

Aluminium disc, D=80 mm

DE432-2M Magnetic and non-magnetic material

Set of six metal discs, D=25 mm
Materials: Al, Me, Cu, Fe, Pb, Zn



Experiment: Shielding a magnetic field



DE454-5F Free-fall body

Iron cylinder with tapped hole, nickel-plated,
D=25 mm

DS102-3S C-hook, threaded

DS412-2K Bead chain, short



Experiment: A magnet used as a compass

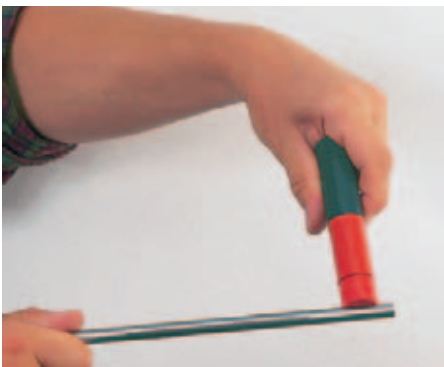
magnetostatics



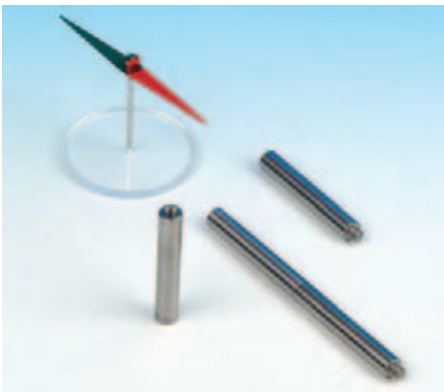
DE431-1S Steel rod
L=240 mm, D=10 mm

DE431-1W Soft iron rod
L=240 mm, D=10 mm

DE431-4S Threaded rods, set
Set of 4; L=60 mm, D=10 mm



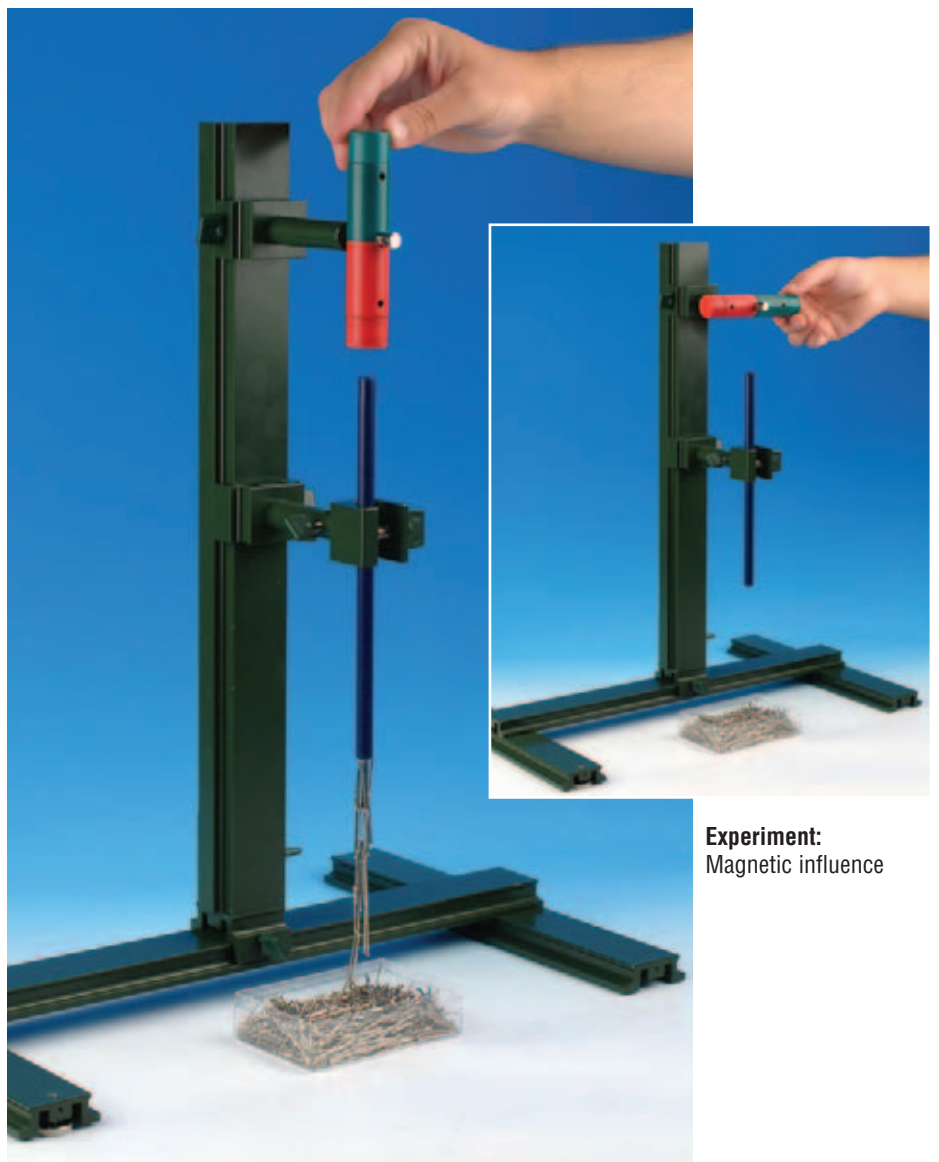
Experiment: Molecular magnets - creating a permanent magnet



Experiment: Dividing a permanent magnet - identifying the poles



Experiment: Dividing a permanent magnet - identifying the individual magnets



Experiment:
Magnetic influence



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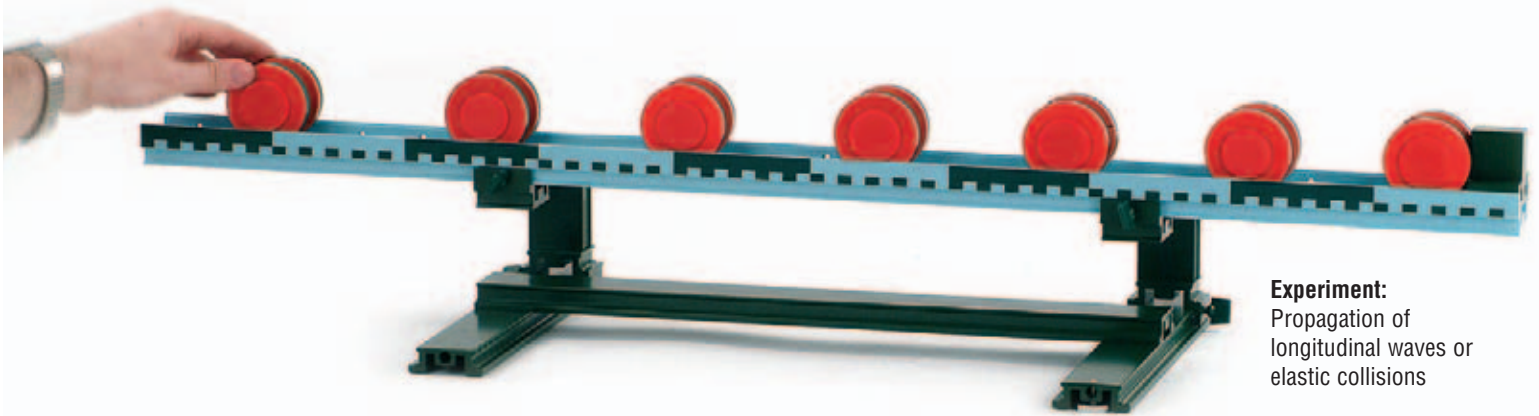


DE715-2M Magnetism E 3 set "inno"

consisting of:

DE300-2N	1x Box of nails, nickel-plated, 160x120 mm	DE431-4S	1x Threaded rods, set of 4, L=60 mm, D=10 mm
DE400-1E	1x Load stone	DE432-1E	1x Shield plate, iron, D=80 mm
DE405-2R	1x Tube for floating magnets, slotted, L=240 mm	DE432-2A	1x Shield plate, aluminium, D=80 mm
DE410-1N	1x Bar magnet with bearing cup, neodymium, L=126 mm, D=26 mm	DE432-2M	1x Magnetic and non-magnetic material
DE411-1N	1x Bar magnet, neodymium, L=126 mm, D=26 mm	DE454-2R	1x Free-fall ring, D=33 mm
DE411-1S	1x Yoke on support, 120x28x10 mm	DE454-3A	1x Aluminium ring, pivoting, on support, D=60 mm
DE413-1S	1x Rods for dia-, para- and ferromagnetism, set, L=40 mm	DE454-5A	1x Eddy current tube, slotted, L=500 mm
DE420-1P	1x Magnetic needle with agate bearing; L=100 mm	DE454-5F	1x Free-fall body
DE420-2A	1x Bearing needle on acrylic support	DE455-1N	1x Pole plates with pins, 68x28 mm, pair
DE420-2R	1x Frame with pivot bearings on support	DM300-2A	1x Dynamics trolley, demo, 120x68 mm
DE420-2W	1x Compass rose, D=140 mm	DM301-1M	1x Magnet holder for bar magnets
DE421-1N	1x Dip needle, L=100 mm	DS102-3S	2x C-hook, threaded
DE431-1S	1x Steel rod, L=240 mm, D=10 mm	DS412-2K	1x Bead chain, short
DE431-1W	1x Soft iron rod, L=240 mm, D=10 mm	P7806-1B	1x Storage box, large
		P7810-1M	1x Box insert "inno" for magnetism

magnetic field

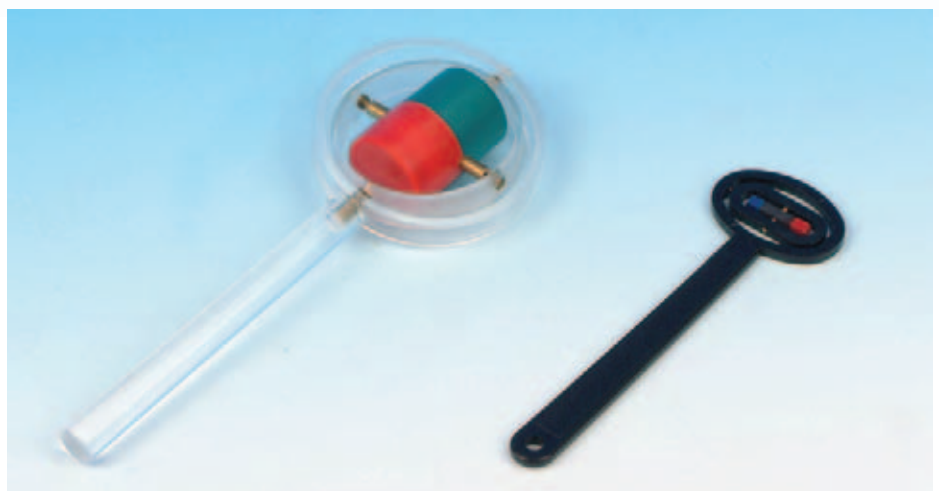


Experiment:
Propagation of longitudinal waves or elastic collisions



DW470-1R Axle for ring magnets

Holds two ring magnets (DE420-1E) for use as a magnet roll in experiments on the propagation of longitudinal waves or elastic collisions; universal rails DS101-3B/4B may be used as a track; acrylic cylinder with two, red and green plastic rings and two, red and green plastic caps for fastening the ring magnets to the axle



P3411-1D Magnetic field sensor, demo

Strong neodymium bar magnet (L=36 mm, D=24 mm) mounted on gimbals, with support; for detecting the spatial distribution of magnetic fields

P3410-2C Magnetic field sensor SE

Small ferrite bar magnet (L=19 mm) mounted on gimbals, with support; for detecting the spatial distribution of magnetic fields



Experiment: Detecting the three-dimensional distribution in space of a bar magnet's field



DE420-3D Magnetic field model, three-dimensional

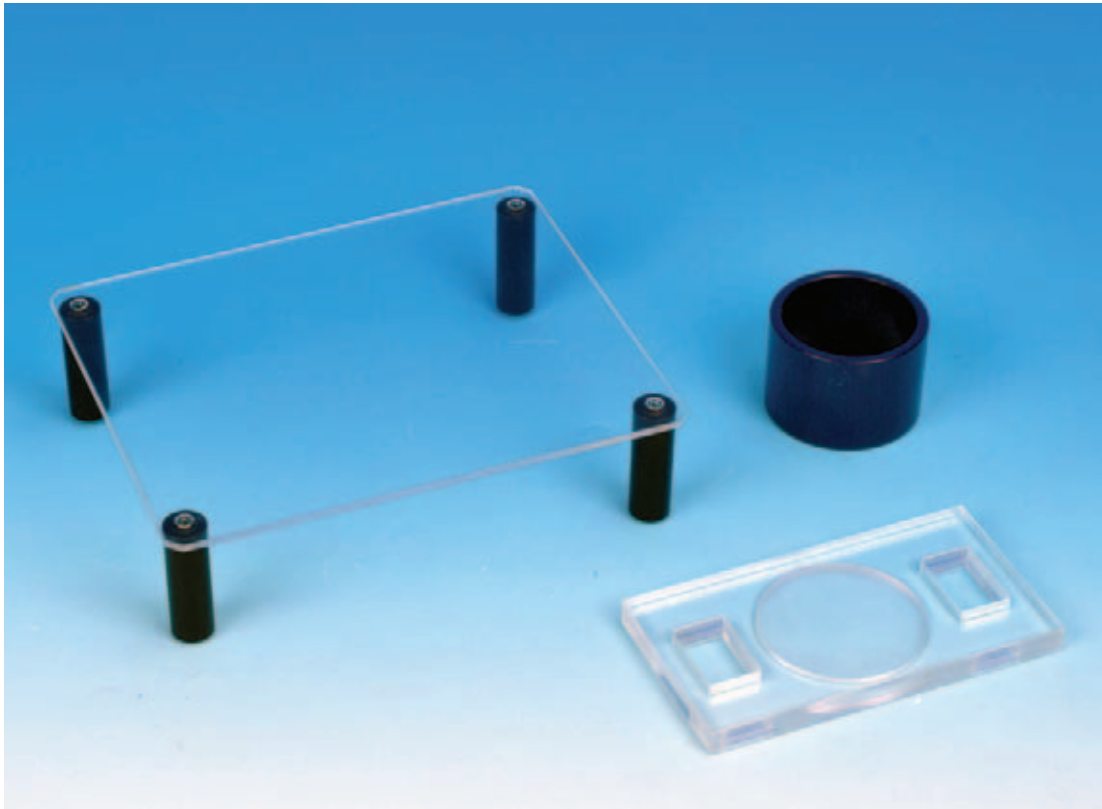
For spatially depicting a bar magnet's field; acrylic housing filled with a special liquid and iron filings; hole at centre for inserting a round bar magnet up to 15 mm in diameter
Dimensions: 126x102x102 mm



Experiment: Spatially depicting a bar magnet's field



magnetic field

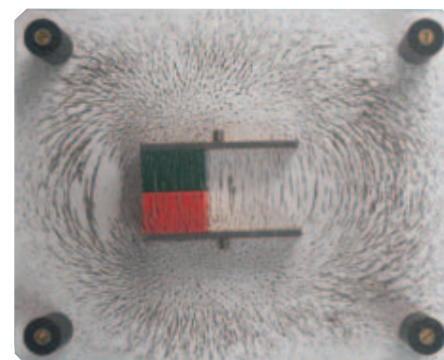
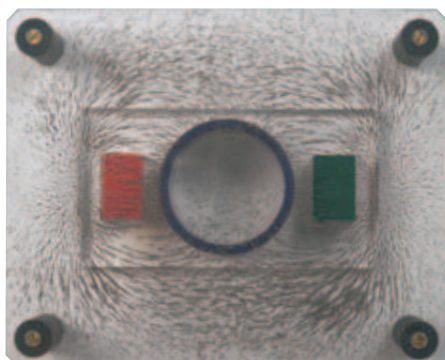
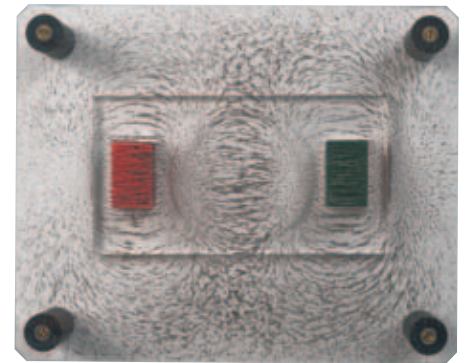
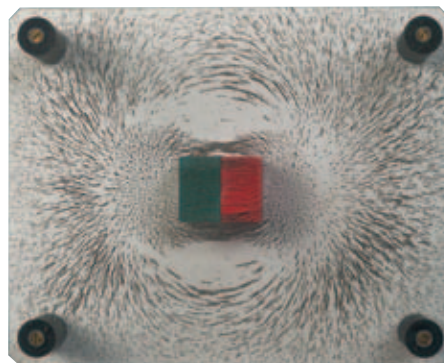
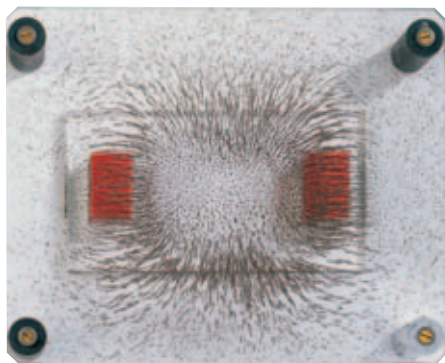


DE419-1M Magnetic field plate on acrylic base, set

For showing, with the aid of iron filings, the shape of magnetic field lines; suitable for overhead projectors; acrylic plate (185x150 mm), with four plastic feet, and an acrylic base with cut-outs for accepting block magnets DE412-1B or soft iron ring DE430-3B

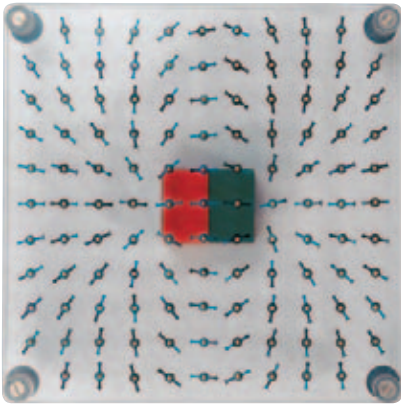
DE430-3B Soft iron ring "inno"

Soft iron ring (D=57 mm) for shielding a magnetic field; for use with the magnetic field plate on acrylic base (set DE419-1M)



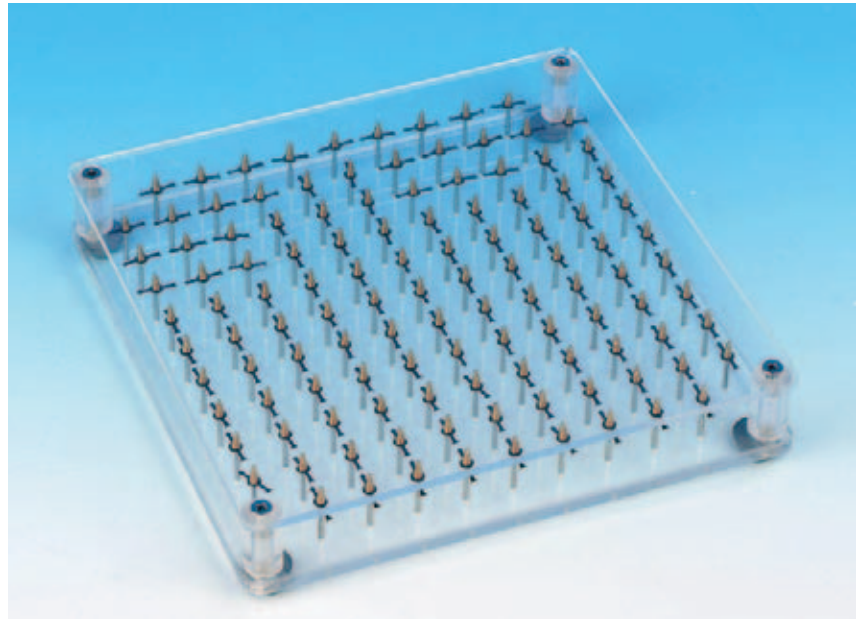
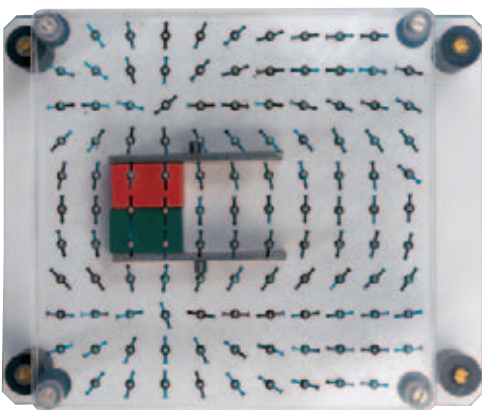
Series of experiments: Depicting a magnetic field using iron filings or using plotting compasses (field line patterns)

magnetic field



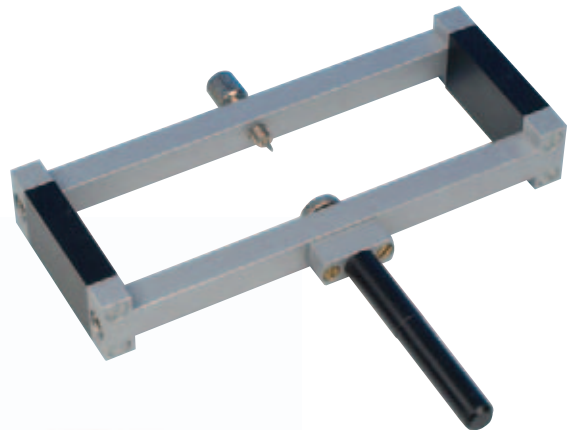
Series of experiments:

Depicting the magnetic field around a bar magnet and a u-magnet with the aid of the cubical magnet model



DE420-2D Magnet model, cubical

For demonstrating the behaviour of molecular magnets in ferromagnetic substances; 117 freely pivoting magnetic needles mounted between two acrylic sheets; suitable for overhead projectors; length of magnetic needles: approx. 11 mm
Dimensions: 150x150 mm



DE420-2R Frame with pivot bearings on support

For demonstrating the magnetic field of a current-carrying conductor; may be used for mounting cylindrical bar magnet DE410-1N to pivot with little friction between the two needle bearings of the frame; the upper and lower brackets of the frame are insulated and have two 4-mm jacks each for connecting a power supply
Dimensions: 160x65 mm; support: L=70 mm, D=10 mm



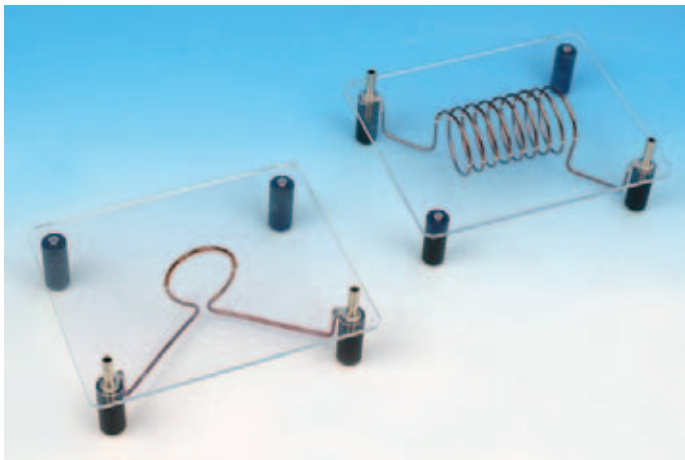
Experiment: An electric current creates a magnetic field - Oersted's experiment

Power supplied by high-current power supply P3172-1H (see page 266 for technical details)





magnetic field

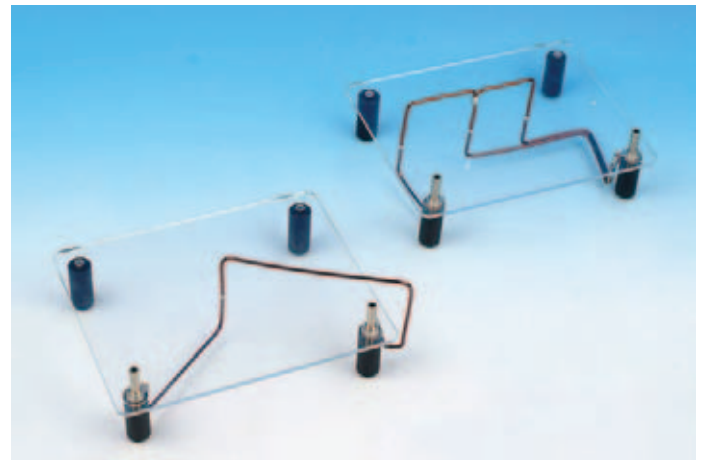


DE450-1B Conductor loop on acrylic base

For depicting the magnetic field of a current-carrying conductor loop on an overhead projector; two 4-mm jacks for supplying power; Dimensions: 185x150 mm

DE450-1C Coil on acrylic base

For depicting, with the aid of iron filings and an overhead projector, magnetic fields inside a coil; two 4-mm jacks for supplying power; coil with nine turns; diameter of one turn: 50 mm
Dimensions: 185x150 mm

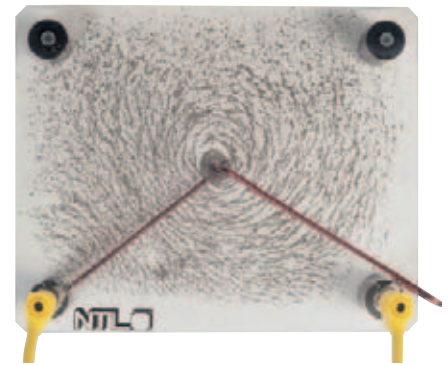
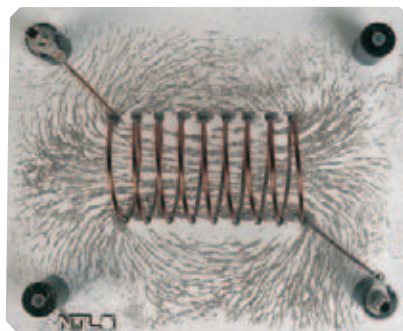
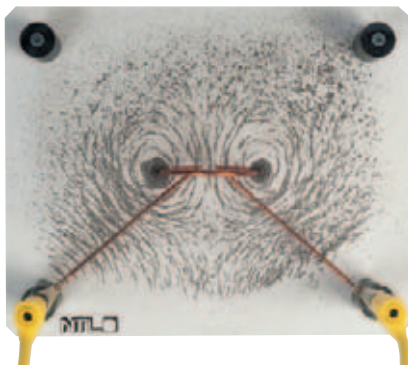


DE450-1A Straight conductor on acrylic base

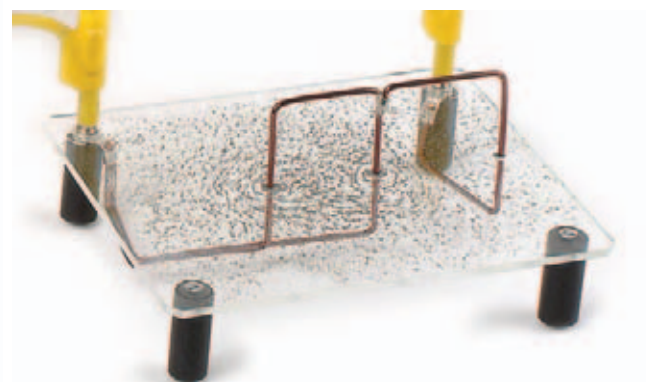
For depicting the magnetic field of a straight current-carrying conductor on an overhead projector; two 4-mm jacks for a power supply; dimensions: 185x150 mm

DE450-2A Parallel straight conductors on acrylic base

For depicting, on an overhead projector, the magnetic field of two parallel straight conductors carrying current flowing in the same direction; two 4-mm jacks for a power supply; Dimensions: 185x150 mm



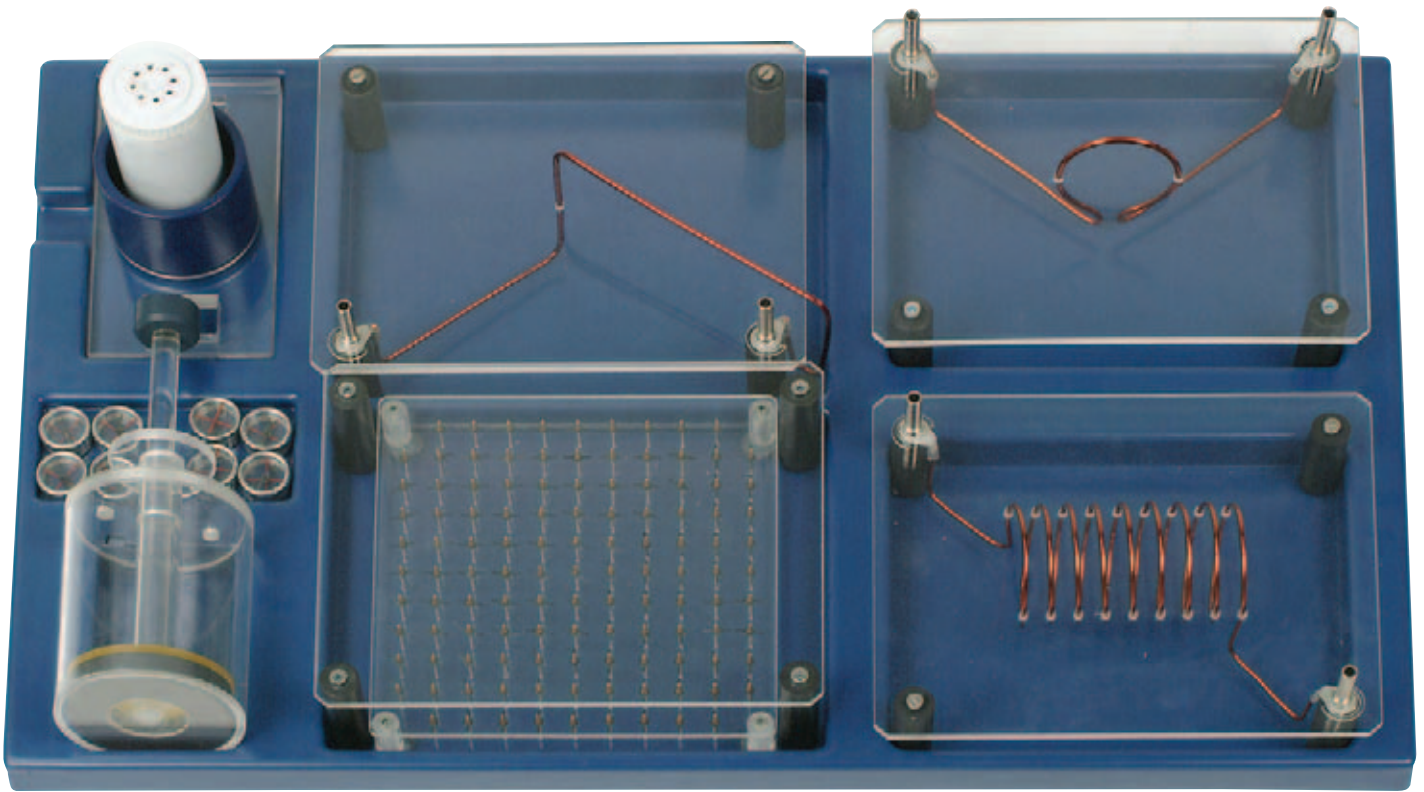
Series of experiments: Field lines produced by various conductor models on an acrylic base



Experiment: Depiction of the magnetic fields of two parallel straight conductors carrying current flowing in the same direction

Power supplied by high-current power supply P3172-1H (see page 266 for technical details)

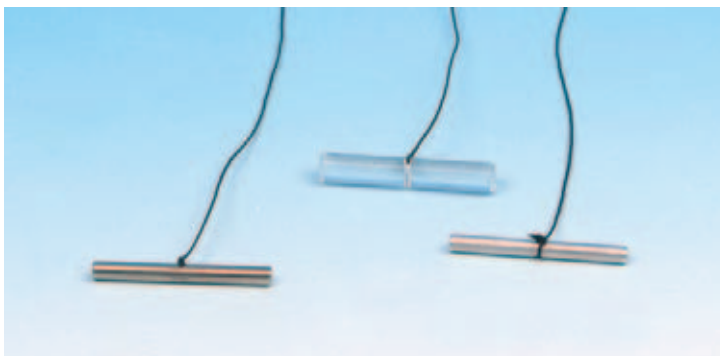
magnetic field



DE715-5E Electricity set 5, magnetic field lines - "inno"

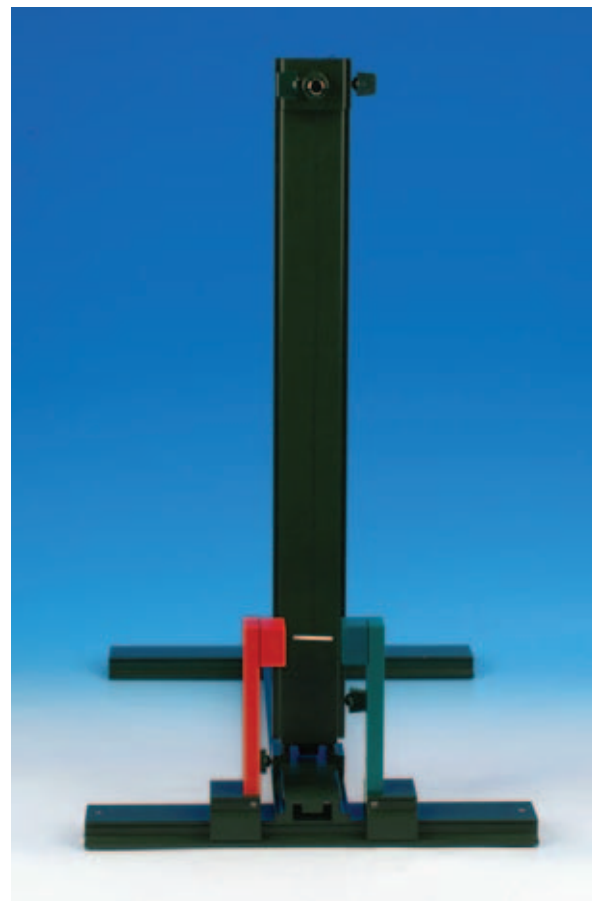
consisting of:

- DE300-1S 1x Iron filings, 250 g
- DE410-2E 1x Iron filings collector
- DE419-1M 1x Magnetic field plate on acrylic base, set, 185x150 mm
- DE420-1Z 8x Plotting compass, D=20 mm
- DE420-2D 1x Magnet model, cubical, 117 magnetic needles, 150x150 mm
- DE430-3B 1x Soft iron ring, D=57 mm
- DE450-1A 1x Straight conductors on acrylic base, 185x150 mm
- DE450-1B 1x Conductor loop on acrylic base, 185x150 mm
- DE450-1C 1x Coil on acrylic base, 185x150 mm
- P7806-1B 1x Storage box, large
- P7810-5E 1x Box insert electricity set 5 "inno"



DE413-1S Rods for dia-, para- and ferromagnetism

Set of 3, L=40 mm; material: nickel, acrylic, iron



Experiment: Dia-, para- and ferromagnetism



magnetic field



MB270-2V LF amplifier "compact"

Used in amplifying weak audio signals for measurement purposes or for driving a loudspeaker

Amplification factor: 1, 3, 10, 30, 100, 300, 1,000, 3,000, 10,000 times

Accuracy: better than 20 %

Frequency range: 25 Hz ... 70 kHz

Output voltage: 2.8 Veff (2.1 Veff rms at 4 ohms); two 4-mm output jacks, short-circuit protection

Input voltage: 2.8 Veff (max. 30 Veff)

Power supply voltage: 12 V DC through hollow jack, supplied by mains transformer P3130-1P (12V/2A)

Dimensions: 84x84x39 mm

MB240-1L MBC Loudspeaker

Yellow ABS plastic case and two 4-mm safety jacks

Loudspeaker: 8 ohms/1 watt; dimensions: 84x84x39 mm

DP130-3A Cable, shielded

Two 4-mm safety plugs at the ends, yellow and black; length: 50 cm

P3712-1S Jumper plugs "compact", black

Used to electrically connect two magnetic components of the "compact" system (MBC) or the "inno" system (MBI); black plastic handle and two 4-mm plugs connected electrically; plugs 25 mm apart

Dimensions: 36x12x20 mm

Experiment: Barkhausen Effect



DE453-1H Helmholtz coils, pair

Pair of coils for generating a homogeneous magnetic field; insulated coils of wire encased in an acrylic frame on a support (D=10 mm); spacing bracket with notches for placing the coils at a precise distance apart

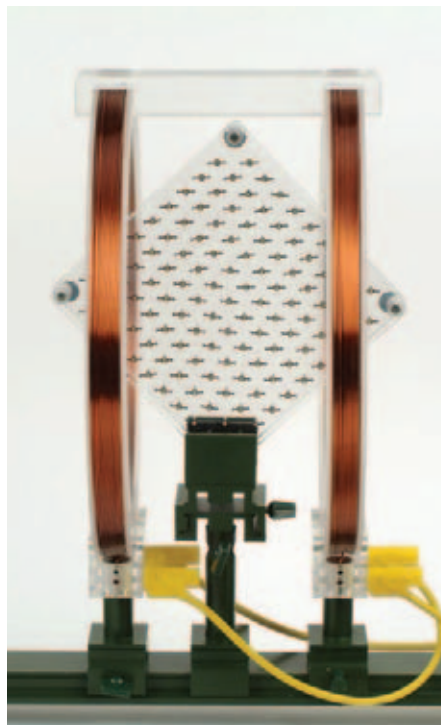
Number of turns: 145 turns each;

max. current: 5 A

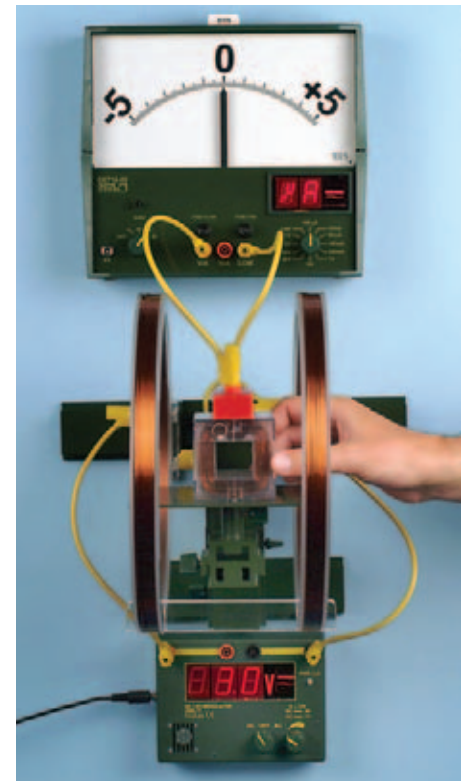
Coil diameter: approx. 300 mm

Coils may be mounted on two sliding saddles (DS103-3G) on a large stand base (DS101-1G) or on stand base DS100-1H,

L=250 mm (not included)



Example of an experiment: Depiction of a homogeneous magnetic field; experiment in ferromagnetism using the cubical magnet model



Experiment: Voltage is not always induced in a coil

measuring magnetic fields



DE722-1M Teslameter "inno"

Demonstration instrument for measuring magnetic flux density using an axial or tangential magnetic field sensor; this instrument is easy to transport and can be mounted magnetically; the 26-mm LED display allows readings to be taken even from a distance

Technical data:

Display: 3 1/2-digit LED display; digit height 26 mm

Measuring range: ± 200 mT

Accuracy: ± 1.5 %; toggle switch: ON/OFF

DIN jack: for connecting an axial or tangential sensor; control for resetting to zero

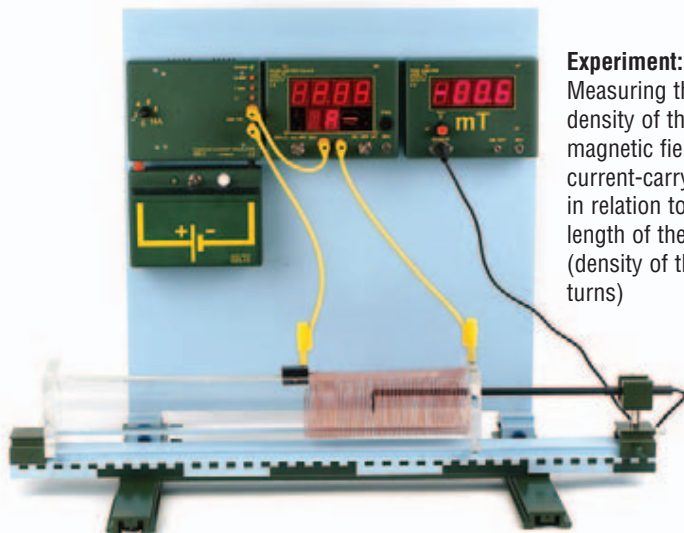
Power supply: 4 x 1.5 V mignon cells (included) or 5.5-mm hollow DC jack for 6 V/500 mA external power supply P3120-6N; case: green ABS plastic with yellow labelling

Dimensions: approx. 160x120x45 mm; weight: 400 g

Required accessory:

DE722-2A Magnetic field sensor, axial

DE722-2T Magnetic field sensor, tangential



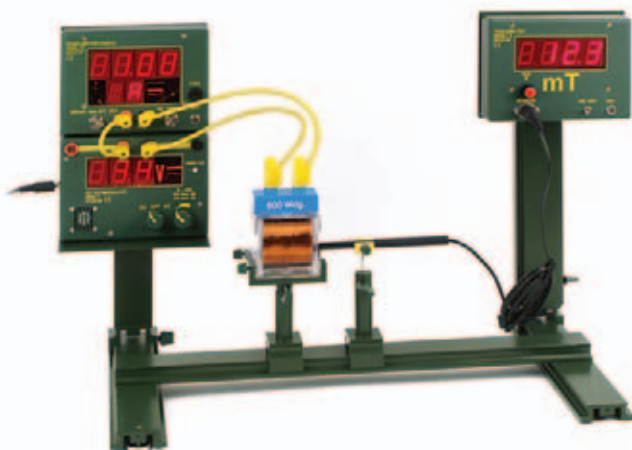
Experiment:

Measuring the flux density of the magnetic field of a current-carrying coil in relation to the length of the coil (density of the wire turns)

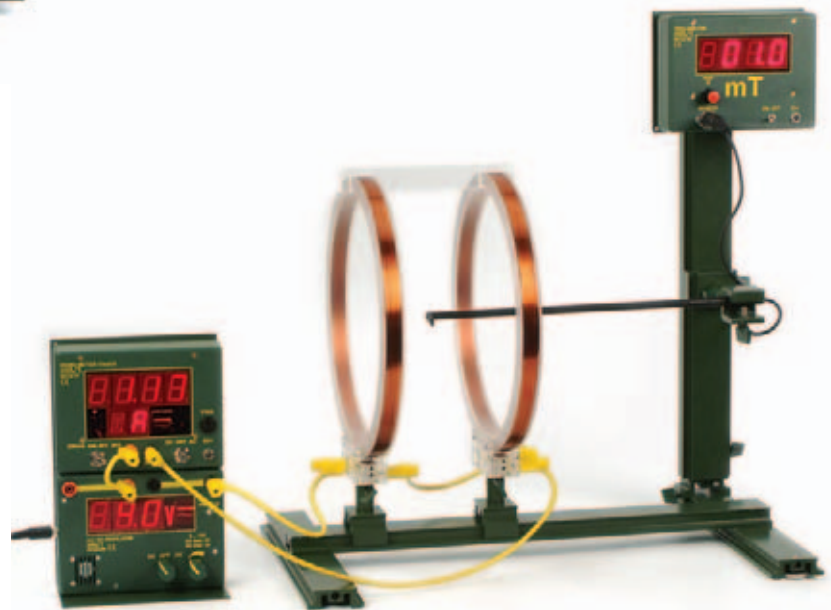


Experiment:

Measuring the flux density of a u-magnet's field



Experiment: Demonstrating how the flux density of a current-carrying coil is proportional to amperage



Experiment: Measuring the flux density of the homogeneous magnetic field arising from a current-carrying Helmholtz coil