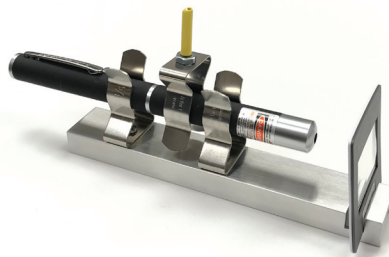
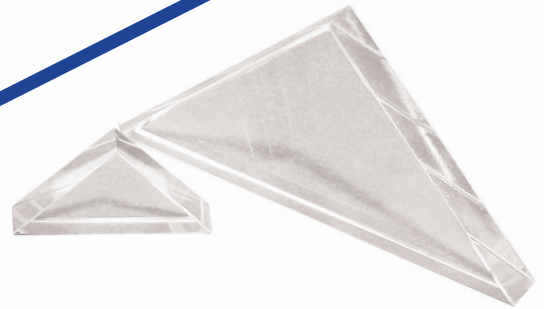


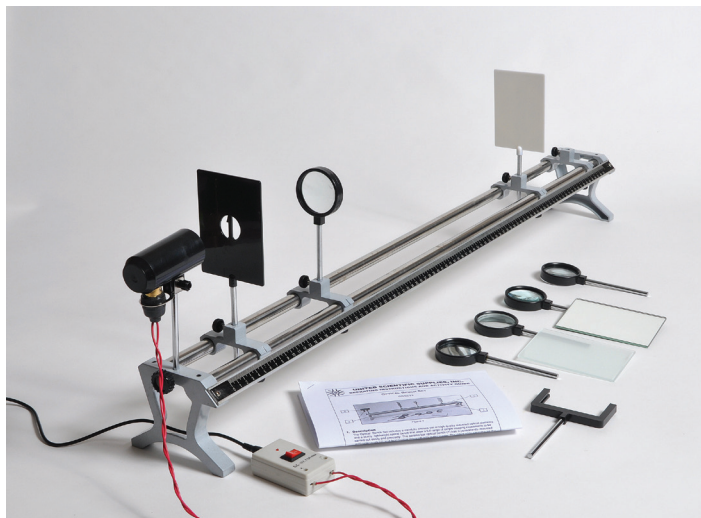


# United Scientific

## Physics 2020



## Optical Bench Set



The optical elements are mounted in protective frames with mounting rods for easy alignment. Captive riders feature index marks and set screws to secure the rider and optical elements without disturbing their alignment. The bench is 96cm long and the set includes a pre-focused illuminator with a 12V/6W incandescent lamp, four 50mm diameter lenses, two mirrors, an object diaphragm, two screens, and an operator's manual. Also includes a 12V/0.5A power supply operating on 110VAC. Includes activity guide.

Item No.	Description
OBSET3	Optical Bench Set

### Contents:

Optical Bench with Printed Scale	1
Rider Mounted on Optical Bench	4
Opaque Screen	1
Object Diaphragm	1
Frosted Glass Screen, Translucent	1
Screen and Mirror Holder	1
Plane Mirror	1
Mounted Lens	4
Concave Mirror	1
Illuminator, 12V/6W	1
Activity Guide	1



Scan to view demonstration video

## Introductory Optical Bench

NEW PRODUCT



An economical, high quality bench set that is excellent value for introductory lens work.

### Features:

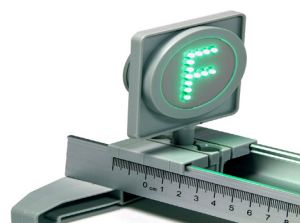
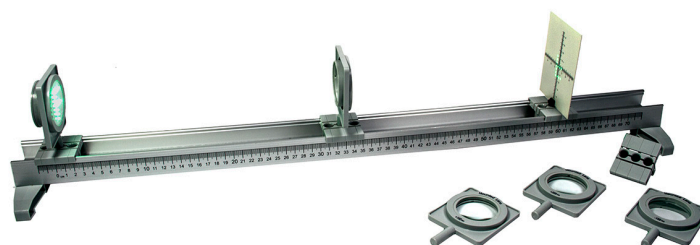
- 74 cm extruded aluminum bench with push-on plastic feet and large, easy-to-read scale
- Three-position riders accommodate push-in stems of optical parts.
- Pushing stem in locks rider in position
- Four 50 mm diameter mounted lenses (3 convex, 1 concave)
- LED-illuminated "F" object
- Opaque screen with scales

**This introductory bench set** allows the basic properties of lenses to be explored. The optical elements are mounted in robust molded holders that are simply pushed into sockets in the riders. Each rider can accept up to three elements. The riders slide freely on the aluminum bench until an optical element is pushed in, when the rider locks in place. This eliminates accidental repositioning and allows the entire lightweight setup to be carried around without anything falling off.

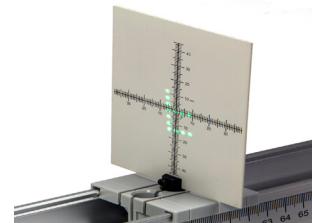
**The LED-illuminated object** is self-contained (powered by an AAA battery—no cables!) and generates bright, clear images on the opaque screen.

**Four high quality lenses** are included, all with 50mm diameter. The focal lengths are +100mm, +150mm, +200mm, (all convex) and -150mm (concave).

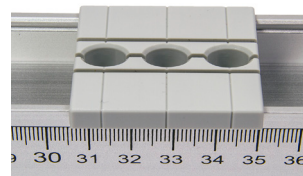
Item No.	Description
OBSET4	Introductory Optical Bench



LED Illuminator

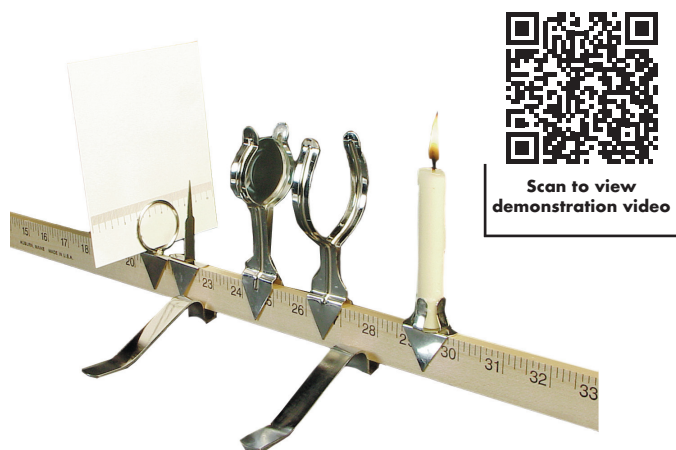


Opaque Screen



Three-position rider





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## Meter Stick Optical Bench



Student optical bench contains sufficient equipment for high school physics applications.

### Contents:

Meter stick	1
Screen support	1
Lens support for 38mm and 75mm lenses/mirrors	2
Board screen measuring 10 x 125cm with a millimeter scale on both sides	5
Marker and object	1
Metal support for meter stick	2
Candle holder	1
Paraffin candle	1
Activity guide	1

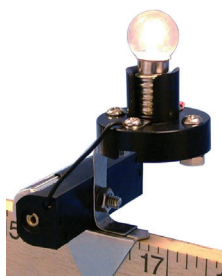
Item No.	Description
OBSET1	Meter Stick Optical Bench
OBSET2-NS	Optical Bench Set without meter stick

### Individual Accessories

Item No.	Description
OBLS38	Lens Support, 38mm
OBLS75	Lens Support, 75mm
OBMRK1	Marker and Object
OBCNH1	Candle holder, for 1 candle
OBLS01	Bulb Holder
OBSCS1	Screen Support
OBSCR5	Board Screens, pk/5
OBMS02	Metal Supports, pk/2
CLHW02	Wooden Support
OBMST1	Meter Stick

## Light Source with Battery Holder

This light source is designed for use with a meter stick optical bench. The 1.5V bulb operates on a single AA battery (not included).



Item No.	Description
OBLSBH	Light Source with Battery Holder



## Economy Optics Kit



Optics set includes everything you need to demonstrate basic principles of light and color. Includes a reusable storage box.

### Contents:

Double convex lens, 38 mm diameter, glass	1
Prism, equilateral, 25mm x 50mm, acrylic	2
Double concave lens, 38mm diameter, glass	1
Plain lens, 38mm diameter, glass	1
Mirror, square, acrylic	2
Plastic mirror support	2
Wooden lens holder	1
Beaker, graduated, plastic	1
Flashlight (2 batteries included)	1
Plastic screen, white	1
Clear glass screen	1
Candle	1
Cellophane square, set of 5 colors	1
Activity guide, containing 20 experiments	1



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Item No.	Description
OPTKIT	Economy Optics Kit



## Mirror Supports

Wood mirror support is designed to support spherical mirrors and lenses. This polished wooden support is 5" tall and has a 1.5" V-shaped grooved wedge to securely hold mirrors or lenses 38mm through 100mm.

Plastic mirror supports securely hold a mirror in a vertical position on any flat surface. Available in two sizes.

Item No.	Picture	Description
MSW001	A	Wood Mirror Support
MSP001	B	Plastic Mirror Support, pack of 6
MSP002	C	Plastic Mirror Support, pack of 36



## Hartl Optical Disk



The Hartl Optical Disk is a compact apparatus that demonstrates the behavior of optical elements by means of ray paths through clear acrylic models. It consists of a circular 9" diameter graduated disk mounted on a stand and fitted with a ray box on an adjustable arm. Narrow, parallel rays of light are created across the surface of the disk by a cylindrical lens in the ray box and a pair of slit diaphragms placed in front of the lens.

The set includes six clear acrylic lenses and prisms with a magnetic backing that allows them to be attached to the disk in any suitable position, for use as optical element models. Includes activity guide.

The mounting of the disk allows it to be rotated through 360 degrees about

an axis passing horizontally through its center to investigate the effect of angle variation on the ray paths through the optical element models.

The ray box requires a separately supplied power source capable of providing 12V/2A for the lamp.

Item No.	Description
HOD001	Hartl Optical Disk



## Reflection and Refraction Tank



This product effectively demonstrates the laws of reflection and refraction. The 16cm diameter acrylic water tank has a 360 degree scale and a moveable arm carrying a laser activated by a momentary switch. The sharp beam of light produced by the laser can be adjusted to pass the center of the scale. Batteries and activity guide are included.

Please note: This product emits laser light. Max. output power < 1mW. Wavelength 630-680nm. Class II laser product.



Item No.	Description
RRT002	Reflection and Refraction Tank



## Laser Optical Disk Set

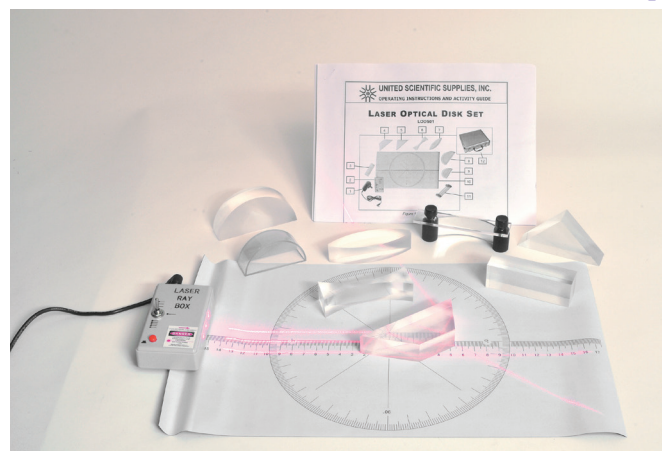


This is an excellent and economical set for introductory ray optics. The laser ray box projects one, three, or five parallel bright beams and is equipped with a momentary switch for safety. A vinyl template with a degree circle and a linear scale forms the optical disk, and the set includes seven clear acrylic optical elements and a mirror with adjustable curvature for investigating refraction, lenses, prisms, and mirrors. The bottoms of the acrylic elements are frosted to show the ray paths inside them. The set also includes an activity guide and storage box.

Please note: This product emits laser light. Max. output power < 1mW per beam. Wavelength 650nm. Class IIIa laser product.

### Contents:

Wall-mount Power Supply	1
Laser Ray Box (1, 3, or 5 rays)	1
Parallel-sided Block	1
Trapezoidal Prism	1
Right Angle Prism	1
Biconcave Lens	1
Biconvex Lens	1
Semicircular Lens (solid)	1
Semicircular Cell	1
Flexible Template—ruler & protractor	1
Adjustable Mirror—plane/concave/convex	1
Aluminum Storage Case	1
Activity Guide	1



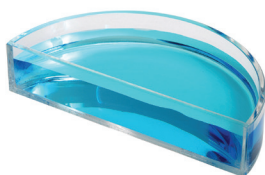
Scan to view  
demonstration video



Set includes a durable hard-shell storage case with foam insert for convenient storage of component parts.



Item No.	Description
LODS01	Laser Optical Disk Set



Uniform wall thickness  
provides distortion-free  
viewing from any angle.

## Semicircular Refraction Cell

This clear acrylic semicircular refraction cell is excellent for showing refraction and internal reflection in water, and to measure its refractive index. The cell has uniform wall thickness to eliminate distortions.

Item No.	Description	Size
RCSC01	Semicircular Refraction Cell	12cm diameter x 2.5cm high



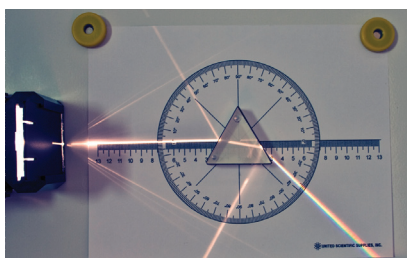
Uniform wall thickness provides distortion-free viewing from any angle.

## Rectangular Refraction Cell

This clear acrylic rectangular refraction cell is excellent for showing refraction and internal reflection in water, and to measure its refractive index. The cell has uniform wall thickness to eliminate distortions.

Item No.	Description	Size
RCRC01	Rectangular Refraction Cell	6cm x 3cm x 6.2cm high

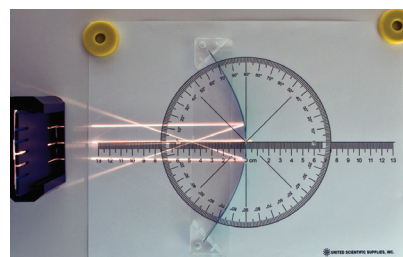




Light box and prism are used together to produce a spectrum.



Scan to view demonstration video



Mirror can be adjusted to demonstrate concave (shown) and convex properties.



Colored filters and paddles enable a dramatic presentation of color mixing properties.

## Whiteboard Optics Set



A comprehensive and economical set of equipment for ray optics and color experiments. Magnetic-backed components can be used on the included whiteboard or any installed steel whiteboard. The whiteboard has a usable surface of 23" x 15.5" and has swiveling feet on two sides so that it can be set up in wide or tall format. The double-ended light box contains a 12V/20W halogen lamp powered by a wall-mount AC adapter and cooled by a built-in fan. One end carries a cylindrical lens and slots for mounting the three slit diaphragms for ray optics.

The other end carries two adjustable mirrors and an open area for color mixing work using colored filters that fit into slots in the ray box.

Item No.	Description
WBOPS1	Whiteboard Optics Set
WBOPS1-A	Optical Parts Set only
WBOPS1-W	Whiteboard Only

### Contents:

Whiteboard, 23" x 15.5"	1
Double-ended Light Box	1
Convex Acrylic Lens	1
Concave Acrylic Lens	1
Semicircular Acrylic Lens	1
Rectangular Acrylic Block	1
Acrylic Right Angle Prism	1
Acrylic Equilateral Prism	1
30°/60°/90° Prism	1
Hollow Acrylic Rectangular Cell for Water Refraction	1
Plane Mirror	1
Adjustable Concave/Convex Mirror	1
Matched Set of Seven Color Filters	1
Set of Seven Corresponding Colored Paddles	1
White Card Screen, 10" x 10"	1
Card Protractor Circle	1
Magnet to hold Protractor	4
Activity Guide	1
Storage Box with Molded Inserts	1

## Spherometer

A fine instrument to determine the radius of curvature of spherical surfaces, such as mirrors and lenses. Its micrometer screw is graduated to measure displacement as small as 0.01mm. The instrument has two brass plates and three steel legs. A flat glass plate is provided for support while taking precision readings.

Item No.	Description
SPRM01	Spherometer





## Laser Diffraction Kit

NEW PRODUCT



The Laser Diffraction Kit lets students create, view, and measure diffraction and interference patterns. The kit includes two laser pointers - red and green - along with a convenient mounting base and a slide set of diffraction objects. Each laser operates on two "AAA" batteries (not included).

Two of the included slides have various double slit patterns. One slide has a fixed slit separation with the slits on either side varying in width. The other has the slit width constant with varying slit separations.

For investigating single slit patterns, one of the slides contains five slits of varying widths. An additional slide carries a traditional diffraction grating with 300 lines/mm.

The unique base securely holds the included standard laser pointers. An included clip allows you to hold the laser button on during experiments. Measurements of the light patterns are easy to read when the laser patterns are projected against a wall. Includes activity guide.

Item No.	Description
LDFKIT	Laser Diffraction Kit
LSPB06	Laser Pointer Holder
MTCLIP	Momentary Toggle Clip

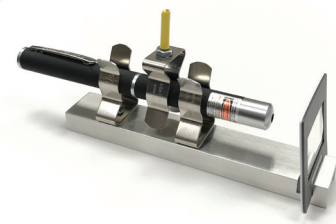


MTCLIP

Momentary Toggle Clip is designed to hold push-button during experiments



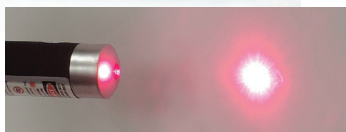
Scan to view demonstration video



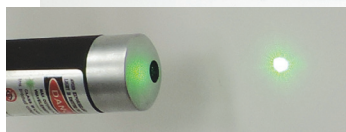
LSPB06



RLP006



GLP006



DLP006

## Laser Pointers

NEW PRODUCT

Economical laser pointers are useful for many optical experiments. Lasers operate on a push-button switch, are housed in a rubberized aluminum pen-style case, and include a pocket clip.

The 6" long x 0.5" diameter Class 3R Red laser pointer has a maximum output of 5mW and a wavelength of 632.8nm. Operates on two "AAA" batteries (not included).

The 6" long x 0.5" diameter Class 3R Green laser pointer has a maximum output of 5mW and a wavelength of 532nm. Operates on two "AAA" batteries (not included).

Item No.	Description
RLP006	Laser Pointer, Red
GLP006	Laser Pointer, Green
DLP006	Laser Pointer, Dual, Red/Green



## Basic Spectrometer



Assists in the measurement of spectroscopic angles, refraction, and diffraction. It is geared to meet the requirements of student lab experiments. The unit is mounted on stable base with an attached collimator. The platform is able to rotate 360 degrees.

### Specifications include:

- A 2.6cm diameter achromatic optical system with a 10x eyepiece and crosshair.
- A 16cm diameter, 360 degree x 0.5 degree enclosed graduated circle with a double-ended external 0-30' x 1' vernier and 2 built-in scale reading magnifiers.
- An 8cm diameter grating/prism table with an engraved ring pattern. Table has adjustable prism and grating holders.
- A 6mm slit, opening to 2mm.
- Angular measurement accuracy of up to 1 degree.
- Wooden storage box, teacher activity guide, and diffraction grating and prism are included.

Additional spectrometer prisms and diffraction gratings are available separately.

Item No.	Description
SPECT01	Spectrometer
SPECPRS	Spectrometer Prism
DFG600	Diffraction Grating



## Intermediate Spectrometer



This instrument is easy to set up, easy to use, and is designed to make precise measurements. Features high quality 22mm optics, a built-in illuminated auto-collimator for fast setup, a 17.8cm diameter divided circle with clear graduations, a double-ended vernier with illuminated magnifier reading to 1' resolution, and a 7cm diameter prism table which rotates 360 degrees and adjusts 2cm in height to accommodate various accessories. The spectrometer is supplied with diffraction grating and grating holder, prism, illuminated magnifier, auto-collimation mirror, power supply (for 110VAC), and an instruction manual.

Additional spectrometer prisms and diffraction gratings are available separately.

Item No.	Description
SPECT02	Intermediate Spectrometer
SPECT02-P	Spectrometer Prism
DFG300	Diffraction Grating

## Intermediate Spectrometer with 30mm Optics



This instrument is an enhanced version of our popular Intermediate Spectrometer (SPECT02.) Its larger 30mm diameter optics give brighter line images and make precise measurements easier. The optical focusing system has also been refined and the instrument retains the same premium features as the earlier version, including the built-in illuminated auto-collimator for fast set up, 17.8cm diameter divided circle, double-ended vernier reading to 1' resolution, and 7cm diameter rotatable and height-adjusting prism table to accommodate various accessories. The spectrometer is supplied with a 300 lines/mm diffraction grating and grating holder, high quality prism, illuminated magnifier, auto-collimation mirror with a power supply for 110VAC, and an instruction manual.

Additional spectrometer prisms and diffraction gratings are available separately.

Item No.	Description
SPECT03	Intermediate Spectrometer with 30mm Optics
SPECT02-P	Spectrometer Prism
DFG300	Diffraction Grating







## Spectrum Tubes

The classic demonstration of spectral lines. These tubes acquaint students with the spectra of common gases in their pure form and are also used for demonstrating wavelength. Each gas has its own distinctive set of spectral lines when energized and viewed through a spectroscope. A spectrum tube power supply (not included) is required to energize the tubes.

The glass tubes are 25cm long with the capillary portion about 10cm long. An electrode is sealed in each end and attached to a metal end cap with a loop for convenient hookup to wire connections. Each spectrum tube includes an activity guide.

Item No.	Description
SPTAI01	Air Spectrum Tube
SPTAR01	Argon Spectrum Tube
SPTBR01	Bromine Spectrum Tube
SPTCD01	Carbon Dioxide Spectrum Tube
SPTCL01	Chlorine Spectrum Tube
SPTDT01	Deuterium Spectrum Tube
SPTHE01	Helium Spectrum Tube
SPTHY01	Hydrogen Spectrum Tube
SPTKR01	Krypton Spectrum Tube
SPTNE01	Neon Spectrum Tube
SPTNI01	Nitrogen Spectrum Tube
SPTOX01	Oxygen Spectrum Tube
SPTWV01	Water Vapor Spectrum Tube
SPTXE01	Xenon Spectrum Tube

## Basic Spectroscope

An excellent hand held spectroscope for viewing the spectra of many different light sources. Durable construction with compound prisms and converging lenses made of high quality optical glass.



Item No.	Description
SPSCP1	Basic Spectroscope



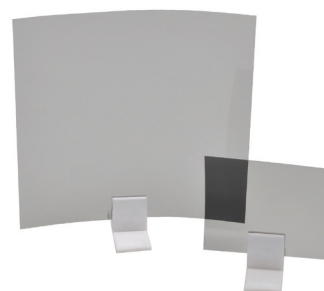
NEW PRODUCT



## Hydrogen & Helium Spectrum Tube

Standard spectrum tube filled with a mixture of hydrogen and helium. During most of their life, stars are mostly composed of hydrogen and generate energy by converting it to helium. Although other elements are present to give individual stars their "fingerprint", the lines of hydrogen and helium are visible in stellar spectra, as in this tube.

Item No.	Description
SPT2HH1	Hydrogen-Helium Spectrum Tube



## Polarizing Film



An effective yet economical tool for demonstrating polarization of light. 2" x 2" mounted film is available in packs of 10. Unmounted film is available as packs of 2 in 3" x 3" and 6" x 6" sizes. Include instructions.

Item No.	Description
PLF020	Polarizing Film, mounted in 2" x 2" slide holders, pack of 10
PLF030	Polarizing Film, 3" x 3", pack of 2
PLF060	Polarizing Film, 6" x 6", pack of 2



## LED Stroboscope

NEW PRODUCT

This unique hand-held stroboscope was made possible by the development of high-power LEDs. The 30W Super-LED delivers bright flashes at adjustable rates from 1 Hz to 250 Hz, ideal for the motion rates encountered in lab situations. The frequency can also be displayed in rpm (1 – 15,000). The stroboscope measures only 18cm x 6cm x 4cm and is powered by four “AAA” batteries (not included), giving a continuous use time of 3 hours.



Item No.	Description
STROBE01	LED Stroboscope



## Digital Luxmeter

NEW PRODUCT

This device offers a practical and economical solution for light measurements in a variety of learning situations. Whether measuring environmental light or quantifying an optical experiment, this compact luxmeter meets the need. For most uses, the autoranging feature makes this a one-button-and-done instrument. Readings stabilize quickly. The auto power-off (after 5 minutes of no activity) conserves battery power, and for the times where more data is required, the MAX, MIN, HOLD, and difference functions are readily accessed. A threaded socket for tripod mounting is provided on the back of the case.

### Specifications

**Length:** 17cm **Width:** 5.3cm **Thickness:** 3.6cm **Weight:** 154g

**Sensor diameter:** 2.5cm **Sensor type:** silicon diode

**Display size:** 2.5cm x 2.5cm

**Display type:** 3½ digit LCD with backlight

**Power:** 9V battery (not included)

Item No.	Description
LXM001	Digital Luxmeter



## Demo Diffraction Grating

Demonstration slide has three 20mm x 10mm gratings with 100, 300, and 600 lines per mm, mounted between glass plates. The viewing area of each section is 15mm x 10mm.

Item No.	Description
DFG003	Demo Diffraction Grating

## Newton's Rings Apparatus



The Newton's Rings Apparatus consists of a plano-convex lens on top of a flat glass plate, held together by a plastic frame. The pressure between the lens and the plate can be adjusted by means of three thumbscrews.

Item No.	Description
NEWRIN2	Newton's Rings Apparatus

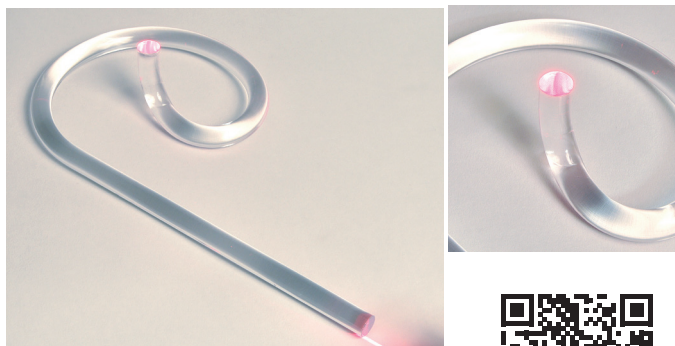


## Student Transmission Gratings

Quality linear gratings protected by two glass plates, 60mm x 45mm. Viewing area measures approximately 37mm x 20mm.

The DFG525-pk/5 Diffraction Gratings in Slide Viewers has a viewing area of 35mm x 25mm.

Item No.	Description
DFG100	Student Gratings, 100 lines per mm
DFG300	Student Gratings, 300 lines per mm
DFG600	Student Gratings, 600 lines per mm
DFG525-pk/5	Diffraction Gratings in Slide Viewers (13,400 lines per inch), pack of 5



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## Lumirod (Light Pipe)



Excellent tool to demonstrate the principle of fiber optics. The curled, 24", clear acrylic rod conducts light by internal reflection. A flashlight or laser pointer can be used for the demonstration. Includes activity guide.

Item No.	Description
LUMRD24	Lumirod (Light Pipe)



## Periscope

Inspired by naval periscopes used on submarines, our handheld periscope is designed to show students the reflective qualities of light. Our version consists of an outer case with mirrors at each end, set parallel to each other at a 45-degree angle.

Item No.	Description
PSCOPE	Periscope

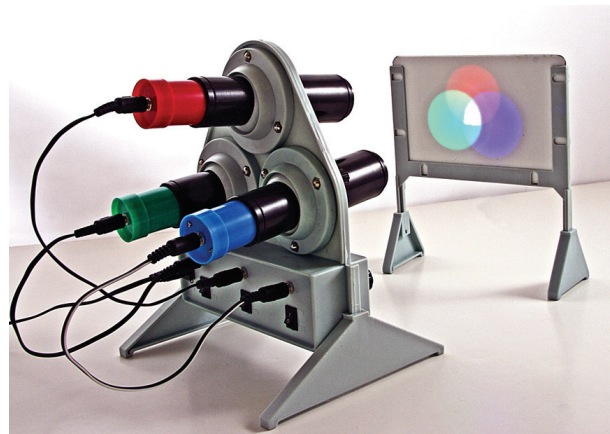


NEW PRODUCT

## Color Filters Acrylic, Set of 5

Set of five color filters (2.5" x 2.5" x 1/8") made of acrylic. Includes one each of the following colors: red, orange, yellow, blue and green.

Item No.	Description
COLORF-5	Color Filters, Acrylic, Set of 5



## Color Mixing Apparatus



A compact and economical color mixing apparatus updated version of the classic three-color light projector uses three low voltage, high power LED's to project easily-seen red, green, and blue light onto a white screen. The projector mounting allows the beam angles to be adjusted to vary the overlap of the three colored images. The intensity of each LED can be adjusted separately by a potentiometer to give a convincing white light or various shades of mixed colors. Colored shadows can also be explored in a darkened room. The set includes a wall-mount power supply and activity guide.



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Item No.	Description
CMA001	Color Mixing Apparatus

NEW PRODUCT



## LED Array

The vertically-aligned set of LEDs make an easy and dramatic demonstration of the relationship between the color and wavelength of light. The spectral range of each LED can be investigated with a spectrometer, or just viewed for comparisons with each other and with the "white" LED spectrum. Each LED can be turned on individually with the rotary switch on the top of the column. Includes power supply.

### Specifications

**Height:** 33.5 cm, **Base diameter:** 10 cm,

**Column diameter:** 3.3 cm

**Power supply:** Input: 110-240VAC 50/60Hz, 0.3A;  
Output: 5VDC, 2A



Scan to view demonstration video



Item No.	Description
LEDA01	LED Array





## Large Demonstration Prism Set, Magnetic



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demonstration video

An oversized set of six lenses and prisms designed for mounting on a magnetic chalk or marker board. Lenses are about 8" long, so your optics experiments would be clearly visible from every part of the classroom. Each piece in the set has a pre-attached magnetic backing. An activity guide is also included. Set comes in a sturdy wooden storage case. Please note: Laser Ray Box not included.

### Contents:

Semi-circular lens	1
Equilateral prism, 75mm sides	1
Double convex lens	1
Double concave lens	1
Single convex lens	1
Single concave lens	1

### Item No.

### Description

PST620

Large Demonstration Prism Set

### Properties of Acrylic:

Transmission of white light: 92%

Refractive index: 1.48 to 1.5

Haze: 1% to 3%



## Prism and Lens Sets



These superior quality, yet economical, prisms and lenses can be used to teach a wide variety of optical principles. Includes a sturdy wooden storage case and an activity guide.

### Contents:

Double convex lens	1
Double concave lens	1
Semi-circular lens	1
Trapezoidal prism	1
Small right angle prism	1
Equilateral prism	1
Large right angle refraction prism	1

### Item No.

### Description

OPSETG2	Prism and Lens Set of 7, Glass
OPSETP3	Prism and Lens Set of 7, Acrylic



Scan to view  
demonstration video

## Set of Prisms



Boxed set of high-quality acrylic prisms, made from clear acrylic sheet, all sides polished. The set consists of six prisms in a variety of shapes, and an activity guide.

### Contents:

Rectangular block, 75mm x 50mm x 15mm	1
Semi-circle, 90mm base x 15mm thick	1
Equilateral prism, 75mm sides, 15mm thick	1
Double convex lens, 90mm long, 23mm at center	1
Double concave lens, 90mm long, 10mm at center	2

### Item No.

### Description

PSET06

Set of 6 Prisms

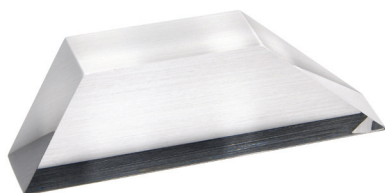


## Hollow Acrylic Prism

Equilateral prism has 45mm sides. One end has a hole for adding fluids to study refraction and dispersion. Includes a funnel and stopper.



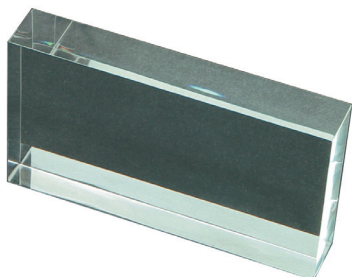
Item No.	Description
PHA045	Hollow Acrylic Prism



## Trapezoid Prism

Clear acrylic trapezoid, with one flat surface frosted to enhance visibility. Bases are 89mm, and 40mm. Faces measure 47mm, and 35mm.

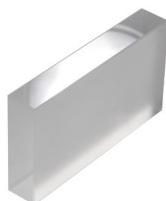
Item No.	Description
PATRAP	Trapezoid Prism



## Rectangular Block

Rectangular blocks are available in a variety of sizes and are designed for use as an index of refraction plate.

Item No.	Description
RCB075	Rectangular Block, 75 x 50 x 15mm, Acrylic
RCB100	Rectangular Block, 100 x 75 x 20mm, Acrylic
RCB115	Rectangular Block, 115 x 65 x 20mm, Acrylic
RCB115-G	Rectangular Block, 115 x 65 x 20mm, Glass
RCB125	Rectangular Block, 125 x 65 x 20mm, Acrylic



## Glass Block

Rectangular glass block measures 114mm x 63mm x 19mm and includes two frosted sides.

Item No.	Description
RGF114	Glass Block with Two Frosted Sides



## Optics Set



Includes two acrylic lenses, one each of double convex and double concave, and three mirrors, one each of convex, concave and plane. Packed in a cushioned wood storage box. Includes activity guide.

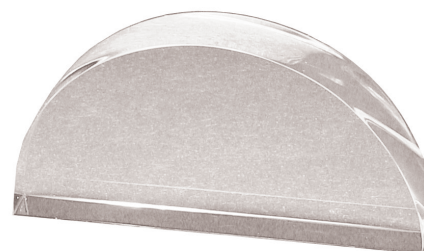
Item No.	Description
OPSET1	Optics Set



## Acrylic Lenses

Lenses are made from clear acrylic with one frosted plane surface. Double convex lens is 89mm long, 15mm thick, and 25mm across the beam axis. Double concave lens is 86mm long, 15mm thick, and 18mm wide at the center.

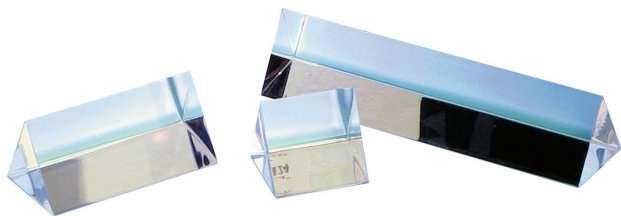
Item No.	Description
PACV86	Acrylic Lens, Double Convex
PACC86	Acrylic Lens, Double Concave



## Semi-Circular Lens

Acrylic semi-circular lens has a 75mm base and is 15mm thick.

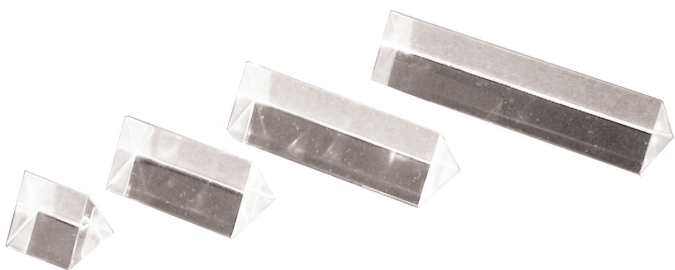
Item No.	Description
SCL075	Semi-Circular Lens



## Equilateral Acrylic Prism Set

Constructed of clear acrylic with highly polished surfaces, these prisms are ideal for projecting a clear, sharp spectrum. Set of equilateral prisms includes 25mm, 50mm, and 100mm lengths.

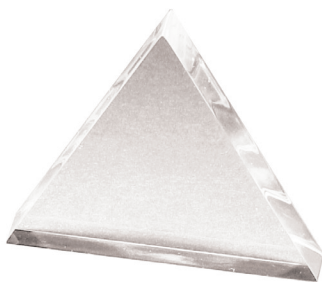
Item No.	Description
PAE124	Equilateral Acrylic Prism Set



## Equilateral Prisms

Equilateral prisms made from high-quality clear acrylic sheet or glass sheet. Highly polished surfaces.

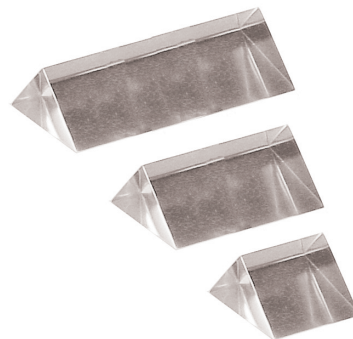
Length	Face Size	Acrylic Item No.	Glass Item No.
25mm	25mm	PAE025	PGE025
50mm	25mm	PAE050	PGE050
75mm	25mm	PAE075	PGE075
100mm	25mm	PAE100	PGE100
125mm	25mm	PAE125	PGE125
150mm	25mm	PAE150	PGE150



## Equilateral Refraction Prisms

Prism measures 75mm long by 9mm thick, available in acrylic or flint glass versions.

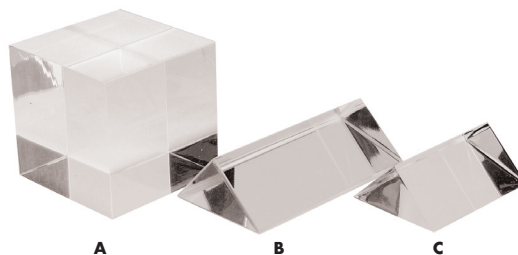
Item No.	Description
FAP075	Equilateral Refraction Prism, Acrylic
FGP075	Equilateral Refraction Prism, Glass



## Right Angle Acrylic Prism Set

Constructed of clear acrylic with highly polished surfaces, these prisms are ideal for projecting a clear, sharp spectrum. Set of right-angled prisms includes 25mm, 50mm, and 100mm lengths.

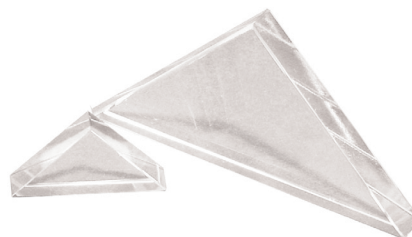
Item No.	Description
PAR123	Right Angle Acrylic Prism Set



## Right Angle Prisms

Prisms are manufactured from acrylic or flint glass, and feature polished surfaces. Available in a variety of sizes.

Item No.	Description (Length x Right Angle Side x Hypotenuse)	Picture
PAR048	Acrylic Prism, 50mm x 47mm x 67mm	Not Shown
PAR050	Acrylic Prism, 50mm x 25mm x 35mm	C
PAR075	Acrylic Prism, 75mm x 25mm x 35mm	B
PGR075	Glass Prism, 75mm x 28mm x 38mm	Not Shown
PAR100	Acrylic Prism, 100mm x 25mm x 35mm	Not Shown
PGRE10	Glass Prism, 115mm x 12mm x 18mm	Not Shown
CUBA02	Acrylic Cube, 2" sides	A

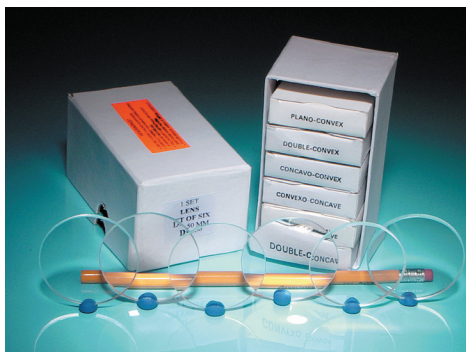


## Right Angle Refraction Prisms

Glass and acrylic right angle refraction prisms feature highly polished surfaces.

Item No.	Description
PFG050	Right Angle Refraction Prism, 32mm x 45mm, Glass
PFG080	Right Angle Refraction Prism, 80mm x 115mm, Glass
PFA080	Right Angle Refraction Prism, 80mm x 115mm, Acrylic





## Demonstration Lens Set, Glass

This six-lens set includes one each of double convex, plano-convex, concavo-convex, double concave, plano-concave, and convexo-concave. Comes in a reusable cardboard storage box.

Available in 38mm, 50mm or 75mm diameters. Lenses in all sets have focal lengths of 150mm.

Item No.	Description
DEMO38	38 mm Demonstration Lens Set, Glass
DEMO50	50 mm Demonstration Lens Set, Glass
DEMO75	75 mm Demonstration Lens Set, Glass



Scan to view demonstration video



## Demonstration Lens Set, Acrylic



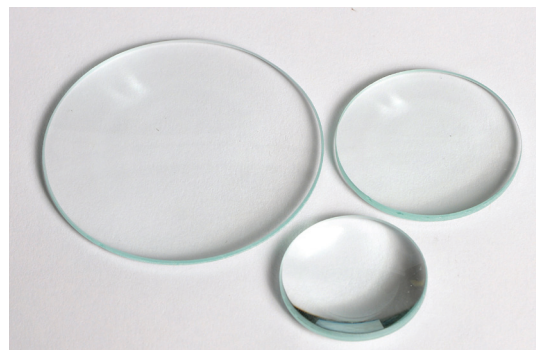
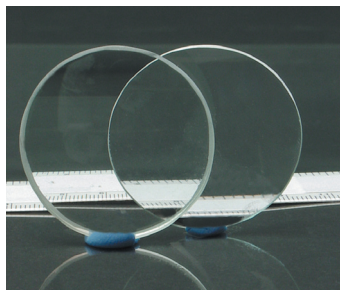
This six-lens set includes one each of double convex, plano-convex, concavo-convex, double concave, plano-concave, and convexo-concave. Includes an activity guide and a reusable cardboard storage box.

Item No.	Description
LSTA38	38 mm Demonstration Lens Set, Acrylic
LSTA50	50 mm Demonstration Lens Set, Acrylic
LSTA75	75 mm Demonstration Lens Set, Acrylic

## Neutralizing Lens Set

Set of two lenses, one concave and one convex, 38mm in diameter. Both lenses have a focal length of 150mm.

Item No.	Description
NELS38	Neutralizing Lens Set, 38mm diameter



## Individual Glass Lenses

Made from plate glass, with carefully ground and polished optical surfaces and cleanly ground edges.

Diameter	Focal Lengths (mm)	Double Convex Item No.	Double Concave Item No.
38	50	LCV302	LCC302
38	100	LCV304	LCC304
38	150	LCV306	LCC306
38	200	LCV308	LCC308
38	250	LCV310	LCC310
38	300-500*	LCV306**	LCC306**
50	50	LCV502	LCC502
50	100	LCV504	LCC504
50	150	LCV506	LCC506
50	200	LCV508	LCC508
50	250	LCV510	LCC510
50	300-500*	LCV506**	LCC506**
75	50	LCV702	LCC702
75	100	LCV704	LCC704
75	150	LCV706	LCC706
75	200	LCV708	LCC708
75	250	LCV710	LCC710
75	300-500*	LCV706**	LCC706**
100	100	LCV104	LCC104
100	150	LCV106	LCC106
100	200	LCV108	LCC108
100	250	LCV110	LCC110
100	300-500*	LCV106**	LCC106**
125	100	LCV204	LCC204
125	150	LCV206	LCC206
125	200	LCV208	LCC208
125	250	LCV210	LCC210
125	300-500*	LCV206**	LCC206**

\* Focal lengths available are 300, 350, 400, 450 and 500mm.

\*\* Please specify focal length when ordering.

**Properties of Flint Glass:**  
Refractive index: 1.5 to 1.6

**Properties of Acrylic:**  
Transmission of white light: 92%  
Refractive index: 1.48 to 1.5  
Haze: 1% to 3%



Concave Mirror



Convex Mirror

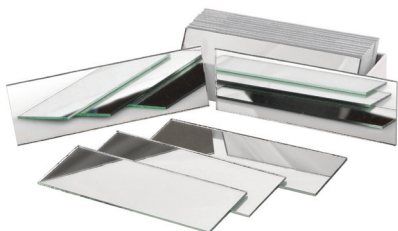
## Individual Glass Mirrors

Optically true glass, with scratch-resistant copper silvering on back.

Diameter	Focal Lengths (mm)	Convex Item No.	Concave Item No.
38	25	MCV301	MCC301
38	50	MCV302	MCC302
38	100	MCV304	MCC304
38	150-500**	MCV306**	MCC306**
50	50	MCV502	MCC502
50	100	MCV504	MCC504
50	150-500*	MCV506**	MCC506**
75	50	MCV702	MCC702
75	75	MCV703	MCC703
75	100	MCV704	MCC704
75	150-500*	MCV706**	MCC706**
100	100	MCV104	MCC104
100	150-500*	MCV106**	MCC106**

\* Most popular focal length is 150mm. Focal Lengths available are 150, 200, 250, 300, 350, 400, 450 and 500mm.

\*\* Please specify focal length when ordering.



## Plane Mirror Strips

Glass Mirror Strips are made from plate glass about 2mm thick, with a highly silvered back. Acrylic Mirror Strips are about 3mm thick.

### Glass Mirror Strips

Item No.	Dimensions	Quantity per pack
MSG2X2	2" x 2"	12
MSG3X1	3" x 1"	12
MSG3X2	3" x 2"	12
MSG4X2	4" x 2"	12
MSG4X4	4" x 4"	12
MSG6X2	6" x 2"	12
MSG6X4	6" x 4"	12
MSW6X4	6" x 4" x 1/4"	6

### Acrylic Mirror Strips

Item No.	Dimensions	Quantity per pack
MSA4X2	4" x 2"	1
MSA4X4	4" x 4"	1
MSA6X4	6" x 4"	1



## Mirror Set, Glass

A set of six glass spherical mirrors with back surface silvering. Includes three convex and three concave mirrors, all of 50mm diameter. Focal lengths are 50mm, 100mm, 200mm, -50mm, -100mm, and -200mm.

Item No.	Description
MCVSET	Glass Mirrors, Set of 6



## Flexible Mirrors, Acrylic

These double-sided, acrylic mirrors are flexible and can be used to demonstrate concave and convex properties. Material can be cut easily with scissors. Available in various sizes and as an assortment. Mirror supports not included.

Item No.	Description
MSA2X3-F	Mirrors, Flexible Acrylic, Double sided 2" x 3", pk/15
MSA4X6-F	Mirrors, Flexible Acrylic, Double sided 4" x 6", pk/3
MSA8X11-F	Mirrors, Flexible Acrylic, Double sided 8.5" x 11", pk/4
MSAST6	Mirrors, Flexible Acrylic, Double sided, pk/12 (4 each of 6" x 7-1/2", 3" x 4", and 2" x 3" sizes)



## Plane Spherical Mirrors

Optically true glass, with scratch-resistant copper silvering on back.

Item No.	Description
MPL038	Plane Spherical Mirror, 38 mm diameter
MPL050	Plane Spherical Mirror, 50 mm diameter
MPL075	Plane Spherical Mirror, 75 mm diameter
MPL100	Plane Spherical Mirror, 100 mm diameter



## Hand Lens - Metal Frame

Glass lenses mounted on metal frames with bakelite handles. 2.5x magnification.

Item No.	Description
MFG050	Hand Lens, Metal Frame, 50mm diameter
MFG065	Hand Lens, Metal Frame, 65mm diameter
MFG075	Hand Lens, Metal Frame, 75mm diameter
MFG100	Hand Lens, Metal Frame, 100mm diameter



## Hand Lens - Plastic Frame

Glass lenses molded into high quality unibody plastic frames. 2.5x magnification.

Item No.	Description
MFP050	Hand Lens, Plastic Frame, 50mm diameter
MFP065	Hand Lens, Plastic Frame, 65mm diameter
MFP075	Hand Lens, Plastic Frame, 75mm diameter
MFP090	Hand Lens, Plastic Frame, 90mm diameter
MFP100	Hand Lens, Plastic Frame, 100mm diameter



## All-Plastic Magnifier

This inexpensive 3x magnifier is great for general purpose use. Plastic lens, 2" diameter. Overall length, 6".

Item No.	Description
XT81304	All-Plastic Magnifier



## Clear Plastic Magnifier, 3x/6x

Clear plastic magnifier is 110mm (4.50") in length and features dual lenses of 3x and 6x magnification. 3x lens is 50mm in diameter and 6x lens is 20mm in diameter.

Item No.	Description
PMD002	Clear Plastic Magnifier, 3x/6x



## Clear Plastic Magnifier, 3X

Clear plastic magnifier is 90 mm (3.5") in length and features a lens of 3x magnification. The lens is 35mm in diameter.

Item No.	Description
PMS001	Clear Plastic Magnifier, 3X



## Triple Magnifier - Plastic

Handy molded plastic magnifier has 2x, 6x, and 8x magnification lenses. Overall length is 100mm (4").

Item No.	Description
PMT003	Triple Magnifier, Plastic





MP5010



MPD010



MPT010

## Folding Magnifiers

Folding magnifiers in plastic cases. Glass lenses are 25mm in diameter with 5x magnification. Single magnifier includes one lens. Double magnifier includes two lenses for 10x magnification. Triple magnifier includes three lenses for 15x magnification.

Item No.	Description
MPS010	Single Folding Magnifier, 5x
MPD010	Double Folding Magnifier, 10x
MPT010	Triple Folding Magnifier, 15x



MPD038



MPS038

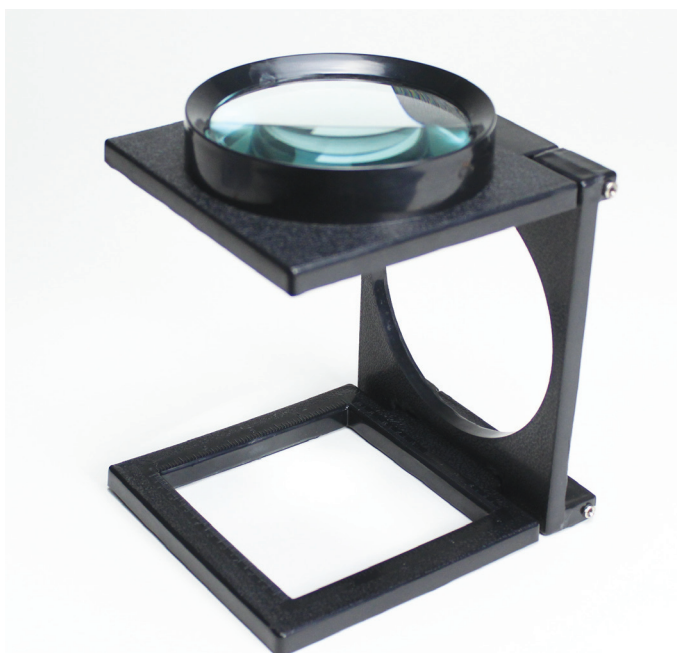


MPT038

## Large Folding Magnifiers

Sturdy plastic frames with 38mm (1.5") diameter glass lenses for a larger field of view. These versatile magnifiers can magnify objects up to 15x.

Item No.	Description
MPS038	Single Folding Magnifier, Large, 5x
MPD038	Double Folding Magnifier, Large, 10x
MPT038	Triple Folding Magnifier, Large, 15x



## Giant Folding Magnifier

This magnifier offers an extra-large field of view, hands-free use, and folds down to a compact size for storage. The 10cm lens provides 6x magnification.

Item No.	Description
MGFL6X	Giant Folding Magnifier, 6x



## Folding Magnifier in Pouch

Folding magnifier in a pouch, 50mm dia., 2.5x magnification.

Item No.	Description
MPF050	Folding Magnifier in Pouch, 2.5x



## Plastic Tripod Magnifier

10x magnification glass lens in plastic screw-thread holder is mounted on a metal tripod base.

Item No.	Description
TRP10X	Plastic Tripod Magnifier, 10x



## Brass Tripod Magnifier

10x magnification glass lens in brass holder is mounted on a tripod brass base.

Item No.	Description
TRPBR1	Brass Tripod Magnifier, 10x



## Pocket Loupe

Compact pocket loupe, in a sturdy folding metal case. 10x magnification.

Item No.	Description
MFC010	Magnifier, Pocket Loupe, 10x



## Folding Magnifier - Aluminum Case

Single folding magnifier folds into a protective aluminum case. Features a glass 10x magnification lens, 25mm in diameter and mounted in a plastic frame.

Item No.	Description
MPF010	Folding Magnifier in Aluminum Case, 10x



## Loupe-Style Magnifiers

These high quality loupes feature a 25mm glass lens mounted in a sturdy black plastic frame. Available in either 6x or 10x magnification.

Item No.	Description
MFL006	Loupe-Style Magnifier, 6x
MFL010	Loupe-Style Magnifier, 10x



NEW PRODUCT

## Fresnel Lens

Fresnel Lens with vinyl sleeve is 3 3/8" wide x 2 1/4" tall. The magnifying window is 3 1/8" wide and 1 3/4" tall and has a magnification of 1.25x.

Item No.	Description
FRESLNS	Fresnel Lens



## Alnico Magnet Set

Set of 4 powerful alnico magnets with keepers. Set consists of 2 bar magnets 80mm x 15mm x 10mm; a small horseshoe magnet 25mm tall x 8mm wide; and a large horseshoe magnet 35mm tall x 15mm wide.

Item No.	Description
MSET4	Alnico Magnet Set of 4



ABM030



ABM010

## Alnico Bar Magnets

Powerful Alnico 1 grade bar magnets, shipped in pairs, with end keepers. Magnets are painted with North and South poles, clearly marked. Width 1/2", Thickness 1/4".

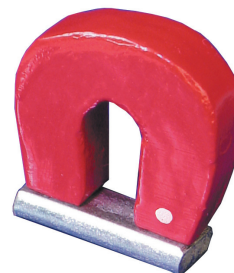
Item No.	Description	Color
ABM010	Alnico Bar Magnet, 1"	Red
ABM015	Alnico Bar Magnet, 1.5"	Red
ABM020	Alnico Bar Magnet, 2"	Red
ABM030	Alnico Bar Magnet, 3"	Red/Blue
ABM040	Alnico Bar Magnet, 4"	Red
ABM060	Alnico Bar Magnet, 6"	Red



## Alnico U-Shaped Magnet, 3"

Powerful 3" tall U-shaped alnico magnet is painted red and supplied with a keeper. North pole is marked with a dot.

Item No.	Description
MHS030	Alnico U-Shaped Magnet, 3"



## Alnico U-Shaped Magnet, 1"

Powerful 1" tall U-shaped alnico magnet is painted red and supplied with a keeper. North pole is marked with a dot.

Item No.	Description
AUM025	Alnico U-Shaped Magnet, 1"



ACM050

## Alnico Cylindrical Magnets

Strong Alnico 1 grade cylindrical magnets, shipped in pairs, with separators and keepers. North pole is marked with a dot.

Item No.	Description	Color
ACM020	Alnico Cylindrical Magnet, 5cm x 8mm	Red
ACM050	Alnico Cylindrical Magnet, 12.5cm x 10mm	Red





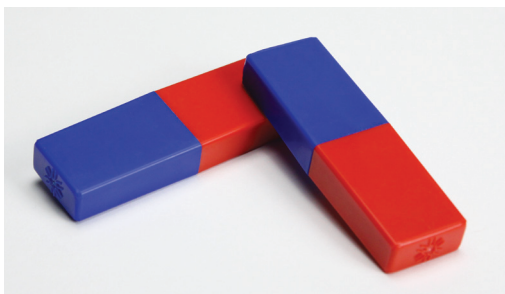
# Physics Magnetism



## Steel Horseshoe Magnets

Strong steel magnets, zinc-plated with North and South poles marked. Supplied with keeper.

Item No.	Description
SHM020	Steel Horseshoe Magnet, 2"
SHM030	Steel Horseshoe Magnet, 3"
SHM040	Steel Horseshoe Magnet, 4"
SHM050	Steel Horseshoe Magnet, 5"
SHM060	Steel Horseshoe Magnet, 6"



## Magnets, Plastic Covered

These alnico magnets are encased in red and blue plastic to provide extra durability. Each magnet measures 80 x 15 x 10mm. Shipped as a pair.

Item No.	Description
MPC080	Magnets, plastic covered, red/blue (pair)



## Stirrup

Brass support for bar magnets or friction rods. Allows magnets or friction rods to hang freely and turn in a horizontal plane. Hooks are 89mm apart. Dimensions 3-1/2" x 2" x 1".

Item No.	Description
MGSTR01	Magnet Stirrup

## Floating Magnets Set

This set includes a plastic stand designed to easily demonstrate the "floating" magnets effect. Plastic-encased magnets are durable and resist breakage. Set includes six brightly colored magnetic rings, plastic stand, and cardboard storage box. **Suitable for ages 11+.**



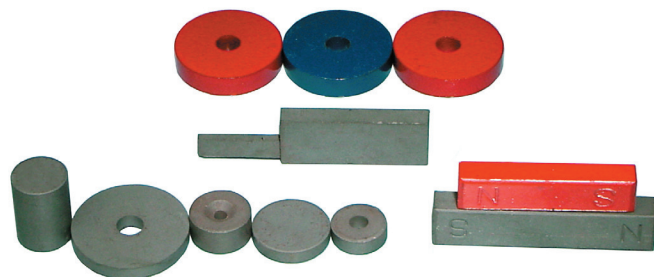
Item No.	Description
CMSET6	Floating Magnets Set



## Ceramic Disc Magnets, Set of 6

A set of colorful ceramic disc magnets in six primary colors. Magnets are 25mm in diameter. **Suitable for ages 11+.**

Item No.	Description
CMSET1	Ceramic Disc Magnets, Set of 6



## Ceramic Magnets

We offer a variety of economical ceramic bar, disc, and ring shaped magnets. Magnets are unpainted except where noted.

Item No.	Description
CBM050	Bar, 50mm Long x 10mm Wide x 7mm Thick (pair), painted
CBM070	Bar, 70mm Long x 15mm Wide x 8mm Thick (pair)
CM7912	Disc, 25mm Dia., 5mm Thick
CM7702	Rectangular, 27mm Long X 8mm Wide X 3mm Thick
CM3030	Square, 30mm Sides, 3mm Thick, 10mm hole
CM8711-S	Ring, 30mm Dia., 5mm Thick, 12mm Hole
CM7907	Ring, 38mm Dia., 8mm Thick, painted
CM7907-PK/2	Pack of two, 38 x 8mm Rings, one Red, one Blue



## Economy Magnet Kit



This kit includes a variety of magnets and accessories for teaching basics of magnetism. Includes a reusable storage box and an activity guide.

### Contents:

Steel horseshoe magnet	1
Ceramic bar magnet	2
Ceramic donut magnet	3
Metal squares (one each of iron, copper, aluminum, zinc)	4
Iron filings pack	1
Lodestone	1
Magnetic compass	2
Activity guide, containing 17 experiments	1



Scan to view demonstration video

Item No.	Description
MGTKIT	Economy Magnet Kit



## Cow Magnet, Alnico

Strong alnico magnet with a magnetic pole on each end. It can be used for magnetic field demonstrations and a variety of other lab experiments. Magnet is 7.5cm long, 1.25cm in diameter, and weighs approximately 100 grams.

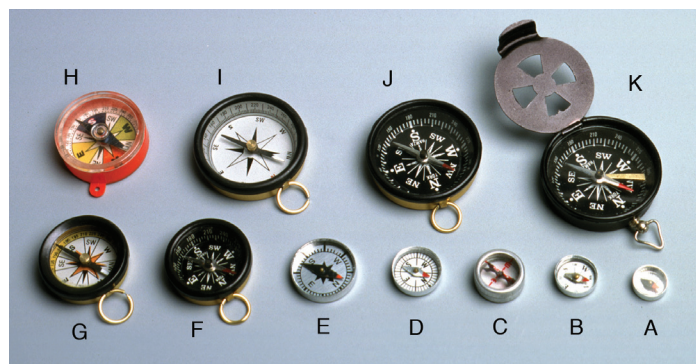
Item No.	Description
MGTCOW-A	Cow Magnet, Alnico



## Cow Magnet

Designed like a magnet that is generally fed to cows to attract metal particles they may have ingested while grazing. Students can use it in the classroom for magnetic field demonstration and other interesting experiments. Cylindrical magnet is 7.5cm long, 1.9cm in diameter, and weighs approximately 100 grams.

Item No.	Description
MGTCOW	Cow Magnet



## Magnetic Compasses

We offer a variety of magnetic compasses, from small plotting compasses up to a 45mm compass with a cover and locking mechanism. Our compasses include sturdy aluminum cases and magnetic needles with the North pole marked.

Item No.	Picture	Size (Dia.)	Description
C1SG12	A	12 mm	Aluminum case, glass top
C1SG16	B	16 mm	Aluminum case, glass top
CBSG18	C	18 mm	Aluminum ring, glass top and bottom
C1SG20	D	20 mm	Aluminum case, glass top
C1SG25	E	25 mm	Aluminum case, glass top
CWR025	F	25 mm	Aluminum case, glass top with ring
CWR030	G	30 mm	Aluminum case, glass top with ring
CPL035 *	H	35 mm	Plastic case, plastic top *
CWR045-W	I	45 mm	Aluminum case, glass top with ring
CWR045-B	J	45 mm	Aluminum case, glass top with ring
CWL045	K	45 mm	Aluminum case, glass top with lock

\* Suitable for ages 11+

## Large Magnetic Compass

This magnetic compass is extra large (90mm diameter) and includes a bright color plastic case with a clear plastic top.

**Suitable for ages 11+.**



Item No.	Description
CPL090	Large Magnetic Compass, 90mm diameter



## Compass, Liquid-Filled Magnetic

Durable, liquid-filled clear magnetic compass is housed in a black plastic rotatable bezel. Graduated in 5° increments. Outer diameter of bezel is 45mm. Outer diameter of clear compass is 35mm. Includes a lanyard.

Item No.	Description
CLF045	Compass, Liquid-Filled Magnetic



## Demonstration Compass

This device includes a 4" magnetic needle mounted on a plastic support with a brass pivot. The North pole of the needle is painted red.

Item No.	Description
MNSB04	Demonstration Compass



## Lodestone

A natural rock, collected in Utah USA, that contains traces of iron ore with natural magnetic properties. Measures approximately 2" long. Available individually or as a pack of 5.

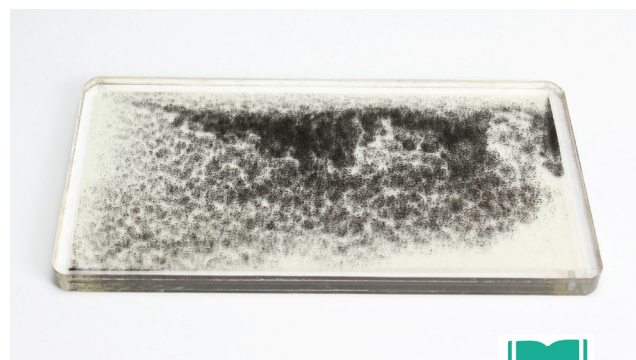
Item No.	Description
LODE02	Lodestone
LODE02-PK/5	Lodestone, pack of 5



## Pair of Magnetic Needles

Two 14cm long magnetic needles with colored poles are mounted on plastic stands with needle bearings. Use individually as a demonstration compass, or as a pair to show attraction and repulsion.

Item No.	Description
MNSB05	Pair of Magnetic Needles



## Magnetic Field Demonstrator



This is a quick and clean way to visualize magnetic fields. The demonstrator is a transparent acrylic case that holds iron filings suspended in a fluid of mineral oil. When it is placed over a magnet, the field pattern can be viewed directly, or it can be placed on an overhead projector for classroom demonstration.

Item No.	Description
MGFD03	Magnetic Field Demonstrator



## Magnetic Field Demonstrator Student Version

Iron filings sealed in a transparent plastic case that measures approximately 90mm x 65mm x 6mm.

Item No.	Description
MGFD01	Student Magnetic Field Demonstrator



## Ampere's Rule Apparatus

This apparatus allows students to study the magnetic field around a wire. A heavy brass wire with terminals is arranged on a clear plastic base. Also included are one each 45mm compass, six each 16mm compasses, and an activity guide.



Scan to view demonstration video

Item No.	Description
AMPR01	Ampere's Rule Apparatus





## Large U-Shaped Electromagnet



Operating on 1.5 to 6 VDC, this electromagnet lifts up to 3.5kg. A current direction indicator is included for the study of the magnetic field.

Item No.	Description
EMGT01	Large U-Shaped Electromagnet



Scan to view demonstration video

## Primary and Secondary Coils



Superior version of the classic device for investigating electromagnetic induction. Primary and secondary coils are wound on robust molded formers fitted with shielded banana jacks. The plated iron core has a molded handle for accurate positioning in the coils. The primary coil has 175 turns of 18 AWG insulated copper wire (diameter 34mm, length 100mm, resistance 0.43  $\Omega$ , self-inductance  $\approx 3.1\text{mH}$ ). Secondary coil has three available windings with 500, 1000, and 1500 turns of 26 AWG insulated copper wire (diameter 52mm, length 102mm, resistances 11.5  $\Omega$ , 23.3  $\Omega$ , 35.7  $\Omega$ , self-inductances  $\approx 490\text{mH}$ , 1.97H, 4.43H). Plated iron core is 19mm in diameter and 165mm long (including handle). Includes activity guide.

Item No.	Description
PSC001	Primary and Secondary Coils



## Electromagnet Kit



This kit is designed for high school students to learn the principles and applications of electromagnets. It includes two coils on plastic spools, a U-shaped iron core, a straight iron core, two magnetic compasses with stands, and a pair of wires. Students can build a bar-shaped and a U-shaped electromagnet which they power with a 6V battery (not included) or DC power supply (not included), to determine the magnitude and polarity of electromagnetic forces. An activity guide and a plastic storage case are included.



Scan to view demonstration video

Item No.	Description
EMKIT2	Electromagnet Kit



## Tangent Galvanometer



Classic demonstration of how a current loop generates a magnetic field. Two coils of insulated wire, with five and ten turns respectively, are wound around a 6" diameter plastic ring. The ring is mounted on a plastic base with three binding posts that allow connection to five, ten, or fifteen turns of wire. A magnetic compass (included) can be placed on the base to observe and measure deflection of the compass. An activity guide is included. Power source and connecting wires not included.

Item No.	Description
TNGV01	Tangent Galvanometer



## Electricity and Magnetism Kit



This comprehensive 29-piece kit introduces students to the basic principles of electricity and magnetism, including magnetic attraction and repulsion, magnetic fields, and electromagnetism. Electrical circuitry, voltage, current and resistance are covered, as well as series and parallel connection. Force in a magnetic field and electric motor basics are included, and light emitting diodes and a relay are provided for further investigations. The components are mounted on sturdy molded bases and connections are made with reliable screw terminals. An activity guide details the experiments. Requires three AA batteries (not included).



Scan to view  
demonstration video



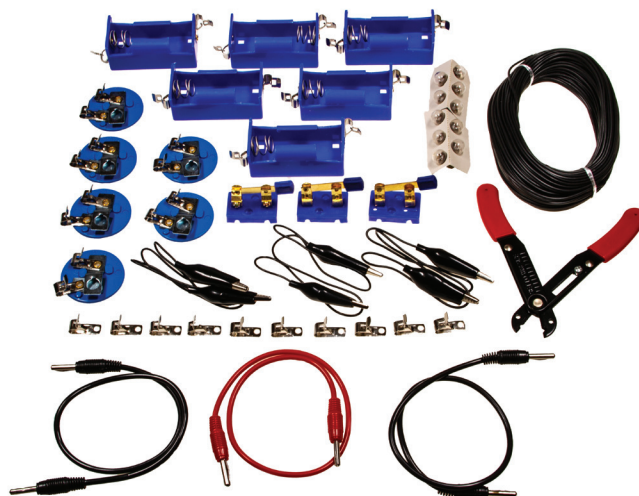
## Student Electricity Assortment

Convenient, economical package of materials to start investigating electricity concepts.

### Contents:

Round Plastic Bulb Holder	.6
Knife Switch, Single Pole, Single Throw	.3
Battery Holder with Fahnestock Clip	.10
Wire Stripper	.1
Wire with Alligator Clips, 18", Assorted Colors	.3
Wire with Banana Clips, 18", Assorted Colors	.3
Insulated Copper Wire, 22 gauge, 100 foot roll	.1
1.5V Light Bulb	.10

Item No.	Description
EAKIT1	Student Electricity Assortment



## Create-A-Circuit Kit



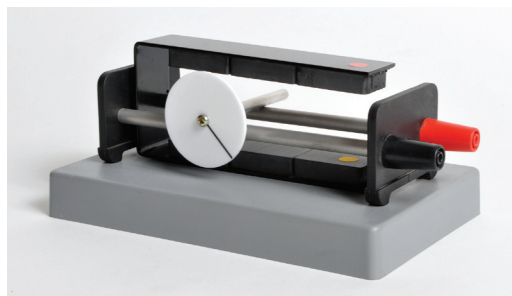
Build your own series or parallel circuit using this kit. It comes complete with a battery holder (D size battery not included), a knife switch, two miniature light bulbs, two lamp holders, and four alligator clip connecting cords. Includes activity guide.

Item No.	Description
CCK001	Create-A-Circuit Kit



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demonstration video





## LaPlace's Law Demonstrator



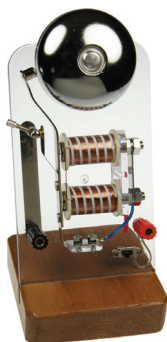
A great device for teaching Fleming's left hand rule, this demonstrator consists of a base with two separate parallel conductors, a large U-shaped magnet that fits between the parallel conductors, and a conducting rod attached to a plastic disc. When a current is passed through the rods, a force is exerted on the rod with the disc which causes it to roll along the parallel rods. Includes activity guide.

Item No.	Description
LLDE01	LaPlace's Law Demonstrator



## Electric Bell Model

This well constructed and attractive electric bell model is mounted on a clear acrylic plate and a finished wooden stand to allow the functional parts to be clearly seen. Model operates on 6V DC with an on/off switch, adjustable contact screw, and binding posts for easy connection. Includes activity guide.



Item No.	Description
ELBM01	Electric Bell Model



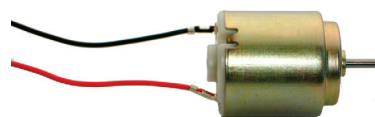
## Eddy Current Demonstrator

A simple but effective device for demonstrating Lenz's Law using eddy currents induced in the wall of a copper tube by a falling magnet. The demonstrator consists of a 12" long copper tube and two apparently identical metal slugs with rubber end caps. One slug is plain steel and falls through the copper tube quickly. The other slug is a strong neodymium magnet that falls very slowly through the tube due to the braking effect of eddy currents. Includes activity guide.



Scan to view demonstration video

Item No.	Description
EDYCR1	Eddy Current Demonstrator



## Miniature DC Motor

Operates on 1.5V or 3V DC. Speed: 7000-11000 RPM. Motor is approximately 40mm long x 20mm in diameter. Shaft size is 8mm long x 2mm in diameter. Includes soldered-on on 4" wire leads.

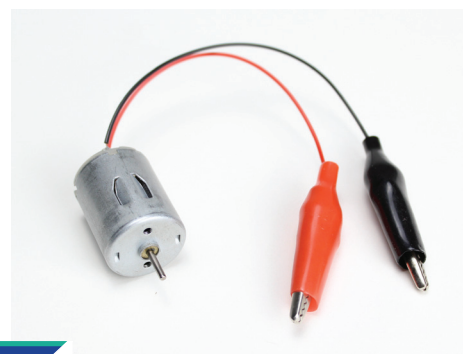
Item No.	Description
DCM015	Miniature DC Motor



## Miniature DC Motor for Solar Experiments

Solar motor is specifically designed for experiments using low starting voltage (0.5V) and current (25mA). Speed: 1000-5000 RPM. Motor is approximately 38mm long x 24mm in diameter. Shaft size is 8mm long x 2mm in diameter. Includes soldered-on 4" wire leads.

Item No.	Description
DCM015-C	Miniature DC Motor for Solar Experiments



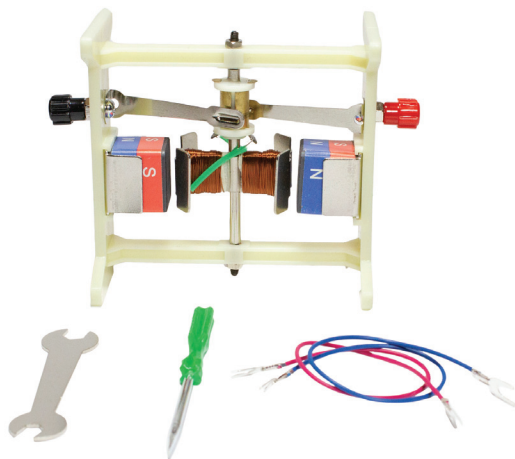
NEW PRODUCT

## Miniature DC Motor, with Alligator Leads

This miniature DC motor is designed for experiments using low starting voltage (4.5V) and current (70mA). Speed: 1000-5000 RPM. Motor is approximately 34mm long x 24mm in diameter. Shaft size is 10mm long x 2mm in diameter. Includes soldered-on 7" lead with alligator clips.

Item No.	Description
DCM045-L	Miniature DC Motor, with Alligator Leads





## Demonstration DC Motor



This pre-assembled DC motor is designed for students to learn about electromagnetic forces. The open structure resembles the diagram found in many textbooks. The polarity of the magnets can be reversed to change the direction of rotation. The motor can also be used with a rheostat to observe the change of speed with the change of current. The DC motor can stand vertically or horizontally and operates on a 1.5V battery (not included). It includes a sturdy plastic storage case and an activity guide.

Item No.	Description
DMOT01	Demonstration DC Motor



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## Morse Code Experiment Kit



Discover how people communicated over long distances before the telephone was invented. The Morse code experiment kit is designed to show the principle of a telegraph. The kit consists of a battery holder (D size battery not included), a telegraph key, one miniature bulb, one lamp holder, and three alligator clip connecting cords. Includes activity guide.

Item No.	Description
MCE001	Morse Code Experiment Kit



## Telegraph Key

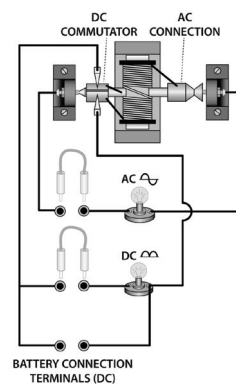
Telegraph key, mounted on a solid plastic base, measuring 11cm x 5cm, with two screw-type connecting terminals.

Item No.	Description
TGKY01	Telegraph Key



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AC/DC Generator Circuit Diagram.

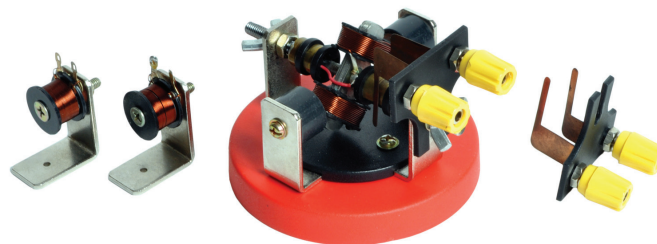


## AC/DC Generator Demo Set



This unique hand generator is an easy yet effective way to teach how AC and DC electricity is produced. Banana plugs can be inserted into the different connectors to change from AC to DC electricity. The unit has a clear base for easy demonstration of connections. Includes activity guide.

Item No.	Description
ACDCSET	AC/DC Generator Set



## Demonstration Motor/Generator Set



This high quality yet economical device can be used as either a motor or generator demonstration in your classroom. The motor uses electrical energy to perform mechanical work. The generator converts mechanical work to electrical energy. Includes activity guide.



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Item No.	Description
DMG002	Demonstration Motor/Generator Set



## Solar Furnace

NEW PRODUCT



This simple device gives a graphic demonstration of the sun's radiative energy. A large convex mirror concentrates solar radiation onto a small container of water suspended at the mirror's focal point. In a few minutes, the water boils.

The mirror's angle is adjustable though 180° to allow it to be aimed at the sun at any time of day.

### Specifications:

**Mirror Diameter:** 30cm, **Aperture area:** 700cm<sup>2</sup>,

**Mirror focal length:** 16cm, **Furnace capacity:** 20ml

**Base diameter:** 22cm, **Height:** 33 - 45cm

Item No.	Description
SLF001	Solar Furnace



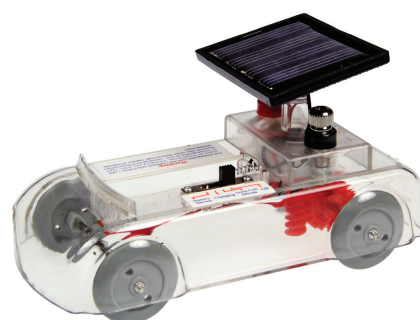
Scan to view demonstration video

## Hand Held Generator



This 6V DC hand held generator can deliver up to 400mA current. The generator is equipped with a polarity coded plug-in lead with alligator clips. The clear plastic housing allows students to watch the coils, terminals, and gears. Students get a hands-on demonstration of the Second Law of Thermodynamics. Includes activity guide.

Item No.	Description
GENH02	Hand Held Generator



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## Solar Powered Car



This economical demonstration solar car can be powered by a solar cell or a rechargeable battery (AA size, not included). Battery can be recharged from the solar cell, demonstrating an electricity storage system for solar power. The solar cell can be tilted to maximize solar input, features an on/off and select function switch, and includes two binding posts to measure output. All working parts are visible through the clear molded housing. Includes activity guide.

Item No.	Description
SLRCR1	Solar Powered Car

## Energy Conversion Kit



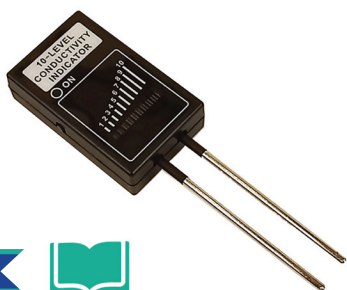
Scan to view demonstration video

This economical seven-piece kit lets you demonstrate the conversion between different forms of energy. It includes four devices for generating electrical energy and three devices that use electrical energy. A set of cables is included for connecting the devices to each other in various combinations. Batteries not included.

### Contents:

Hand generator (to produce electrical energy from motion) . . . . .	1
Battery holder (to produce chemical energy) . . . . .	1
Solar panel (to produce light energy) . . . . .	1
Windmill (to produce wind energy) . . . . .	1
LED lamp (to use electrical energy to produce light) . . . . .	1
Electric motor (to use electrical energy to produce motion) . . . . .	1
Buzzer (to use electrical energy to produce sound) . . . . .	1
Connecting cords, banana plug, red . . . . .	3
Connecting cords, banana plug, black . . . . .	3
Activity guide . . . . .	1

Item No.	Description
ECK001	Energy Conversion Kit



NEW PRODUCT



## Conductivity Tester

This handheld device provides a qualitative visual indicator of the conductivity of different solutions, acids or salts. Two brass probes can be touched to a solid substance, or immersed in a liquid, to show conductivity on green LEDs that range from 1 to 10. Each probe is 53mm long with a diameter of 3mm. Overall length of the meter and probes together is 14cm. Includes a 12V battery and operating instructions.

Item No.	Description
CNDT01	Conductivity Tester



NEW PRODUCT



## Current Balance

The classic method for demonstrating and measuring the small force experienced by a conductor carrying an electric current in a magnetic field. One half of the balance is placed inside a solenoid. The other half has an adjustable counterweight and can carry light additional masses. When current is supplied to the balance and the solenoid from an external power supply, the balance deflects. Adding light masses until balance is restored allows the force on the conductor to be measured. Includes activity guide.

### Specifications:

**Balance:** 240mm x 65mm x 3mm, **Base:** 87mm x 87mm x 35mm

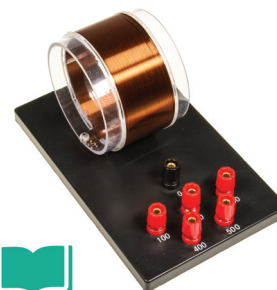
Item No.	Description
CBA001	Current Balance



## Conductivity of Solutions Apparatus

This 3V conductivity tester demonstrates the electrical properties of various liquids. The item consists of a molded plastic lamp socket mounted on a base with two binding posts for connecting a wire cord. It comes complete with a bulb and glass tumbler. Includes activity guide.

Item No.	Description
CSA001	Conductivity of Solutions Apparatus



NEW PRODUCT



## Air Core Solenoid

This product is used for investigating the magnetic field of a coil and for the current balance experiment. The clear acrylic former and the large diameter allow items placed inside the coil to be easily seen.

Five tappings give easy access to windings of 100, 200, 300, 400 and 500 turns by simply moving one plug between the five red binding posts.

The coil has a total resistance of 20  $\Omega$ , or 4  $\Omega$  per 100 windings and can carry up to 1.5A of current in a single 100-turn segment, allowing a 6VDC power source to be used (and up to 12V for the full 500 turns). Includes activity guide.

### Specifications:

**Coil Diameter:** 9.0cm, **Coil Length:** 4.0cm,

**Total turns:** 500, **Total coil resistance (500 turns):** 20  $\Omega$

**Maximum current:** 1.5A (through one segment)

Item No.	Description
ACS001	Air Core Solenoid

## Deluxe Current Balance

NEW PRODUCT



This kit includes an air core solenoid and a current balance for demonstrating and measuring the small force experienced by a conductor carrying an electric current in a magnetic field. To run the experiment, one half of the current balance is placed inside the solenoid. The other half has an adjustable counterweight and can carry light additional masses. When current is supplied to the balance and solenoid from an external power supply, the balance deflects. Adding light masses until balance is restored allows the force on the conductor to be measured. Includes activity guide.

Item No.	Description
DCBA01-KIT	Deluxe Current Balance







## Van de Graaff Generator, Dual Drive

This large van de Graaff generator uniquely offers alternative drive modes, either hand-cranked or motor driven. The generator reliably delivers charge and sparks with a length of 10cm long and more immediately upon setting it in motion, even under high humidity conditions. In hand-cranked mode the amount of charge generated can be seen to increase at higher cranking speeds, while the much faster motor-driven mode delivers a fast succession of sparks. The generator is 76cm high and features a 28cm diameter polished steel sphere, which is less vulnerable to dents and scratches than comparably sized aluminum spheres. A further unique feature of this generator is a built-in lamp close to the bottom of the belt that delivers a small amount of UV light when turned on. This can be seen to increase the charge production. A set of accessories is included, containing a discharge wand with a grounding cord, an electric plume, an electric whirl, a discharge bulb, a cord for connecting other electrostatic demonstration items, a spare charge belt and a spare motor drive belt. The generator measures 38cm x 23cm x 76cm.

Item No.	Description
VANDGF1-DD	Van de Graaff Generator, Dual Drive
VANDGF1-RB	Replacement Belt for Van de Graff Generator



## Light Leaper Accessory

A popular accessory for electrostatic demonstrations. An insulating printed circuit board carries a metallic conduction path with six breaks and a binding post at each end. When connected to an operating electrostatic generator, simultaneous sparks occur in each of the breaks as charge flows between the poles of the generator. Measures 195mm x 100mm x 21mm (7½" x 4" x ⅞"). Includes activity guide.

Item No.	Description
LLA001	Light Leaper Accessory



NEW PRODUCT



## Wimshurst Generator

We offer a superior quality Wimshurst machine for demonstrating high voltage electric charges. Our unit features acrylic rotating disks, good quality foil strips and brushes, insulated cylindrical capacitors, and a durable plastic platform. Guaranteed to produce large sparks for easy classroom demonstration.



Scan to view demonstration video

Item No.	Description
WIMS02	Wimshurst Generator



## Electrostatics Lab

NEW PRODUCT

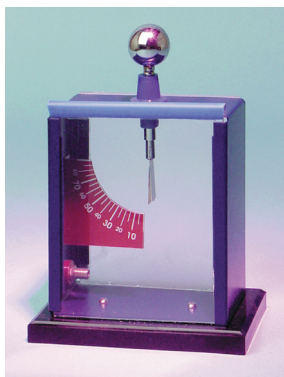


Demonstrate multiple electrostatic principles: electrophorus, charging electroscopes by induction and contact, electrostatic attraction, repulsion and induction, Faraday's ice pail experiment, and surface distribution of the charge. Contents include: Electroscopes with ball terminals, charge transfers rods, disks terminals for electroscopes, glass beaker, Faraday cage with cover, insulated base for Faraday cage, aluminum can, electrophorus plates and handle, pith balls, charge transfer ball, acrylic sheet, neon bulb, insulated point, acetate cloth, and friction rods (polyethylene, PVC, acrylic, glass, nylon, polystyrene).

Item No.	Description
ELSLAB	Electrostatics Lab



Scan to view  
demonstration video



## Gold Leaf Electroscope

This sturdy electroscope features a metal case with front and rear glass windows for preventing air currents from affecting the deflection of the leaves. Leaves are gold and aluminum. Leaf support rod is held in place by an insulating plastic sleeve. A graduated scale is also provided for measuring the deflection from 0 to 90 degrees. Includes activity guide.

Item No.	Description
ELGL01	Gold Leaf Electroscope
ELGL01-FOIL	Spare gold leaves, pack of 6



ELFL02-PK/3

## Flask Form Electroscope

This electroscope is housed in a 250ml borosilicate flask with a metal rod attached to a rubber stopper. A pair of aluminum leaves is suspended from an alligator clip. The knob on top of the rubber stopper accepts a charge. When the charge enters the flask, the aluminum leaves separate. Also available are rod and alligator clip assembly for use with your own flask and replacement aluminum leaves. Includes activity guide.

Item No.	Description
ELFL01	Flask Form Electroscope
ELFL02-PK/3	Electroscope Assembly, without flask, pack of 3
ELFL01-FOIL	Spare aluminum leaves, pack of 6



## Leyden Jar



Learn about static electricity and the function of a dielectric with this device. Two aluminum jars (one with an attached aluminum electrode) and one plastic jar are used to collect the charge. Assembled device is 6" tall and 3-1/4" in diameter. Includes activity guide.

Item No.	Description
LYJ001	Leyden Jar



Scan to view  
demonstration video



## Electroscopes Kit

Demonstrate key electrostatics concepts with this kit. Contains everything necessary to construct two flask form electroscopes. Detailed manual includes experiments using two electroscopes for positive and negative charge studies, and a Faraday's Pail experiment.

### Contents:

Glass flask.....	2
Aluminum disc terminal.....	2
Set of 4 foil leaves.....	2
Electrode assembly.....	2
Aluminum can (Faraday pail).....	1
Hard rubber rod.....	1
Silk cloth.....	1
Acrylic rod.....	1
Wool cloth.....	1
Activity guide.....	1

Item No.	Description
ELKIT1	Electroscopes Kit



FRSG12



FRHG12



FRSP12



FRHR12



RPSL30



RPCT30



RPWL30

## Friction Rods and Pads

Friction rods and pads are available in various materials. Rods are 12" long and approximately 1/2" in diameter. Pads are 12" x 12".

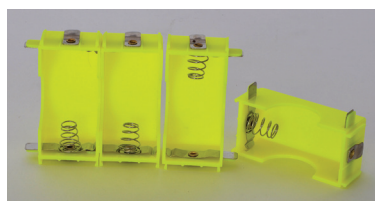
Item No.	Description
FRICTION RODS:	
FRSG12	Solid glass
FRHG12	Hollow glass
FRSP12	Solid plastic (acrylic)
FRHR12	Hard rubber (ebonite)
FRHR06	Hard rubber, 6" length (not shown)
FRICTION PADS:	
RPSL30	Silk
RPCT30	Cotton
RPWL30	Wool



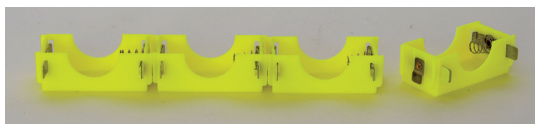
## Battery Holder Set

This battery holder fits four D cell batteries (not included) and is useful for virtually any experiment requiring a low voltage power supply and ships fully assembled. Five color-coded binding posts on the base make for easy, safe, and reliable connections to hook-up cords providing outlets for 1.5V, 3V, 4.5V, or 6V supply voltages. Battery holder is firmly mounted on a heavy duty base.

Item No.	Description
BHS001	Battery Holder Set



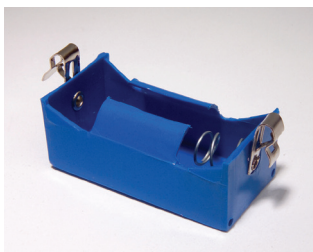
BTHD01 can be connected together in parallel or series.



## D Cell Battery Holder and Joiner

Single holders can be snapped together in parallel or series to extend capacity or voltage. Include male and female button snaps on ends to allow series connections. Also includes extensions on sides for parallel connections.

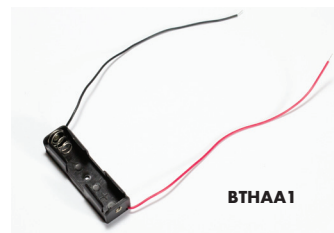
Item No.	Description
BTHD01	D Cell Battery Holder and Joiner
BTHD01-PK/4	D Cell Battery Holder and Joiner, pack of 4



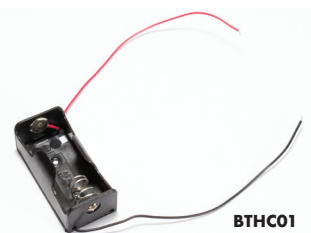
## Battery Holder with Fahnestock Clips

Unbreakable plastic battery holder includes curved tabs to prevent the battery from falling out when the holder is inverted. Fahnestock clips enable easy and quick connections.

Item No.	Description
BTHP01-F	D Cell Battery Holder with Fahnestock Clips



BTHAA1



BTHC01

## Battery Holders with Leads

These battery holders are made of unbreakable plastic. Curved tabs prevent the battery from falling out when the holder is inverted.

Item No.	Description
BTHAA1	AA Cell Battery Holder with Leads
BTHC01	C Cell Battery Holder with Leads

## Fahnestock Clips

Versatile connecting clips for use in many electrical experiments. Supplied as a package of 10 clips.



Item No.	Description
FSCP01-PK/10	Fahnestock Clips, pack of 10

## 9-Volt Battery Connector

An insulated snap-on connector with 15cm red and black leads.



Item No.	Description
BTNV15	9-Volt Battery Connector



## Insulated Alligator Clips

2" long, with protective vinyl sleeve, chrome plated, with excellent conductivity. Pack of 10, five each red and black.

Item No.	Description
ACL01-PK/10	Alligator Clips, insulated, pack of 10

## Alligator Clips

2" long, plain, chrome plated, with excellent conductivity. Available in packs of 10 or 100.



Item No.	Description
ACL01-PK/10	Alligator Clips, plain, pack of 10
ACL01-PK/100	Alligator Clips, plain, pack of 100





# Physics Electricity



## Lamp Boards

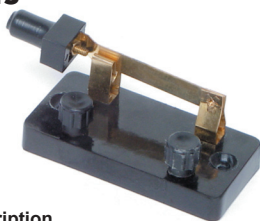


Ideal for demonstrating series and parallel circuits. Miniature bulb receptacles are mounted on a clear acrylic base. Each receptacle is connected to two fahnestock clip terminals. Includes bulbs and activity guide.

Item No.	Description
LMPB01	Lamp Board, 1 Lamp
LMPB03	Lamp Board, 3 Lamps
LMPB04	Lamp Board, 4 Lamps
LMPB05	Lamp Board, 5 Lamps

## Knife Switches, Screw Posts

Knife switches with plastic bases are suitable for low voltage experiments (less than 3.6V). Include thumbscrew connecting posts. Available in three different pole/throw configurations.



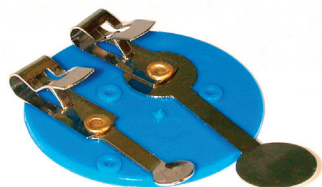
Item No.	Description
KSW001	Knife Switch, Screw Posts, Single Pole, Single Throw
KSW002	Knife Switch, Screw Posts, Single Pole, Double Throw
KSW004	Knife Switch, Screw Posts, Double Pole, Double Throw

## Knife Switch, Small

Knife switch with plastic base is suitable for low voltage experiments (less than 3.6V). Includes screw connecting posts.



Item No.	Description
KSW001-K	Knife Switch, Small, Screw Posts, Single Pole, Single Throw



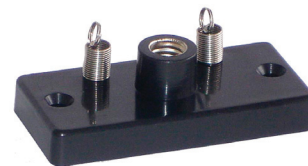
## Economy Switch

Simple switch uses fahnestock clips for easy, quick connections.

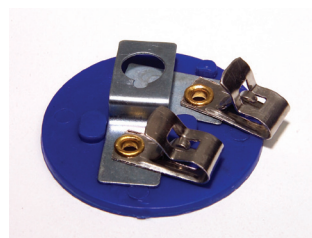
Item No.	Description
KSE001	Economy Switch

## Miniature Lamp Holder, Spring Posts

Suitable for miniature base lamps, this plastic holder includes a brass receptacle and two spring post terminals.



Item No.	Description
LMP001	Miniature Lamp Holder, Spring Posts



## Miniature Lamp Holder, Fahnestock Clips

Suitable for miniature base lamps, this plastic holder includes fahnestock clips for quick, easy connections.

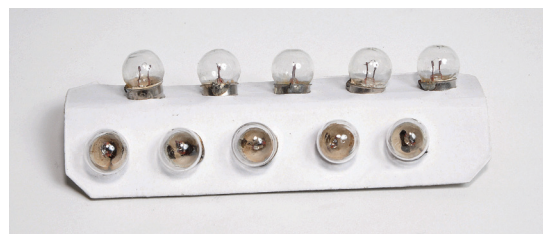
Item No.	Description
LMP002	Miniature Lamp Holder, Fahnestock Clips

## Miniature Lamp Holder, Screw Type

Suitable for miniature base lamps, this plastic holder includes a brass receptacle and two screw type terminals.



Item No.	Description
LMP001	Miniature Lamp Holder, Screw Type

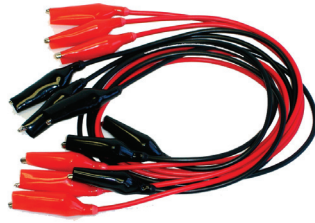


LMP015-PK/10

## Miniature Lamp Bulbs

Miniature lamp bulbs are available in a variety of voltages. Sold as packs of 10.

Item No.	Description
LMP015-PK/10	Miniature Bulb, 1.5V, 0.3A, pack of 10
LMP025-PK/10	Miniature Bulb, 2.5V, 0.3A, pack of 10
LMP038-PK/10	Miniature Bulb, 3.8V, 0.3A, pack of 10
LMP062-PK/10	Miniature Bulb, 6.2V, 0.5A, pack of 10



## Alligator Clip Leads

Flexible, 18 gauge (SWG) stranded wire cord with alligator clips at both ends. Alligator clips have protective vinyl sheath. Available in various lengths.

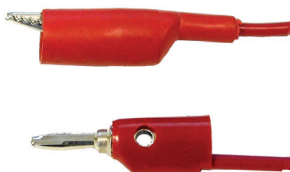
Item No.	Description
WAG012-PK/6	Alligator Clip Leads, 12", pack of 6 (3 red, 3 black).
WAG024-PK/6	Alligator Clip Leads, 24", pack of 6 (3 red, 3 black).
WAG036-PK/6	Alligator Clip Leads, 36", pack of 6 (3 red, 3 black).
WAG012-R	Alligator Clip Lead, 12", red, each
WAG012-B	Alligator Clip Lead, 12", black, each
WAG024-R	Alligator Clip Lead, 24", red, each
WAG024-B	Alligator Clip Lead, 24", black, each
WAG036-R	Alligator Clip Lead, 36", red, each
WAG036-B	Alligator Clip Lead, 36", black, each



## Banana Plug Cords

Flexible, 18 gauge (SWG) stranded wire cord with two-way stackable banana plugs at both ends. Available in various lengths.

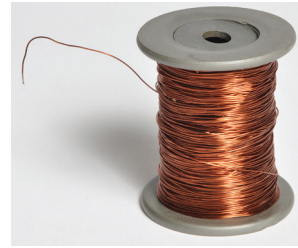
Item No.	Description
WBP012-PK/6	Banana Plug Cords, 12", pack of 6 (3 red, 3 black)
WBP024-PK/6	Banana Plug Cords, 24", pack of 6 (3 red, 3 black)
WBP036-PK/6	Banana Plug Cords, 36", pack of 6 (3 red, 3 black)
WBP012-R	Banana Plug Cord, 12", red, each
WBP012-B	Banana Plug Cord, 12", black, each
WBP024-R	Banana Plug Cord, 24", red, each
WBP024-B	Banana Plug Cord, 24", black, each
WBP036-R	Banana Plug Cord, 36", red, each
WBP036-B	Banana Plug Cord, 36", black, each



## Banana Plug / Alligator Clip Cords

Flexible, 18 gauge (SWG) stranded wire cord with a stackable banana plug at one end and an alligator clip at the other end. Alligator clip has a protective vinyl sheath. Available in various lengths.

Item No.	Description
WAB012-PK/6	Banana/Alligator Cords, 12", pack of 6 (3 red, 3 black)
WAB024-PK/6	Banana/Alligator Cords, 24", pack of 6 (3 red, 3 black)
WAB036-PK/6	Banana/Alligator Cords, 36", pack of 6 (3 red, 3 black)
WAB012-R	Banana/Alligator Cord, 12", red, each
WAB012-B	Banana/Alligator Cord, 12", black, each
WAB024-R	Banana/Alligator Cord, 24", red, each
WAB024-B	Banana/Alligator Cord, 24", black, each
WAB036-R	Banana/Alligator Cord, 36", red, each
WAB036-B	Banana/Alligator Cord, 36", black, each



## Connecting Wire, Enameled Copper Magnet

Enameled copper magnet wire is supplied in 4-ounce spools. Available in two gauges (SWG).

Item No.	Description
WEC026	Enameled Copper Wire, 26-gauge, 4-ounce spool
WEC028	Enameled Copper Wire, 28-gauge, 4-ounce spool

## Connecting Wire, Soft Bare Copper

Soft bare copper wire is available in 4-ounce or 1-pound spools. Available in a variety of gauges (SWG).



Item No.	Description
WBC018-4oz	Soft Bare Copper Wire, 18 gauge, 4-ounce spool
WBC018-1lb	Soft Bare Copper Wire, 18 gauge, 1-pound spool
WBC020-4oz	Soft Bare Copper Wire, 20 gauge, 4-ounce spool
WBC020-1lb	Soft Bare Copper Wire, 20 gauge, 1-pound spool
WBC022-4oz	Soft Bare Copper Wire, 22 gauge, 4-ounce spool
WBC022-1lb	Soft Bare Copper Wire, 22 gauge, 1-pound spool
WBC024-4oz	Soft Bare Copper Wire, 24 gauge, 4-ounce spool
WBC024-1lb	Soft Bare Copper Wire, 24 gauge, 1-pound spool

## Connecting Wire, Nickel-Chromium

Bare nickel-chromium connecting wire is supplied in 4-ounce spools. Available in a variety of gauges (SWG).



Item No.	Description
WNC018	Nickel-Chromium Wire, 18-gauge, 4-ounce spool
WNC020	Nickel-Chromium Wire, 20-gauge, 4-ounce spool
WNC022	Nickel-Chromium Wire, 22-gauge, 4-ounce spool
WNC024	Nickel-Chromium Wire, 24-gauge, 4-ounce spool
WNC028	Nickel-Chromium Wire, 28-gauge, 4-ounce spool



## Connecting Wire, Plastic Insulated Copper

22 gauge (SWG) plastic insulated copper wire is supplied in 100 foot rolls. Available in three colors.

Item No.	Description
WCP22-BK	Plastic Insulated Copper Wire, Black, 100-foot roll
WCP22-R	Plastic Insulated Copper Wire, Red, 100-foot roll
WCP22-W	Plastic Insulated Copper Wire, White, 100-foot roll



MACA01 AC Ammeter



MACV01 AC Voltmeter

## NEW PRODUCT

## Electrical Meters for Alternating Current (AC)

These meters complement our popular series of DC meters. The ranges cover values of voltage and current suitable for use in the classroom.

Our meters are mounted in black plastic cases. Meters have a scale length of 75mm, offer  $\pm 2.5\%$  accuracy and come with 5-way binding posts and an external zero-setting screw. Meters are not protected against prolonged or significant overload. Stackable for storage.

Item No.	Range / (Readability)
AC AMMETERS:	
MACA01	0-100mA (2mA); 0-500mA (10mA)
MACA02	0-1A (20mA); 0-5A (100mA)
AC VOLTMETERS:	
MACV01	0-1000mV (40mV)
MACV02	0-5V (100mV); 0-15V (300mV)



## Electrical Meters for Direct Current (DC)

Our meters are mounted in black plastic cases. Meters have a scale length of 75mm, offer  $\pm 2.5\%$  accuracy, and come with 5-way binding post and external calibrating screw. Meters are not protected against prolonged or significant overload. Stackable for storage.

Item No.	Range / (Readability)
DC VOLTMETERS:	
MVT001	0-3V (0.1V); 0-15V (0.5V); 0-300V (10V)
MVT002	0-3V (0.1V); 0-10V (0.2V); 0-15V (0.5V)
MVT003	0-3V (0.1V)
MVT004	0-5V (0.1V)
MVT005	0-10V (0.2V)
MVT006	0-5V (0.1V); 0-15V (0.3V)
DC AMMETERS:	
MAM001	0-50mA (1mA); 0-500mA (10mA); 0-5A (0.1A)
MAM002	0-1A (20mA); 0-5A (100mA)
MAM003	0-1A (20mA)
MAM004	0-3A (100mA)
MAM005	0-5A (100mA)
MAM006	0-10A (100mA)
DC MILLIAMMETERS:	
MMA001	0-200mA (4mA)
MMA002	0-500mA (10mA)
MMA003	0-500uA (10uA)
MMA004	0-1mA (0.02 mA)
MMA005	0-100mA (1mA)
DC GALVANOMETERS:	
MGV001	-35mV/+35mV (1mV)
MGV002	+/-500-0-500uA (20uA)
MGV003	+/-50-0-50 (2uA)

## Multimeter



Compact analog multimeter offers popular features such as AC voltage, DC voltage, DC current, Ohms, measures capacitance and decibels, and comes with overload protection and diode test. Includes test leads and instruction manual. Operates on two AA size batteries (not included).

Item No.	Description
YX360TRF	Multimeter

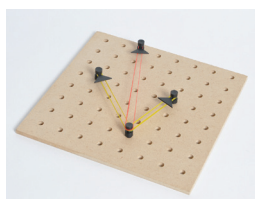




The Lever as a Balance activity



Moments and the Balance activity



Vector and Scalar Quantities activity



Balancing Forces activity



Scan to view demonstration video



## Forces & Simple Machines Kit



The Forces & Simple Machines Kit contains a variety of custom made and unique components, including a Force Board, Inclined Plane, and Vector Board. Also included is a complete set of accessories needed for 15 different activities, including an 11 piece weight set, spring scales, pulleys, levers, support base and rod, and much more.

We have also included a comprehensive lab activities manual (over 80 pages) and a CD containing a slide presentation of all experiments that can be performed.

Item No.	Description
FSMKIT-01	Forces & Simple Machines Kit

## Force Table



This student force table is a complete set that features a dual scale, an outer scale for accurate pulley positioning and an inner scale for orienting a tracing paper overlay. The set includes four complete weight sets (each with brass slotted weights, 2 x 5g, 4 x 10g, 4 x 20g, and a 20g brass weight hanger), four pulleys with clamps and two sets of strings that allows students to investigate the equilibrium of either three or four forces. A 16" diameter lightweight, durable table top and sturdy cast iron support allow both ease of use and accuracy. Includes activity guide.

Item No.	Description
FTE001	Force Table



## Basic Simple Machines Kit

This economical version of our Forces & Simple Machines Kit, this set is ideal for introducing students to the concepts of changing force by levers and pulleys, and the notion of mechanical advantage. The manual describes experiments with the three types of levers, single and double pulley systems, and shows the characteristics of each machine.

### Contents:

Lever with centimeter scale	1
Pulley	2
Spring scale	1
Weight hanger	2
Slotted weight set	1
Base and support rod	1
Support rod with clamp	1
Hook collar	2
Pulley cord	1
Activity Guide	1



Scan to view demonstration video

Item No.	Description
FSMKIT02-E	Basic Simple Machines Kit



## Tandem Pulleys

Free-running tandem pulleys feature plastic sheaves, plated aluminum frames, and a hook at each end.



Item No.	Description
PTAN01	Single Tandem, 50mm sheave
PTAN02	Double Tandem, 40 & 50mm sheaves
PTAN03	Triple Tandem, 30, 40, & 50mm sheaves



## Multi-Use Bench Pulley

High quality bench pulley that can be mounted on a support stand rod. Constructed of a heavy duty cast aluminum support frame, this 50mm diameter pulley is mounted on heavy duty low friction cone bearings. Fits table tops up to 1-3/4" thick (4.5cm).

Item No.	Description
PULB01	Multi-Use Bench Pulley

## Bench Pulley with Clamp, Horizontal

Pulley with table clamp features a sturdy steel frame and a 50mm diameter plastic sheave. Clamp opens to 25mm.



Item No.	Description
PULBN1	Bench Pulley with Clamp, Horizontal

## Bench Pulley with Clamp, Vertical

Pulley with table clamp features a sturdy steel frame and a 50mm diameter plastic sheave. Clamp opens to 30mm.



Item No.	Description
PULBN2	Bench Pulley with Clamp, Vertical



## Pulleys

These free-running, sturdy pulleys feature 50mm diameter plastic sheaves with deep V-grooves, aluminum frames, and swivel hooks on both ends.

Item No.	Description
PULS01	Single Pulley
PULD02	Double Pulley
PULT03	Triple Pulley
PULQ04	Quadruple Pulley



## Demonstration Pulleys

These jumbo sized pulleys are designed for classroom demonstration. The single, double, and triple pulleys are all 70mm in diameter. The pulleys are "open" type so users can run pulley cords through them more easily. Lightweight, low-friction, and deformation-resistant plastic ensures accurate results.

Item No.	Description
PUDS01	Demonstration Single Pulley
PUDD01	Demonstration Double Pulley
PUDT01	Demonstration Triple Pulley



## Pulley on Rod

This sturdy pulley is excellent for use with an inclined plane or any other similar apparatus. It features a 4cm plastic pulley mounted on a chrome plated steel rod. The overall length is 15cm and the shaft diameter is 8mm.

Item No.	Description
PROD01	Pulley on Rod



## Pulley with Clamp

Rugged plastic pulley with deep V-grooves mounted on a metal clamp. The sheave is 50mm in diameter. Clamp can be mounted on surfaces up to 35mm thick.

Item No.	Description
CLPL01	Pulley with Clamp



Scan to view demonstration video



NEW PRODUCT

## Pulley Demonstration Set

Use this convenient set to perform various pulley demonstrations. The durable 20cm x 15cm base is fitted with a capstan and a 61cm tall aluminum support rod. Also includes a 20cm crossbar with clamp. Includes activity guide.

### Contents:

Wooden base with capstan, hook and rod support	1
Vertical support rod, 24"	1
Horizontal support rod with clamp, 8"	1
Wheel and axle	1
Single sheave pulley	8
Double sheave pulley	2
Tommy bar	1
Clamp holder	1
Hook collar clamp	6
Pulley cord, spool	2
Hooked weight, 1kg	1
Hooked weight, 500g	1
Hooked weight, 1kg	1
Hooked weight, 500g	1
Hooked weight, 200g	2
Hooked weight, 100g	1
Hooked weight, 50g	1
Hooked weight, 20g	1
Hooked weight, 10g	1
Activity Guide	1

Item No.	Description
PUDE01	Pulley Demonstration Set

## Pulley String

25 meters of durable string designed to be used with pulleys or force tables. The thread is made of cotton and measures at 1/16 inch (1.5 mm) diameter.



Item No.	Description
PULSTG	Pulley String



## Inclined Plane with Pulley



This versatile and tough steel inclined plane includes a graduated protractor and an adjustable pulley. Incline is 4" wide x 23" long. Includes a 14 oz. roller that can be used as a vehicle on the plane or as a counterweight. Also includes a pan and cord for masses. Includes activity guide.

Item No.	Description
INPL01	Inclined Plane with Pulley
INPL01-R	Roller only for Inclined Plane



## Friction on an Inclined Plane



This set is used to demonstrate the resolution of forces on an inclined plane, uniform and accelerated motions, kinetic and potential energies, and the friction between two surfaces. The wooden inclined board is 60cm long and 10cm wide. It can be set at any angle between 0 degrees and 45 degrees. The two scales on the protractor allow angle measurements to be made directly or by trigonometry. Students can determine the coefficients of static and sliding friction and verify the normal and frictional components of the force exerted by the plane. The aluminum wheel and cone bearings on the Hall's carriage help minimize friction on the inclined plane. Includes activity guide.

### Contents:

Inclined plane with pulley and protractor	1
Hall's carriage	1
Weight hanging pan (mass not included)	1
Large wooden board	1
Small wooden board	1
Metal plate	1
Activity guide	1



Scan to view demonstration video

Item No.	Description
INPW02	Friction on an Inclined Plane

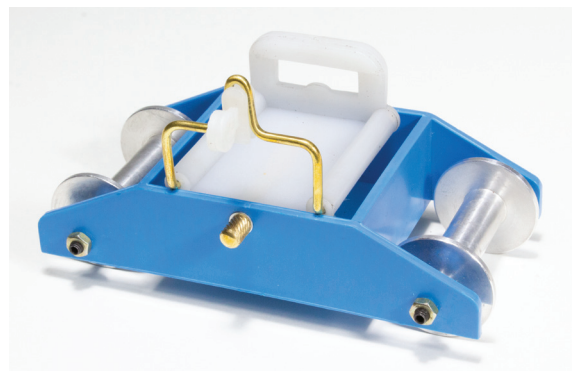




## Economy Inclined Plane

Economical version of the traditional wood inclined plane. 80cm long x 12cm wide. Made of medium-density fiberboard (MDF). Includes adjustable-angle pulley and a 14mm diameter cross hole for support rod.

Item No.	Description
INPM01	Economy Inclined Plane



NEW PRODUCT



## Hall's Carriage with Universal Smartphone Adapter

Utilize the power of your smartphone with this unique Hall's Carriage. The secure clip holds your smartphone securely for motion experiments. Using an app of your own choosing, you can graph acceleration and velocity. Includes activity guide.

Item No.	Description
HLCRG1-USA	Hall's Carriage with Universal Smartphone Adapter



NEW PRODUCT

## Universal Smartphone Adapter

Adapter with spring-loaded clip securely holds smartphones from 5.5cm to 7.5cm wide. Built-in loop enables smartphones for use in a variety of motion and kinematics experiments. Using an app of your own choosing, you can graph acceleration and velocity. Includes activity guide.

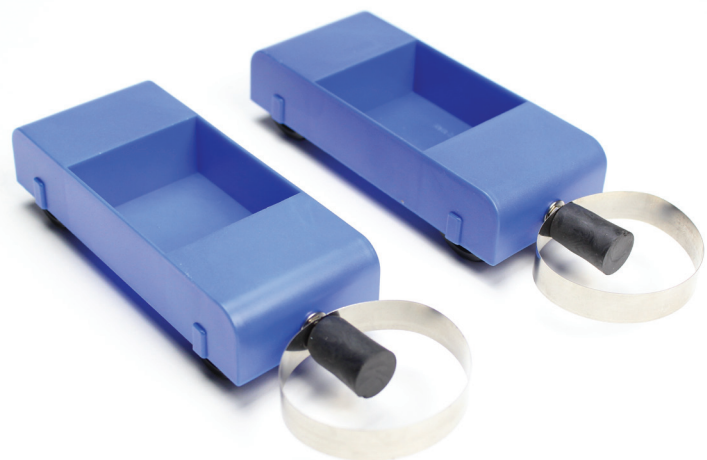
Item No.	Description
USA001	Universal Smartphone Adapter



## Hall's Carriage

This Hall's carriage has a durable plastic body with a roomy well for additional masses (not included). The machined aluminum wheels and axles are mounted on hardened steel cone bearings for minimum friction and long life. For use with all types of inclined planes.

Item No.	Description
HLCRG1	Hall's Carriage



NEW PRODUCT



## Dynamics Carts, Pair

Ideal for demonstrating experiments in conservation, velocity, elastic collisions, acceleration and momentum. Included are two impact carts and two spring steel bumpers with rubber stopper assemblies. Each cart features a well for additional masses (not included). Includes activity guide.

Item No.	Description
DNCART2	Dynamics Carts, Pair



## Ballistics Car with Remote Trigger

This Ballistics Car demonstrates the independence of vertical and horizontal motions. It consists of a four-wheeled cart carrying a vertical tube with a spring-loaded piston inside. The tube is loaded with a ball and the cart is set in motion. During the motion, the piston is released remotely by a wireless signal, projecting the ball upwards out of the tube. Both the ball and the cart share the same horizontal velocity, which is unaffected by gravity, so that when the ball falls back down, it lands back in the tube and does not get "left behind" by the cart.

Cart includes a conical rubber catcher to compensate for slight trajectory variations. Supplied with two 3/4" steel balls. Requires one 9V battery (not included). Includes activity guide.

Item No.	Description
BLCAR2	Ballistics Car with Remote Trigger



## Ballistics Car

Push the cart and eject the steel ball from the spring-loaded barrel. The ball falls back into the barrel of the moving car, demonstrating that the forward motion of the ball is the same as the vehicle from which it was ejected. Comes with a steel ball, release pin, and cord. The barrel permits two different heights of ball flight. Includes activity guide.

Item No.	Description
BLCAR1	Ballistics Car



Scan to view demonstration video

## Impact Car

Sturdy plastic impact car features a graduated spring scale and a slide that is displaced on impact against an obstacle. Includes activity guide.

Item No.	Description
IMPACT1	Impact Car



A transparent plate can be attached to show the effect of reversing the airflow.



## Fan Cart

A basic, inexpensive Fan Cart powered by two AA size batteries (not included) demonstrates Newton's principle of action and reaction. The batteries are contained in the removable power unit and the fan is controlled by a switch. The propeller delivers a thrust of about 88mN, accelerating the cart at  $0.4 \text{ m/s}^2$ . A transparent plate can be attached to show the effect of reversing the airflow. Includes activity guide.



Scan to view demonstration video

Item No.	Description
FNCRT1	Fan Cart



## Loop The Loop Track

The Loop the Loop Track demonstrates centripetal acceleration and the transformation of potential energy into kinetic energy. Included is a sturdy base with rubber feet, metal ramp with loop, 16mm steel ball and 19mm steel ball. The metal ramp with loop features a net at the end of the loop to receive the steel ball. Includes activity guide.

Item No.	Description
LOOP01	Loop The Loop Track

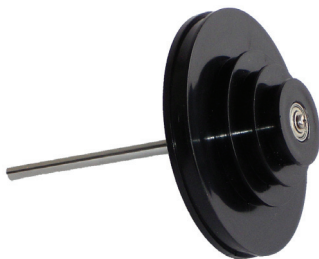


## Maxwell's Wheel



This classic device is used to demonstrate the conservation of mechanical energy and its conversion from one form to another. After the wheel is rotated by hand to roll the supporting cords to the top and then released, its potential energy turns into kinetic energy of rotation as it falls. After the wheel reaches its bottom position, the kinetic energy changes back to potential energy as it rolls the cords up again. This process continues until all the energy is lost to friction. All metal construction. Includes activity guide.

Item No.	Description
MAXW01	Maxwell's Wheel



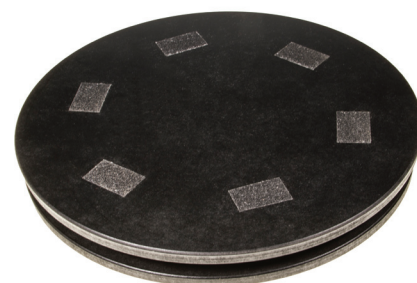
## Wheel & Axle

This is a classic device for demonstrating mechanical advantage and the conservation of energy. It consists of a single stepped wheel with four coaxial steps of 35, 50, 65, and 105mm diameter. The wheel is supported on a steel rod by a ball bearing.

Item No.	Description
WAXL01	Wheel & Axle



Scan to view  
demonstration video



NEW PRODUCT



## Rotating Platform

An essential accessory for experiments with the popular Bicycle Wheel Gyroscope, and for demonstrating the effect of moment of inertia on rotational motion (the "spinning skater effect"). This economical Rotating Plate spins freely due to its heavy duty ball bearing axle.

### Specifications

**Diameter:** 37.5cm, **Height:** 6.5cm,

**Weight:** 4.5kg, **Plates:** MDF, 1.9cm (3/4") thick

Item No.	Description
RTP001	Rotating Platform



Scan to view  
demonstration video



NEW PRODUCT



## Bicycle Wheel Gyroscope

This molded plastic bicycle wheel gyroscope is durably constructed and more resistant to distortion than a spoked wheel. Convincing demonstrations of the gyroscopic forces can be made using a rotating platform and the grooved hub and starting cord make accelerating the gyroscope to a sufficient speed easy. Features free-running bicycle bearings for long duration runs.

### Specifications

**Wheel Diameter:** 50cm, **Wheel Width:** 3.5cm, **Hub Diameter:** 5.3cm

**Width across Handles:** 33cm, **Moment of Inertia:** approx.  $0.07\text{kgm}^2$

Item No.	Description
BWG001	Bicycle Wheel Gyroscope





Scan to view demonstration video

NEW PRODUCT



## Mini Projectile Launcher

This simple but precise launcher projects 16mm steel balls at ranges suitable for use on the bench top or from the bench to the floor. A protractor and plumb line make it easy to set any required launch angle from 45° downwards to straight up. Three different spring tensions give three repeatable launch speeds (ranges of 1m, 1.5m and 2m) and a magnetic piston ensures that the ball does not touch the side of the barrel and launches straight every time. A cable release gives a smooth triggering to prevent jerking. The unit can stand on its own or be fixed to the bench with a clamp.

Item No.	Description
MPL001	Mini Projectile Launcher



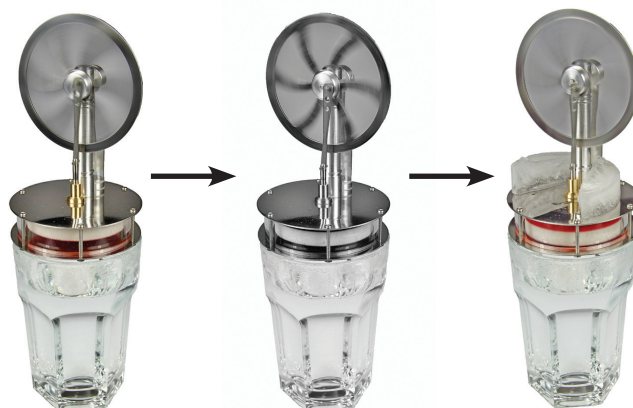
## Inertia Demonstrator

This durable inertia demonstrator works reliably every time and is a great improvement on traditional versions of this classic experiment. A steel ball rests on a thin metal card on top of a pillar, and a spring-loaded catch is mounted next to the pillar. When the catch is released, a piston strikes the edge of the metal card sharply. The card flies out from under the ball, which remains in place on top of the pillar due to its large inertial mass. The card is tethered to the aluminum base for easy recovery after the experiment. In a second experiment the cord is pulled slowly and steadily. In this case, the ball and card fall off the pillar together. Includes activity guide. Approximate product dimensions are 5" x 3" x 2".

Item No.	Description
IDEM01	Inertia Demonstrator



Scan to view demonstration video



The engine runs fast on a glass of hot water

It slows down later as the top plate warms up

And is revived by ice on the top plate.

## Low Temperature Difference Stirling Engine



This economical Stirling Engine runs by exploiting the heat flow generated by the small temperature difference between room temperature and a cup of hot water or ice. It is a classic illustration of converting heat energy into mechanical work using a thermodynamic cycle. The engine runs at about 150 rpm when used with a cup of hot water. Additional information available upon request. Includes activity guide.

Item No.	Description
LTDSE1	Low Temperature Difference Stirling Engine

## The SpillNot™



The design of the SpillNot™ uses the principles of Newtonian physics to keep the liquid in the container. The flexible handle and the location of the suspension point above the center of the tray ensure that the forces on the liquid are always directed towards the supporting tray, even when the tray is in motion. The sideways forces that are usually responsible for spills are not transmitted to the tray by the flexible handle and the radial forces generated during swinging motion only pin the liquid into the container more firmly. An inexpensive demonstration to intrigue students and challenge their analytical powers! Includes activity guide.



Scan to view demonstration video

Item No.	Description
SPNT01	The SpillNot™



## Air Track and Accessories



ATRK01

This air track is constructed of high quality aluminum alloy and has the advantages of being both lightweight and highly durable. Precision machining provides a smooth surface and high linearity. It includes a comprehensive accessory package for experiments in linear motion. The track length is 150cm or 200cm sizes, and it is straight to better than 0.1mm throughout. Includes activity guide

NOTE: This item requires an air source, item QAS001-V, and a digital timer with photogates, item DTPHG1 (both not included). More detailed description available upon request.

Item No.	Description
ATRK01	Air Track and Accessories, 150cm
ATRK02	Air Track and Accessories, 200 cm



ATRK01 Air Track includes a large assortment of accessories.



## Quiet Air Source with Variable Output

This low noise (<58dB) air source is an ideal accessory for air tracks, air tables, and other pneumatic equipment in physics labs. The 250W motor produces a clean air output with a flow rate of 35 m<sup>3</sup>/hour at a 0.70 kPa overpressure.

Item No.	Description
QAS001-V	Quiet Air Source with Variable Output



## Digital Timer with Photogates



This four-digit timer is designed to be used with air tracks, free fall apparatuses, and other equipment. It is microprocessor-controlled and offers eight programmed functions to record counts, interruption timing, time between interruptions, period of oscillation, acceleration, acceleration due to gravity, velocity in collisions, and time scale output. It comes with two photogates. Includes activity guide.

Item No.	Description
DTPHG1	Digital Timer with Photogates
DTPHG1-P	Pair of Photogates with Brackets



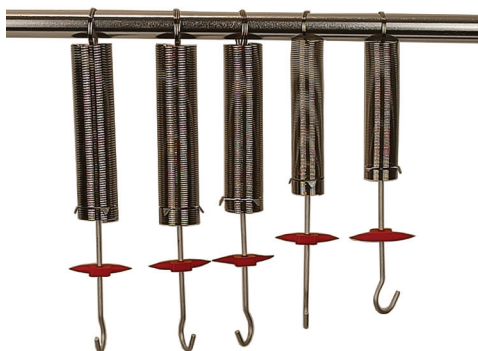
Scan to view demonstration video

## Hooke's Law Apparatus



Quantitatively show the principles related to Hooke's Law with this complete apparatus. Includes a 14" metal rod that mounts on a 4-1/2" diameter base. Scale in centimeters and inches can be easily adjusted along the rod. The plated steel weight holder and spring are attached to an adjustable collar with crossbar. Requires slotted weights (not included - we recommend our WHST08 set of 8 slotted weights). Includes activity guide.

Item No.	Description
HKLW12	Hooke's Law Apparatus



NEW PRODUCT



## Springs for Hooke's Law, Set of 5

A set of 5 springs with different spring constants. The forces required for a 1 cm extension are 0.25N, 0.5N, 1N, 1.5N, and 2.5N respectively. Pre-stress has been removed for accurate results. With a hook to support a weight hanger and a red arrow to indicate position.

Item No.	Description
SPGRS5	Spring for Hooke's Law, Set of 5



## Spring Scales, Clear Plastic

These color-coded spring scales feature a clear plastic tubular design, a suspension ring, and an oversized load hook. A zero adjustment screw is provided at the top. Overall length is approximately 7".

Item No.	Description	Graduation	Color
SB0250-P	250g / 2.5N	5g / 0.05N	Blue
SB0500-P	500g / 5N	10g / 0.1N	Green
SB1000-P	1000g / 10N	20g / 0.2N	Brown
SB2000-P	2000g / 20N	40g / 0.4N	Red
SB3000-P	3000g / 30N	50g / 0.5N	Cream
SB5000-P	5000g / 50N	100g / 1N	Yellow
SBTSET6	Set of 6 Spring Scales (one each of above)		



## Aluminum Spring Scales

Constructed of anodized aluminum, with steel hooks, this spring scale is extremely durable. Available in seven color-coded sizes.

Item No.	Description	Graduation	Color
SB0100-A	100g / 1N	2g / 0.02N	Black
SB0250-A	250g / 2.5N	5g / 0.05N	Blue
SB0500-A	500g / 5N	10g / 0.1N	Green
SB1000-A	1000g / 10N	20g / 0.2N	Brown
SB2000-A	2000g / 20N	40g / 0.4N	Red
SB3000-A	3000g / 30N	50g / 0.5N	Silver
SB5000-A	5000g / 50N	100g / 1N	Gold
SBASET7	Set of 7 Aluminum Scales (one each of above)		





## Push Pull Scales

This versatile spring scale can be used to measure forces using push or pull functions, or to weigh a suspended object from the large hook. Includes a zero adjustment screw and a metal suspension ring. Available in six color-coded sizes.



Item No.	Description	Graduation	Color
PS0250	250g / 2.5N	5g / 0.05N	Blue
PS0500	500g / 5N	10g / 0.1N	Green
PS1000	1000g / 10N	20g / 0.2N	Brown
PS2000	2000g / 20N	40g / 0.4N	Red
PS3000	3000g / 30N	50g / 0.5N	Cream
PS5000	5000g / 50N	100g / 1N	Yellow
PSSET6	Set of 6 Push-Pull Scales (one each of above)		

## Spring Scales

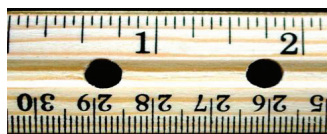
These Spring Scales feature a clear plastic case so students can observe the mechanism. Scales include an aluminum front panel that can be moved up or down for zero adjustment, metal pointer, suspension ring, and load hook. Calibrated in Grams and Newtons.



Item No.	Description	Graduation
SB0100	100g / 1N	2g / 0.02N
SB0250	250g / 2.5N	5g / 0.05N
SB0500	500g / 5N	10g / 0.1N
SB1000	1000g / 10N	20g / 0.2N
SB2000	2000g / 20N	40g / 0.4N
SB5000	5000g / 50N	100g / 1N

## Wooden Ruler

This 12" / 30.5cm wooden ruler has a double bevel and a pencil groove. It is scaled in 1/16" increments on one bevel and 1 mm increments on the opposite bevel. There is a metal edge on one side.



Item No.	Description
SCLW12	Wooden Ruler

## Clear Plastic Rulers

The clear plastic 12" / 30.5cm ruler is scaled in 1/16" increments on one side and 1mm increments on the other side. The clear plastic 6" / 15cm ruler is scaled in 1mm increments on one side.



Item No.	Description
SCALE12	Clear Plastic Ruler, 12"
SCALE6	Clear Plastic Ruler, 6"



## Student Platform Scale

Sturdy economical scale for general use in the lab. It features a round plastic weighing platform. Capacity is 5 kg, or 11 lbs.

Item No.	Description
KCZ-002	Student Platform Scale



## Tape Measure, 7.5 Meter

This 7.5 meter (25 foot) metal blade tape measure is 1" wide and is scaled in 1/16" increments on one side and 1mm increments on the other side. Features an easy to read lockable, retractable yellow blade and high-impact ABS case.

Item No.	Description
TPM025	Tape Measure, 7.5 Meter



## Tape Measure, 3 Meter

This versatile tape measure is perfect for a wide variety of applications. The bright yellow steel tape retracts with a simple push of a button. It also features a high impact plastic case with a belt clip and loop handle. The tape is marked in both English and metric scales.

Item No.	Description
TPM03M	Tape Measure, 3 Meter

## Measurement Tools Kit



Includes a variety of tools and objects for teaching basics of measurement. Kit is shipped in a foam-lined wooden storage box. Includes activity guide with 15 activities.

### Contents:

Depth gauge.....	1
Micrometer .....	1
Protractor, plastic .....	1
Ruler, 12", plastic .....	1
Tape measure.....	1
Vernier caliper, brass .....	1
Wire gauge, with conversion table.....	1
Aluminum square.....	1
Aluminum wire .....	1
Graduated cylinder .....	1
Plastic cylinder .....	1
Plastic vial .....	1
Activity guide.....	1

Item No.	Description
MEAKIT	Measurement Tools Kit

## Precision Measuring Set



This measuring set contains four high quality instruments housed in a sturdy plastic storage case. Includes instructions.

### Contents:

Micrometer Caliper, 0 - 25mm x 0.01mm .....	1
Knife Edge Square, 90°, 100mm x 70mm .....	1
Vernier Caliper, 150mm x 0.02mm .....	1
Ruler, Steel, 15cm x 0.5mm.....	1

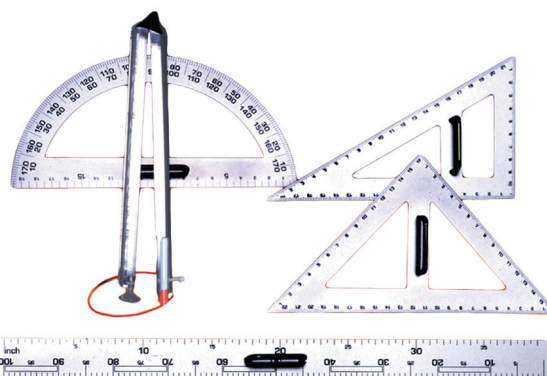
Item No.	Description
PMSET04	Precision Measuring Set

## Chalkboard Drawing Instruments Set

Durable, lightweight oversized plastic instruments, designed for whiteboards and chalkboards. Triangles, protractor, and ruler are made of white polystyrene and feature handles for ease of use. Compass is made of clear acrylic, and accommodates most dry erase and magic markers. Individual parts are also available separately.

### Contents:

Triangle, 45°, 23" base, 16" sides .....	1
Triangle, 60°, 22" base.....	1
Protractor, 180° marked with intervals of 1°, 20" base, 10" height.....	1
Meter Ruler, graduated in inches (1 - 39") and centimeters (1 to 100cm), 7cm wide.....	1
Compass, with locking screw, rubber suction cup, 18" long, accommodates most dry erase and magic markers, radius 15".....	1



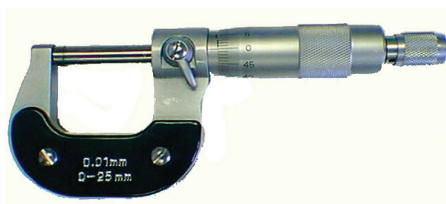
Item No.	Description
CHKSET	Chalkboard Drawing Instruments Set
CHTE45	Triangle, 45°
CHTR60	Triangle, 60°
CHPR01	Protractor, 180°
CHRL40	Metric Ruler
CHCMP1	Compass



## Dial Vernier Calipers

This precision measuring tool is made of hardened steel for long-term durability. It has a range of 0 to 150mm and a large, easy-to-read dial with a resolution of 0.02mm. A storage case and instructions are included.

Item No.	Description
VCDT06	Dial Vernier Calipers



## Deluxe Micrometer

This micrometer is made of hardened steel for precision and durability. Its range is 0 - 25mm and it has a precision rotary scale with a resolution of 0.01mm, a ratchet thimble and a locking lever. Instructions are included.

Item No.	Description
MCRDLX	Deluxe Micrometer



## Micrometer

Introductory level metric micrometer graduated to read up to 25mm in 0.01mm divisions. Comes in a plastic storage case.

Item No.	Description
MCR025	Micrometer



## Digital Vernier Calipers

This advanced measuring tool is accurate to 0.001"/ 0.01mm and measures in both metric and English units. Range is 6"/150mm. It has a bright LCD display and easy access push buttons. A durable plastic storage case with instructions is included.

Item No.	Description
VCD001	Digital Vernier Calipers



Scan to view  
demonstration video

## Vernier Calipers, Stainless Steel

Economical stainless steel Vernier calipers with 125mm/5 inch capacity. Features inside and outside jaws, full length depth gauge, friction ruler and sliding lock for gauging. Graduated in millimeters and 1/16".

Item No.	Description
VCB001	Vernier Calipers, Stainless Steel



## Vernier Calipers, Plastic

All plastic construction. Dual scale range is 6" or 150mm. Readability is 1/128" or 0.05mm.

Item No.	Description
VCP001	Vernier Calipers, Plastic





Two leather strips are attached to the bottom of the Friction Box.

## Friction Box

This friction box is used for coefficient of friction studies when larger loads are required. The 6" x 3.5" x 2.5" box will accommodate a load of 2kg or more. Constructed of smooth sanded wood with two leather strips attached to the bottom.

Item No.	Description
FRBX01	Friction Box



## Friction Apparatus

This set includes a friction block and a friction board, both made of high quality, smoothly finished pine wood. The friction block has a hook for a spring scale and three compartments for additional weights. It can be placed face-up or sideways. Students can vary the weight or area of contact to test their impact on the frictional force. The set comes with three 50g weights and a 100g spring scale. The board is 20" x 2" and the block is 4" x 1.5" x 1". Includes an activity guide.

Item No.	Description
FRAP01	Friction Apparatus



## Half Meter Stick

Hardwood half meter stick for use with our Demonstration Balance Support or other laboratory measurement activities.

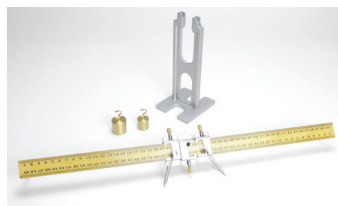
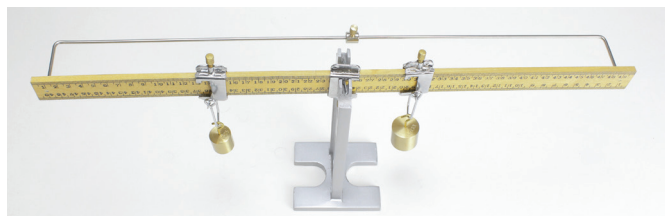
Item No.	Description
OBMST2	Half Meter Stick



## Pendulum Clamp

Connect this clamp to any support rod to set up three separate pendulum demonstrations. Includes individual cord clamps.

Item No.	Description
CLPEN1	Pendulum Clamp



Scan to view demonstration video

## New York Demonstration Balance



21st century New York Balance is ideal for demonstrating basic physics principles including levers and center of gravity. Set includes a demonstration balance support, three knife edge lever clamps, a half meter stick, one 50g hooked weight, and one 100g hooked weight. Includes activity guide.

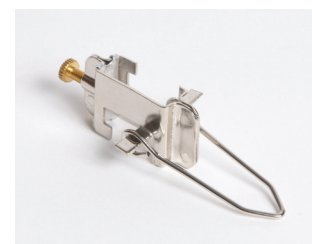
Item No.	Description
NYB001	New York Demonstration Balance



## Demonstration Balance Support

Sturdy support for meter stick demonstration balances and torque experiments. The cast metal support is 18.5cm high. Requires knife-edge clamps, slotted weights and hangers, and a meter stick.

Item No.	Description
DBS002	Demonstration Balance Support



## Knife Edge Lever Clamp

This clamp can be attached to any standard meter stick. It is used as a knife-edge fulcrum for supporting the meter stick in the inverted position.

Item No.	Description
CLMKE1	Knife Edge Lever Clamp



## Pendulum Balls

These drilled balls are excellent for use as pendulum bobs or in impact and collision experiments. All drilled balls feature 3mm countersunk holes so pendulum cord knots can be recessed.

### Aluminum Balls

Item No.	Description
PNBA19	Drilled Aluminum Ball, 19mm diameter
PNBA25	Drilled Aluminum Ball, 25mm diameter
PNBA25-H	Hooked Aluminum Ball, 25mm diameter

### Brass Balls, Polished

Item No.	Description
PNBB19	Drilled Brass Ball, 19mm diameter
PNBB25	Drilled Brass Ball, 25mm diameter
PNBB25-H	Solid Brass Ball, With Hook, 25mm diameter
PNBB38-H	Solid Brass Ball, With Hook, 38mm diameter

### Copper Balls

Item No.	Description
PNBCP25	Drilled Copper Ball, 25mm diameter
PNBCP38-H	Solid Copper Ball, With Hook, 38mm diameter

### Cork Balls

Item No.	Description
PNBCK19	Drilled Cork Ball, 19mm diameter
PNBCK25	Drilled Cork Ball, 25mm diameter
PNBCK38-S	Solid Cork Ball, 38mm diameter



## Assorted Ball Set

A comprehensive set of 12 balls. Includes one each of 25mm diameter drilled aluminum, copper, steel, and wood balls, two each of 25mm drilled brass balls, two each of solid steel balls (one plain and one with suspension lugs), 38mm diameter brass, steel, and copper balls with hooks, and a 38mm cork ball. All drilled balls feature 3mm countersunk holes so pendulum cord knots can be recessed. Packed in a plastic storage box.

Item No.	Description
DBLST12-A	Assorted Ball Set



### Plastic Balls

Item No.	Description
PNBP19	Drilled Plastic (Nylon) Ball, 19mm diameter
PNBP25	Drilled Plastic (Nylon) Ball, 25mm diameter

### Steel Balls

Item No.	Description
PNBS19	Drilled Steel Ball, 19mm diameter
PNBS25	Drilled Steel Ball, 25mm diameter
PNBS13-S	Solid Steel Ball, 13mm diameter
PNBS19-S	Solid Steel Ball, 19mm diameter
PNBS25-S	Solid Steel Ball, 25mm diameter
PNBS38-S	Solid Steel Ball, 38mm diameter
PNBS25-H	Solid Steel Ball, With Hook, 25mm diameter
PNBS25-L	Solid Steel Ball, With Lugs, 25mm diameter

### Wood Balls

Item No.	Description
PNBW19	Drilled Wood Ball, 19mm diameter
PNBW25	Drilled Wood Ball, 25mm diameter



Scan to view  
demonstration video



Set includes a clear plastic box with foam insert for convenient storage.

## Drilled Ball Set

An economical set of 12 drilled balls for all your pendulum experiments. Set contains two each 25mm diameter balls of brass, aluminum, steel, wood, cork, and copper, in a plastic box for easy storage. All drilled balls feature 3mm countersunk holes so pendulum cord knots can be recessed.

Item No.	Description
DBLST12	Drilled Ball Set



## Pendulum Investigation Kit

NEW PRODUCT



Understanding pendulum motion is fundamental to the study of vibrations and waves. This unique kit includes everything necessary for a full exploration of the basic features of pendulum motion in a complete but economical set. The individual components are of proven design - the drilled balls have a larger hole on one end than the other to allow suspension at the center of mass, and the triple support features clamps that make adjusting the cord length precise and easy.

Students can assess the principal factors of mass, length, and amplitude and even venture into a consideration of air resistance. Includes activity guide.

### Contents:

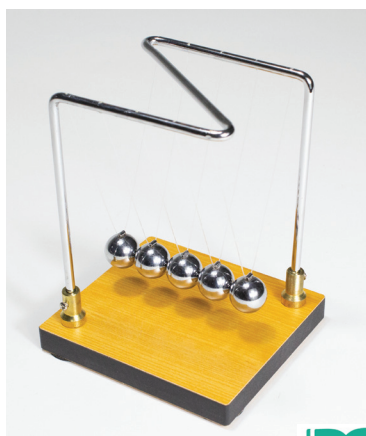
Drilled Ball, 1", Steel.....	2
Drilled Ball, 1", Aluminum.....	2
Drilled Ball, 1", Wood.....	2
Pendulum Support with 3 Positions and Clamp.....	1
Half-Meter Stick.....	1
Support Base, 6" x 9" with 24" Support Rod.....	1
Stopwatch.....	1
Pendulum Cord, Roll.....	1

### Item No.

### Description

PNLKIT

Pendulum Investigation Kit



## Newtonian Demonstrator

Excellent for illustrating Newton's Third Law of Motion and the principle of Conservation of Momentum. The five polished metal balls with thin bifilar suspensions on a unique support design provide for better results and stability.

### Item No.

### Description

NWDM01

Newtonian Demonstrator



Scan to view demonstration video

## Digital Stopwatch, Water-Resistant

Water-resistant stopwatch with lanyard features split and cumulative time modes, 1/100th second increments, calendar/date display, and an alarm.



### Item No.

### Description

STOPWD-HS43

Digital Stopwatch, Water-Resistant

## Digital Stopwatch

This plastic electronic stopwatch can be set to display time (hours/minutes/seconds) in 12 or 24 hour mode, calendar, 24-hour stopwatch, alarm, hourly chime, 1/100 second chronograph, split time, and total elapsed time. It is lightweight, easy to operate, and includes a battery and lanyard.



### Item No.

### Description

STOPWD

Digital Stopwatch





## Free Fall Apparatus

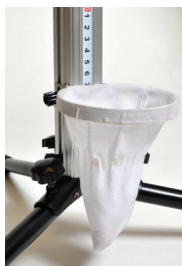


This convenient free fall apparatus for measuring the acceleration of gravity has a 150cm fall length. It includes an electromagnetic ball release, a pair of photogates on a long cable harness, two steel balls, a plumb line, and a catcher. Requires the digital timer DTPHG1 (not included). More detailed description available upon request. Includes activity guide.

Item No.	Description
FFA001	Free Fall Apparatus
DTPHG1	Digital Timer with Photogates



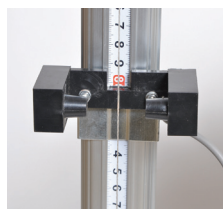
Digital Timer with Photogates



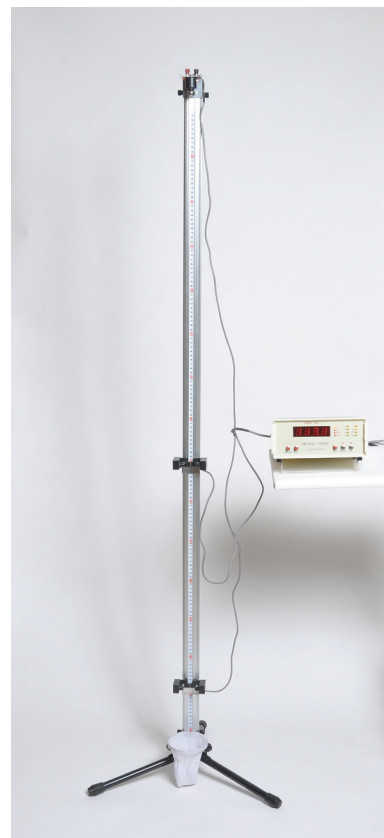
Catcher



Electromagnetic ball release



Photogate mounted on Free Fall Apparatus



Scan to view demonstration video

## Free Fall Tube



An economical version of a classic device! It demonstrates that all objects experience the same gravitational acceleration and fall at the same speed in a vacuum, but in air the air resistance slows down some objects more than others. Features a disc and a feather in a tough, clear, plastic tube, 90cm long and 4.5cm diameter, with rubber end caps and hose cock for connection to any standard vacuum pump (not included). Includes activity guide.

Item No.	Description
FFT001	Free Fall Tube



Scan to view demonstration video



## Collision in Two Dimensions Apparatus

This apparatus allows students to investigate conservation of momentum and kinetic energy change in collisions. It can also be used to compare elastic and inelastic collisions. A flat base supports a curved aluminum track and an adjustable target support. The kit includes two steel balls, a glass ball, a hollow wooden ball, and a plumb line. Includes activity guide.

Item No.	Description
CTDA01	Collision in Two Dimensions Apparatus

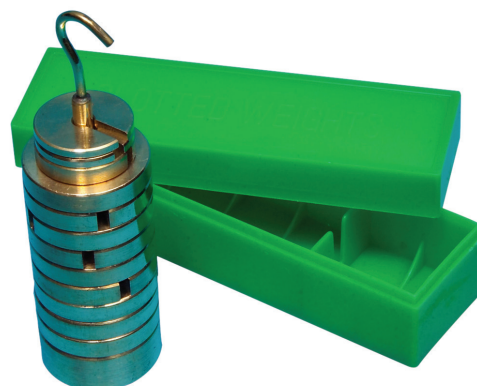




## Deluxe Slotted Weight Set of 8, Brass

Includes rack and eight brass weights, 1 x 500g, 2 x 200g, 1 x 100g, 1 x 50g, 2 x 20g, 1 x 10g,

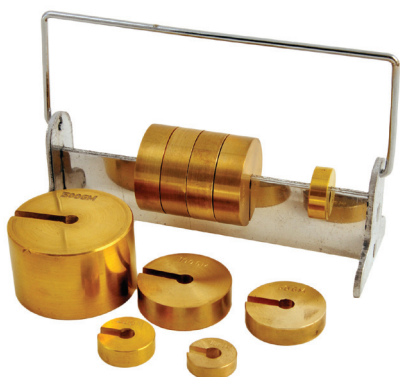
Item No.	Description
WHST08	Deluxe Slotted Weight Set of 8



## Slotted Weight Set of 13, Brass

Includes hanger, case, and thirteen brass weights, 1 x 50g, 9 x 20g, 1 x 10g, 2 x 5g.

Item No.	Description
WHST13	Slotted Weight Set of 13



## Deluxe Slotted Weight Set of 10, Brass

Includes rack and ten brass weights, 1 x 500g, 5 x 100g, 1 x 50g, 2 x 20g, 1 x 10g.

Item No.	Description
WHST10	Deluxe Slotted Weight Set of 10



## Deluxe Slotted Weight Set of 12, Brass

Includes rack and twelve brass weights, 1 x 500g, 2 x 200g, 1 x 100g, 1 x 50g, 2 x 20g, 1 x 10g, 1 x 5g, 2 x 2g, 1 x 1g.

Item No.	Description
WHST12	Deluxe Slotted Weight Set of 12



## Analytical Weight Box Set of 9, Brass

Analytical Weight Box contains nine brass weights (one each of 1g, 5g, 10g, 50g and 100g sizes, and two each of 2g and 20g sizes), in polished wooden box, with a 1 to 500mg fractional weight set, 5mg rider and forceps.

Item No.	Description
AWB100	Analytical Weight Box Set of 9, Brass



Weights are designed to be hooked in tandem.

## Hooked Weight Set of 9, Brass

These weights feature flat countersunk bottoms, with a double-ended hooked rod through the middle. They can be used on balance pans, as well as hooked in tandem for lever arm studies. Set of nine weights consisting of one each 10g, 50g, 100g, 500g, 1,000g, and two each 20g and 200g weights. Please note: because of its size, the 10g weight does not include a countersunk bottom. Weights are made of polished brass and come in a storage block. Replacement weights are available separately.

Item No.	Description
WHSET9	Hooked Weight Set of 9, Brass



WSST10

## Hooked Weight Sets, Stainless Steel

Individually calibrated weights made of high quality stainless steel. Both sets come with a sturdy plastic storage block. Set of 9 includes one each of 5g, 10g, 50g, 100g, and 500g, plus two each of 20g and 200g weights.

Set of 10 includes all of the above, plus one each 1000g weight.

Item No.	Description
WSST09	Hooked Weight Set of 9, Stainless Steel
WSST10	Hooked Weight Set of 10, Stainless Steel



## Basic Hooked Weight Set of 10, Stainless Steel

Set of ten hooked weights are made of high quality stainless steel. Includes one of 200g, two of 100g, three of 50g, and four of 20g weights.

Item No.	Description
WHSET10	Basic Hooked Weight Set of 10, Stainless Steel



## Weight Set of 9, Stainless Steel

Good quality weight set contains nine weights (one each of 1g, 5g, 10g, 50g and 100g sizes, and two each of 2g and 20g sizes) plus a set of 1 to 500mg fractional weights and a 5mg rider and forceps, in a wooden storage box. Weights are made of polished stainless steel and each weight is inscribed with its capacity.

Item No.	Description
AWSS09	Weight Set of 9, Stainless Steel



Weights are designed to be hooked in tandem.

## Hooked Weight Set of 9, Black Enamel

Set of nine weights consisting of one each 10g, 50g, 100g, 500g, 1000g, and two each 20g and 200g weights. Weights are made of cast iron with a black enamel finish and come with a sturdy plastic storage box. Weights can be hooked in tandem.

Item No.	Description
WHSBE9	Hooked Weight Set of 9, Black Enamel





## Hooked Weight Set of 6, Aluminum

Set of six hooked aluminum masses with a plastic storage base. Includes one each of 10g, 20g, 30g, 40g, 50g, and 100g masses.

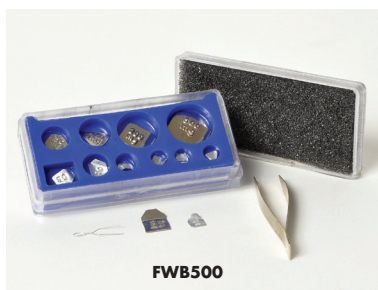
Item No.	Description
WSAL06	Hooked Weight Set of 6, Aluminum



## Slotted Weight Set of 12, Aluminum

Includes a 50g aluminum hanger and 12 aluminum weights, 9 x 20g, 1 x 10g, and 2 x 5g.

Item No.	Description
WSAL12	Slotted Weight Set of 12, Aluminum



FWB500



FWS500

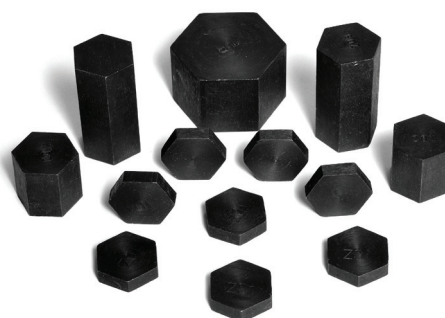
## Fractional Weight Set

Set includes 1 each of 1, 5, 10, 50, 100, and 500mg weights, two each of 2, 20, and 200mg weights, rider, forceps and rectangular plastic box. Also available as a set without forceps in a round plastic box. Riders are also available separately.

Item No.	Description
FWB500	Fractional Weight Set with Rider and Forceps
FWS500	Fractional Weight Set with Rider
AWR005	Rider, 5mg, pack of 3



WHSETM-F



WHSETC-F

## Hexagonal Mass Sets

These weight sets include accurate, non-rolling hexagonal masses made of steel, and feature a durable black oxidized finish. Sets are supplied in sturdy cardboard boxes.

Metric Weight Set includes two each of 5g, 10g, 20g, 50g, and 200g masses, plus one each of 100g and 500g masses.

Customary Weight Set includes eight each of 1 oz., two each of 4 oz., two each of 8 oz., and one each of 1 lb. weights.

Item No.	Description
WHSETM-F	Hexagonal Weight Set, Metric
WHSETC-F	Hexagonal Weight Set, Customary



## Hexagonal Mass Set of 5, Plated

Set of five zinc-plated hexagonal masses supplied in a sturdy cardboard box. Includes one each of 100g, 500g, and 1000g, and two each of 200g masses.

Item No.	Description
WHXP05	Hexagonal Mass Set of 5, Plated



## Individual Brass Masses

Made of brass with nickel plated surfaces. All masses are carefully tested and calibrated (but not certified).

Item No.	Description
ABW001	Individual Brass Mass, 1g
ABW002	Individual Brass Mass, 2g
ABW005	Individual Brass Mass, 5g
ABW010	Individual Brass Mass, 10g
ABW020	Individual Brass Mass, 20g
ABW050	Individual Brass Mass, 50g
ABW100	Individual Brass Mass, 100g



## Individual Hooked Brass Masses

These hooked masses are made of polished brass. All masses are carefully tested and calibrated (but not certified).

Item No.	Description
WHB005	Individual Hooked Brass Mass, 5g
WHB010	Individual Hooked Brass Mass, 10g
WHB020	Individual Hooked Brass Mass, 20g
WHB050	Individual Hooked Brass Mass, 50g
WHB100	Individual Hooked Brass Mass, 100g
WHB200	Individual Hooked Brass Mass, 200g
WHB500	Individual Hooked Brass Mass, 500g
WHB1000	Individual Hooked Brass Mass, 1000g



Brass weight hanger

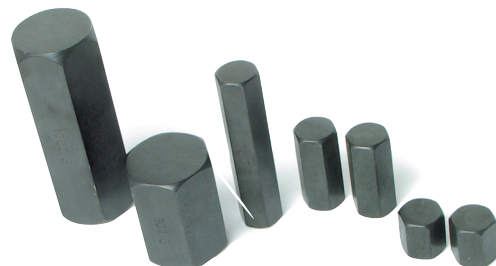


Aluminum weight hanger

## Weight Hangers

For use with slotted weights. Brass hanger weighs 50g. Stem length is 11.5cm. Aluminum hanger weighs 50g. Usable stem length is approximately 11.5 cm with an overall height of 17.5cm.

Item No.	Description
WHNG50B	Weight Hanger, 50g, Brass
WHNG50A	Weight Hanger, 50g, Aluminum



## Hexagonal Masses

Accurate, non-rolling hexagonal masses are made of steel, and feature a durable black oxidized finish. Available in both customary and metric sizes.

### Hexagonal Masses, Metric Sizes

Item No.	Description
WHX001	Hexagonal Mass, 1g
WHX005	Hexagonal Mass, 5g
WHX010	Hexagonal Mass, 10g
WHX020	Hexagonal Mass, 20g
WHX050	Hexagonal Mass, 50g
WHX100	Hexagonal Mass, 100g
WHX200	Hexagonal Mass, 200g
WHX500	Hexagonal Mass, 500g
WHX1000	Hexagonal Mass, 1000g

### Hexagonal Masses, Customary Sizes

Item No.	Description
WHX1OZ	Hexagonal Mass, 1 oz.
WHX4OZ	Hexagonal Mass, 4 oz.
WHX8OZ	Hexagonal Mass, 8 oz.
WHX1LB	Hexagonal Mass, 1 lb.



## Vibrations and Waves Set

NEW PRODUCT



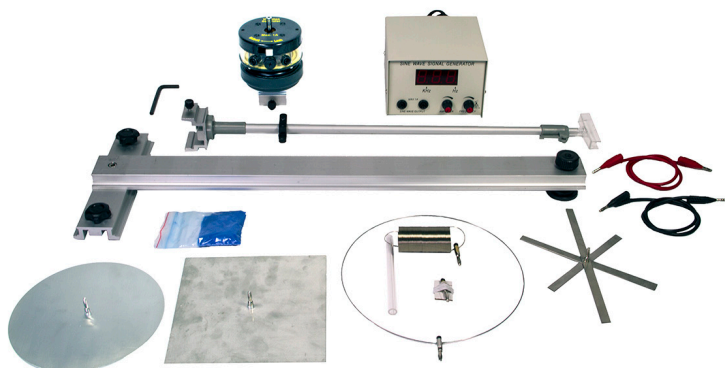
This comprehensive and economical set is based on a mechanical vibration generator and a sine wave signal generator and includes a support system and a range of accessories. The important basic types of mechanical vibrations and waves can be investigated:

- Transverse standing waves on a vibrating string
- Longitudinal standing waves on a helical spring
- Standing waves on a hoop (model of atomic quantization)
- Resonant vibrations of metal strips
- Resonance patterns on round and square vibrating plates (Chladni plates)

### Features:

- Experiments are performed on a stable and easy-to-use extruded bench
- Robust and reliable mechanical generator
- Amplified sine wave generator with large, 3-digit frequency display
- Two frequency ranges: 1—400Hz x 1Hz, 0.01—4.00kHz x 0.01kHz
- Excellent, easily visible results

The wide range of accessories allows both of the fundamental topics of transverse and longitudinal waves to be demonstrated and enables further investigation of resonance phenomena in various systems from the famous and basic waves-on-a-string to the advanced and complex nodal patterns on vibrating plates—a great value!



Includes full range of accessories that attach directly to the generator piston

### Item No.

### Description

VWS001

Vibrations and Waves Set

NEW PRODUCT



## Vibration Generator Set

A comprehensive set of mechanical vibration and wave motion apparatus based on a sturdy, reliable vibration generator that can be used with any frequency generator that can deliver a signal of up to 1A. The piston delivers an amplitude of up to 7mm, depending on the load and frequency. The generator can be used on the bench or attached to stand material via a threaded socket on the bottom surface.

Accessories include: a wire hoop, a set of vibrating metal strips for mechanical resonance studies, a spiral spring, and an elastic cord for wave investigations.

### Specifications

#### Dimensions (Vibration Generator):

**Diameter:** 11cm **Height:** 10.7cm **Weight:** 1150g

**Maximum Piston Amplitude:** approx. 7mm

**Frequency Range:** 1Hz - 4000Hz

#### Dimensions (Accessories):

**Wire Hoop:** 31cm diameter

**Spiral Spring:** 1.5cm diameter, 50cm unstretched length

**Vibrating Strips:** All 1.25cm wide, 0.2mm thick.

Lengths: 9.5, 11.5, 13.5, 16.5, 19, 21cm

**Elastic Cord:** 0.6mm diameter

Item No.	Description
VWG002	Vibration Generator Set



NEW PRODUCT



## Spark Timer

Spark timer is used for measuring velocity and acceleration of falling or moving objects. When the tape is pulled through the timer a spark is created which burns tiny dots in the tape at a precise and same interval. The faster the tape is pulled through the timer the larger the distance between the dots. This allows students to calculate the acceleration. Spark tape, carbon disks, weight and clamp are included. Includes activity guide.

### Item No.

### Description

SPARK1

Spark Timer

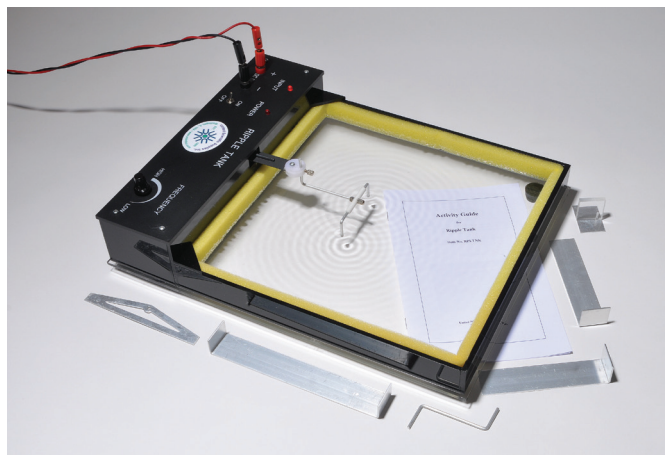
SPARK-CD

Carbon Disks

SPARK-TAPE

Spark Tape





## Ripple Tank



This device demonstrates the generation, propagation, reflection, interference, and diffraction of waves. It comes with all accessories necessary for these experiments. A 6V DC power source and an overhead projector are required (not included). Includes activity guide.



Scan to view demonstration video

Item No.	Description
RPLTNK1	Ripple Tank



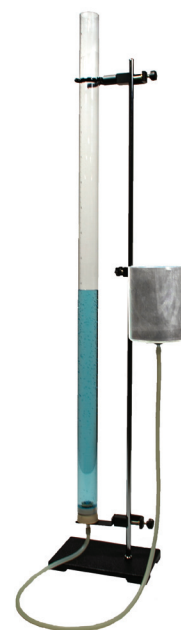
## Wave Demonstrator Set

Set includes two helical springs. The long, narrow spring measures  $\frac{3}{4}$ " x 72" and can be extended to 5 meters. The larger spring measures 3" x 4", and can be extended many times its length without distortion. Includes activity guide.



Scan to view demonstration video

Item No.	Description
WDSET1	Wave Demonstrator Set (both springs and cotton string)
WDS006	Spiral Spring, $\frac{3}{4}$ " x 72"
FCS003	Flat coiled spring, 3" x 4"



NEW PRODUCT



## Resonance Apparatus

The Resonance Apparatus allows students to investigate the resonant behavior of an enclosed air column when it is stimulated by an external sound source. The air column lengths for multiple resonances at various frequencies can be found and the resulting data can be used to determine the speed of sound.

A cylindrical acrylic tube is mounted vertically on a stand base and rod. The tube is open at the top and closed at the bottom by a rubber stopper with a hose barb. A scale is printed along the length of the tube. Flexible tubing connects the bottom of the tube to a large reservoir. The reservoir and tube are partially filled with water, creating an air space in the tube above the water level. The length of the space can be varied by adjusting the height of the reservoir on the support rod.

A suitable sound source, which can be a tuning fork (not included) or a tone generator (not included), is held close the the mouth of the tube while the length of the air column is varied. Points of resonance where the sound in the tube becomes louder can be heard and measured. The sound level may also be recorded for later analysis using probeware.

Item No.	Description
RSAPP01	Resonance Apparatus



NEW PRODUCT



## Super Spring with Stand

Extra long spring (21cm when compressed) allows you to magnify your wave demonstrations to illustrate traveling waves and wave patterns. Included stand prevents tangling or damage to super spring during storage. Includes activity guide.

Item No.	Description
SSPRING	Super Spring with Stand

## Tuning Forks

Made of aluminum alloy. The frequency and scale letter is stamped on each fork.

Individual Tuning Forks

Item No.	Description / Frequency (Hz)	Note
TFK100	100	-
TFK128	128	C
TFK256	256	C'
TFK288	288	D'
TFK320	320	E'
TFK341	341.3	F'
TFK384	384	G'
TFK426	426.6	A'
TFK480	480	B'
TFK512	512	C''
TFK640	640	E''
TFK1024	1024	C'''
TFK2048	2048	C''''
TFK4096	4096	C'''''

Tuning Fork Sets

Item No.	Description
TFSET8	Set of 8 - 256 to 512 Hz
TFSET13	Set of 13 - 100 to 4096 Hz



TFSET8



TFSET13



### Tuning Fork Boxed Set of 8

Tuning Fork Boxed Set of 8 includes a wooden box with foam lining. Each tuning fork has a specific place in the foam lining die-cut for easy storage. Also contains a mallet specially designed with one hard and one soft end for use with all frequencies of forks. Contains one each of tuning forks with frequencies of 256, 288, 320, 341.3, 384, 426.6, 480, and 512 Hz.

Item No.	Description
TFBOX8	Tuning Fork Boxed Set of 8



### Tuning Fork Boxed Set of 13

Tuning Fork Boxed Set of 13 includes a wooden box with foam lining. Each tuning fork has a specific die-cut place in the foam lining for easy storage. Also contains a mallet specially designed with one hard and one soft end for use with all frequencies of forks. Contains one each of tuning forks with frequencies of 100, 128, 256, 288, 320, 341.3, 384, 426.6, 480, 512, 1024, 2048, and 4096 Hz.

Item No.	Description
TFBOX13	Tuning Fork Boxed Set of 13



## Tuning Fork & Striker Set

Discover the science of music with the tuning fork and striker set. The 256 Hz tuning fork is made of high-quality aluminum alloy and has been accurately calibrated. A rubber hammer striker for sounding the tuning fork is included.

Item No.	Description
TFSS01	Tuning Fork & Striker Set



## Tuning Fork Mallet with Acrylic/Rubber Striker

Tuning fork mallet has a head with one end made of hard acrylic and the other end made of rubber. Head is mounted on a metal rod with an easy-grip wooden handle.

Item No.	Description
TFHAMR	Tuning Fork Mallet with Acrylic/Rubber Striker



## Tuning Fork Mallet with Rubber Striker

Economical mallet for striking tuning forks includes a spherical hard rubber head on a hardwood handle.

Item No.	Description
TFWHAM	Tuning Fork Mallet with Rubber Striker



## Resonance Box with Tuning Forks

Each unit consists of a wooden resonator box, tuning fork, and a tuning fork mallet. Resonator box is 18cm x 9cm x 5cm. Available in four tuning frequencies listed below. Additional frequencies can be made per your specifications.

Item No.	Description
TFRB256	Resonance Box with Tuning Fork, 256 Hz (C')
TFRB320	Resonance Box with Tuning Fork, 320 Hz (E')
TFRB341	Resonance Box with Tuning Fork, 341.3 Hz (F')
TFRB512	Resonance Box with Tuning Fork, 512 Hz (C'')



NEW PRODUCT



## Adjustable Tuning Fork

This single tuning fork is a seven tone set with physical-pitched frequencies of the C Major scale: 128C, 144D, 160E, 170.7F, 192G, 213.3A and 240B. The adjustment weights are easily adjusted into position using the scale lines engraved on each tine. The nylon set screws prevent scratching of the polished aluminum fork and increase tone quality.

Item No.	Description
TFKADJ	Adjustable Tuning Fork





## Density Cube Set of 10

This set of 1" cubes includes one each of acrylic, oak, pine, poplar, steel, aluminum, copper, brass, nylon, and PVC cubes packaged in a wooden storage box. Includes a reference table showing density values of individual specimens.

Item No.	Description
DCSET10	Density Cube Set of 10 in Wooden Storage Box



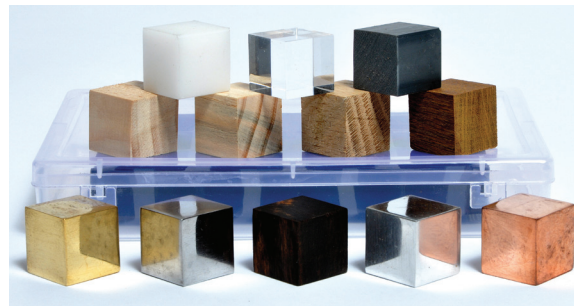
NEW PRODUCT

## Density Cube Set of 24

This set includes three different sized cubes of eight materials commonly used in density experiments. Each material is represented by a  $\frac{1}{8}$ ", 1" and  $1\frac{1}{2}$ " cube. Materials included are acrylic, aluminum, brass, copper, nylon, polypropylene, PVC, and steel. Includes a reference table showing density values of individual specimens.

Density cubes are also available individually.

Item No.	Description
DCSET24	Density Cube Set of 24



## Density Cube Set of 12

This set of 1" cubes includes one each of acrylic, oak, pine, poplar, steel, aluminum, copper, brass, nylon, PVC, lignum vitae, and polypropylene cubes packaged in a plastic storage box. Includes a reference table showing density values of individual specimens.

Item No.	Description
DCSET12	Density Cube Set of 12 in Plastic Storage Box



Scan to view  
demonstration video



## Density Cube Set of 4

This set includes one each of acrylic, pine, nylon, and aluminum cubes packaged in a poly bag. Includes a reference table showing density values of individual specimens.

Item No.	Description
DCSET4	Density Cube Set of 4 in Poly Bag

Density cubes can be custom sized or assembled into sets per your specifications. Please contact us to discuss your specific needs.



## Equal Volume Metal Squares, Set of 4

Square specimen set is used for density and specific gravity studies. Set of four includes aluminum, copper, steel, and brass cylinders. Includes a storage box and activity guide.

Item No.	Description
SGVS04	Equal Volume Metal Squares, Set of 4



## Equal Mass Cylinders, Set of 5

Each specimen in this set of five diverse materials cylinders has identical mass and radius. Materials included are acrylic, PVC, nylon, aluminum and brass. Includes a storage box and activity guide.

Item No.	Description
SGMD05	Equal Mass Diverse Materials Cylinders, Set of 5



NEW PRODUCT



## Compound Bar, Set of 4

Quick and easy tools for demonstrating thermal expansion. There are four bar combinations: Brass/Aluminum, Brass/Iron, Copper/Iron, and Brass/Copper. Since each metal has a different coefficient of thermal expansion, they will create a unique curve when paired with a different metal.

Metal bars are stamped with the identification of each metal, Aluminum (Al), Iron (Fe), Copper (Cu). The brass bar is not stamped.

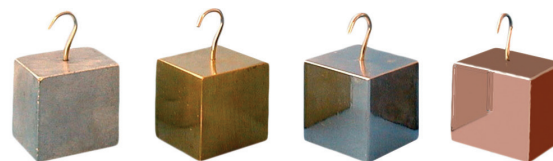
Item No.	Description
BMSET04	Compound Bar, Set of 4



## Equal Mass Metal Cylinders, Set of 5

Each specimen in this set of five metal cylinders has identical mass and radius. Materials included are aluminum, zinc, tin, steel and copper. Includes a storage box and activity guide.

Item No.	Description
SGMC05	Equal Mass Metal Cylinders, Set of 5



## Density Blocks, Hooked Set of 4

These oversized blocks demonstrate the density of four different materials - aluminum, brass, steel, and copper. Each cube is 3.2cm and has a hook. Includes a reference table showing density values of individual specimens.

Item No.	Description
SGHC04	Density Blocks, Hooked Set of 4



Scan to view demonstration video



## Equal Volume Metal Cylinders, Set of 4

Cylinder specimen set is used for density and specific gravity studies. Set of four includes aluminum, copper, steel, and brass cylinders. Includes a storage box and activity guide.

Item No.	Description
SGVC04	Equal Volume Metal Cylinders, Set of 4



## Properties of Materials Kit

NEW PRODUCT



Scan to view  
demonstration video

This unique kit allows students to make a wide range of investigations with only a small number of items. The kit contains two sets of three metal cylinders - aluminum, copper, and steel. In one set the cylinders all have equal masses, and in the other they have equal volumes. The measuring instruments - cylinder, spring scale, and caliper - measure volume, mass, and length. This combination of items allows for a wide range of basic investigations, addressing the concepts of mass, volume, density and specific gravity and extending to an exploration of buoyancy. Includes activity guide.

### Contents:

Equal Volume Metal Cylinders Set - Aluminum, Copper, Steel. . . . .	1
Equal Mass Metal Cylinders Set - Aluminum, Copper, Steel. . . . .	1
Measuring Cylinder, 100ml . . . . .	1
Spring Scale, 2.5N/250g . . . . .	1
Vernier Caliper, stainless steel . . . . .	1

Item No.	Description
PMTKIT	Properties of Materials Kit
PMTKIT-SET	Properties of Materials Kit, Classroom Set of 5

## Precision Boyle's Law Apparatus

NEW PRODUCT



This apparatus permits a quantitative verification of Boyle's Law to be quickly and easily performed. The results are reliable and more convincing than measurements obtained from a simple syringe-based apparatus.

The air sample is enclosed in a thick-walled glass tube of constant bore, so that the length of the air column is strictly proportional to the gas volume. Hydraulic oil seals the air sample in the tube and partially fills a reservoir, so the pressure in the reservoir equals the pressure in the air sample. The pressure is measured by an absolute pressure dial gauge with a range of 0 - 500kPa.

Pressure is applied using a supplied high pressure bicycle pump, which allows precise fine control for making a large series of measurements or for using the volume proportions method. A needle valve allows for controlled pressure release and a vent knob is provided for the tube. Includes activity guide.

Item No.	Description
PBLA01	Precision Boyle's Law Apparatus



Scan to view  
demonstration video







NEW PRODUCT

## Spouting Cylinder

Demonstrate Torricelli's theorem to show the relationship between water pressure and depth. This clear acrylic cylinder, 19-5/16" high, includes three vertically aligned spouting nozzles positioned 4-3/4" apart. Each spouting nozzle also includes a stopper so pressure at each height can be shown individually. A filler hose barb at the top can be used to quickly refill the cylinder or maintain a constant water depth.

Item No.	Description
CYSP01	Spouting Cylinder



NEW PRODUCT

## Gas Measuring Tube, Borosilicate

Gas measuring tube is made from borosilicate glass and features resilient white enamel graduations from the top down. The tube is closed at the zero end for gas measurement.

### Specifications:

- Tube Capacity: 50ml
- Length: 650mm
- Diameter: 13mm
- Graduation Interval: 0.5ml
- Graduation Range: 0.5 to 50ml

Item No.	Description
GTUBE50	Gas Measuring Tube, Borosilicate, 50ml



Four identically-sized bars of common metals are mounted parallel to one another in a plastic support

NEW PRODUCT



## Thermal Conductivity Bars

This simple and ingenious device quickly and graphically shows students how different metals conduct heat at different rates. It consists of four identically-sized bars of common metals - steel, brass, aluminum, and copper - mounted parallel to one another in a plastic support. Attached to each bar is a liquid crystal thermometer. When the ends of the bars are immersed in hot water, the thermometers quickly show the progress of heat along each bar. Students can measure the time for the tops of the bars to reach the top display temperature (42°C) and discover how well each metal conducts heat.

### Specifications

**Height:** 20cm **Width:** 5.5cm **Weight:** 145g

**Bar dimensions (each bar):** **Length:** 13.5cm **Width:** 0.9cm **Thickness:** 0.5cm

**Display temperature range:** 35°C - 42°C x 1°C

Item No.	Description
CBR001	Thermal Conductivity Bars



NEW PRODUCT



## Happy/Sad Ball Set

Set of two black rubber balls, each 1-3/8" in diameter, appear to be identical in terms of appearance and mass but are manufactured from different types of rubber. When dropped on a hard surface from an equal height, the happy ball bounces high and the sad ball barely bounces at all. The happy ball also rolls faster than the sad ball. Provides an interesting and memorable demonstration for studying elasticity, kinetic energy, and polymer composition.

Item No.	Description
HSB002	Happy/Sad Ball Set



Scan to view demonstration video

## Thermoelectric Demonstrator



Demonstrate the Second Law of Thermodynamics with this apparatus. Immerse one of the aluminum legs into ice cold water and the other leg into hot water to demonstrate how heat transfer can be converted to electrical energy. This conversion turns the turbine. Show the reverse effect of converting electrical energy to heat energy by plugging the apparatus into a DC power supply. In this activity, DC current is given to the unit so one of the strips will heat up and the other will remain cold.

Includes a set of two 24" banana connecting cords and a detailed activity guide.

Item No.	Description
TED001	Thermoelectric Demonstrator



## Heat Conductometer



This item is used for comparing the thermal conductivities of aluminum, brass, steel, nickel, and copper. The five radial spokes are attached to a brass hub. Each rod is marked with the metal name on the hub. There are notches in each rod to hold a wax pellet.

The unit comes assembled and with a supply of wax. Includes activity guide.

Item No.	Description
CNDM01	Heat Conductometer



## Density Rod



Machined aluminum cylinder floats in cold water, but sinks in warm water. Includes activity guide. Measures 0.65" diameter x 3.5" long. Weight is 0.5 oz.

Item No.	Description
DNROD1	Density Rod



Scan to view demonstration video

## Bimetal Strip / Compound Bar



A quick and easy tool for demonstrating thermal properties of matter. Bar is bi-metallic and has a wooden handle attached. When heated, the bar bends dramatically. Includes activity guide.

Item No.	Description
BMST05	Bimetal Strip / Compound Bar



Scan to view demonstration video

## Ball and Ring Apparatus



All brass construction with brown lacquer finish wood handle. Includes activity guide.

Item No.	Description
BRA001	Ball and Ring Apparatus



## Hydrometers



HYML01



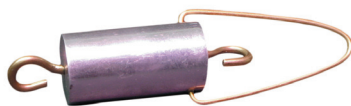
HYMH02

Hydrometers for determining the specific gravity of liquids. Two specific gravity ranges available. Each unit is housed in a reusable storage tube.

Item No.	Description	Specific Gravity Range
HYML01	Light Liquid Hydrometer	0.700 - 1.000
HYMH02	Heavy Liquid Hydrometer	1.000 - 2.000

## Bucket and Cylinder

This Archimedes' Principle apparatus consists of a solid metal cylinder in a close-fitting metal bucket. The bucket is 50mm long and 19mm in diameter and has a displacement capacity of approximately 22ml.



Item No.	Description
BCL001	Bucket and Cylinder

## Overflow Can, Clear Acrylic

This transparent overflow can is graduated to 125ml and includes an attached spout. Made of clear acrylic, the can measures 5.5cm I.D. x 7cm high with a wall thickness of 3mm.



Item No.	Description
OFLCN2	Overflow Can, Clear Acrylic

## Specific Gravity Bottles, Borosilicate Glass

These uncalibrated borosilicate glass bottles are excellent for determining the specific gravity of liquids. Include a ground glass stopper with a hole to allow air to escape. Available in 10ml or 25ml sizes.



Item No.	Description
SGB010	Specific Gravity Bottle, 10ml
SGB025	Specific Gravity Bottle, 25ml



## Overflow Can and Bucket Set

An aluminum overflow can and a catch bucket are packaged as a convenient set for use in Archimedes' Principle, density, and specific gravity experiments. The overflow can measures 4" I.D. x 5" high and has a capacity of approximately 800ml. Its spout is 0.5" I.D. x 1.5" long. The catch bucket with detachable aluminum handle measures 4" I.D. x 3" high. The can and bucket are also sold separately.

Item No.	Description
OFLSET	Overflow Can and Bucket Set
OFLCN1	Overflow Can only
CABKT1	Catch Bucket only



Scan to view demonstration video



## Archimedes' Principle Apparatus, Large

This oversized model has a larger displacement capacity (100ml) than our traditional aluminum model (22ml) for higher accuracy and easier operation. Also, both the cylinder and the cup have marked divisions which allow the students to repeat the experiment with different volumes. The cylinder is made of white nylon. This item requires a 200g spring scale, an overflow can, and a beaker (not included). Includes activity guide.

Item No.	Description
BCL002	Archimedes' Principle Apparatus, Large





## Double Walled Calorimeter

This calorimeter consists of two nested aluminum cans separated by a 1.7cm thick styrofoam liner and a clear molded plastic lid with a filler cap. A plastic insulator ring protects the styrofoam insulation against damage and liquid spills. The inner reservoir has a capacity of 150ml. A thermometer stopper and an insulated stirrer are included. Includes activity guide.

Item No.	Description
CLRM01	Double Walled Calorimeter



Scan to view demonstration video

NEW PRODUCT



## Electric Calorimeter

Calorimeters are used to explore the basic physics of heat and energy. Experiment topics include heat and energy interchange, heat and temperature, heat capacity and specific heat, latent heat, and much more. This Electric Calorimeter is well suited for classwork on all of these topics by its robust construction and attention to detail for ease of use. Can be used as either an electric calorimeter or a class standard calorimeter.

### Specifications

**Diameter:** 10cm

**Height:** Calorimeter only: 11cm, Overall: 15cm

**Liquid capacity (inner can):** 175ml

**Heat capacity (inner can):** approx. 25J/°C

**Weight:** 205g

**Electrical:** Requires 6VDC, up to 2A. Coil resistance: 2.5 - 3Ω

Item No.	Description
CLRE02	Electric Calorimeter



## Radiation Can Set

Two identical sized screw cap metal cans (one smooth metal and other painted dull black) to demonstrate the difference in cooling rates of hot water inside the cans due to different surfaces. The difference in the cooling rates is attributed to the thermal radiation emitted by the two cans. Includes activity guide.

Item No.	Description
RDCN02	Radiation Can Set



RDCNKIT

LWB001



## Radiation Can Kit

Demonstrate how two identically sized cans absorb and radiate energy differently. One of the screw cap cans is smooth metal and the other is painted dull black. Water cools or heats at different rates because of the thermal radiation emitted by the two cans. Kit contains a lamp assembly with reflector and stand (bulb not included), one smooth metal can, one black metal can, and thermometer. Includes activity guide. Lamp assembly with stand is also sold separately.

Item No.	Description
RDCNKIT	Radiation Can Kit
LWB001	Lamp Assembly with Stand



NEW PRODUCT

## Aspirator

Strong plastic aspirator for vacuum filtration and other lab applications. Designed to prevent any flooding, back-flow, or turbulence. Includes 5.9" (15 cm) flexible hose. The top nozzle has an outer diameter of 1.5 cm. The side nozzle can accommodate hoses from 0.5 cm to 1.0 cm inner diameter.

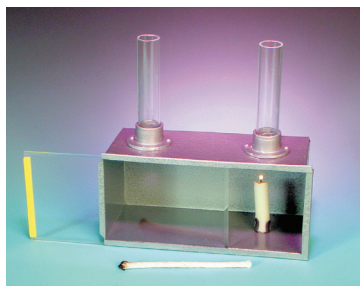
Item No.	Description
ASPT1	Aspirator



## Radiometer

Our Radiometer is made from a glass bulb from which much of the air has been removed. Inside the bulb, on a low-friction spindle, is a rotor with four vanes. Each vane has one blackened side and one silvered side; one black vane features a white dot in order to count rotations easily. When exposed to sunlight or artificial light, the vanes turn with no apparent motive power. This effect is due to differential heating of the black and silvered vanes.

Item No.	Description
RADIO1	Radiometer



## Convection of Gases Apparatus



This apparatus consists of a metal box (22 x 10 x 11cm) with clear acrylic front panel, two glass chimneys, a candle, and a cotton filled wick as the smoke source. Includes activity guide.

Item No.	Description
CGA001	Convection of Gases Apparatus



## Foot Pump

This foot operated air pump is equipped with a 15" hose with locking valve and features a pressure gauge. Ideal for use with rocketry kits.

Item No.	Description
APF001	Foot Pump



Scan to view demonstration video



## Boyle's Law Apparatus



This low cost apparatus is great for demonstrating Boyle's law (elasticity of gases). A plastic syringe is mounted on a wooden base. A piston is mounted to a platform that holds various size weights, allowing students to plot pressure versus volume of gases in the cylinder. Includes activity guide.

Item No.	Description
EGA001	Boyle's Law Apparatus



## Metal Magdeburg Hemispheres



These heavy duty Magdeburg hemispheres are closer to the original version than plastic or rubber models. Thick cast iron walls and large steel handles make this item extremely durable. Plated brass valve and precision machining prevent leakage.

Item No.	Description
MGH001	Metal Magdeburg Hemispheres



## Hand Air Pump

This pump features a painted steel barrel, steel valve assembly, and a wooden handle. Both in and out ports are equipped with hose connectors, for use with vacuum experiments as well as to generate pressure. Creates vacuum of 20" Hg.

Item No.	Description
HAP001	Hand Air Pump

- The items shown on the following pages are suitable for College Physics labs. Detailed technical descriptions and sample copies of Activity Guides are available upon request.
- While we do not hold stock of these items, we can ship any within approximately 90 days. These items can be drop-shipped to your customers.
- Each unit is inspected and tested before shipment from our Waukegan, IL facility. Our staff physicist, Dr. Martin Taylor, will be glad to provide any post-sale technical assistance as needed.

## Surface Plasmon Resonance Apparatus



- **Demonstrate the principles of SPR analysis**
- **Use a light beam to excite resonant electron oscillations under specific conditions**
- **Includes a collimated laser, polarizer, and photodetector**



### Contents:

1. SPR Electronics Unit, 110V . . . . . 1
2. Centering reticle for setup . . . . . 1
3. Syringe for inserting sample . . . . . 2
4. Polarizing Filter Unit . . . . . 1
5. Connecting Cables . . . . . 2
6. Optical Support for Prism . . . . . 1
7. Light Sensor Unit . . . . . 1
8. Centering Pin Puck . . . . . 1
9. Laser Light Source Unit . . . . . 1
10. SPR Prisms . . . . . 2

**Required Accessory:** . . . . . SPECT02 Intermediate Spectrometer

Item No.	Description
SPRA01	Surface Plasmon Resonance Apparatus

**Surface Plasmon Resonance is an analytical technique** used to detect and track a wide variety of surface processes such as DNA and protein interactions, drug mechanisms, immunoassays, anodic stripping, corrosion, gas detection, and many more.

In this technique, a light beam interacts with the electron plasma in a metal film at a metal-dielectric interface to excite resonant electron oscillations—plasmons—under specific conditions. The component of the photon momentum parallel to the metal surface must match the plasmon momentum. This occurs at a specific incidence angle of the light beam, which is highly sensitive to the state of the surface. In particular, any material attached to the surface produces a detectable change in the resonance angle.

**The resonance is detected by monitoring the intensity** of a totally internally reflected laser beam as a function of incidence angle. At resonance, light energy is absorbed and a significant intensity drop is observed.

**The apparatus is used together with** the United SPECT02 Intermediate Spectrometer (not included). The spectrometer's slit, lenses, and eyepiece are replaced by a collimated laser, a polarizer, and a photodetector. An adjustable support plate for the SPR prism fits onto the spectrometer's table and an electronic unit controls the laser and measures the light output.

The SPR prism consists of a precise semicircular glass block with a thin layer of gold deposited on the flat surface and a plastic pocket for liquid samples fixed behind it (the Kretschmann configuration.)

At the laser beam's incidence point, an evanescent wave propagates through the gold layer. Surface plasmons are excited at the interface between the gold layer and the liquid sample, diverting energy from the monitored reflected laser beam.





## Hall Effect Apparatus

NEW PRODUCT



Scan to view  
demonstration video

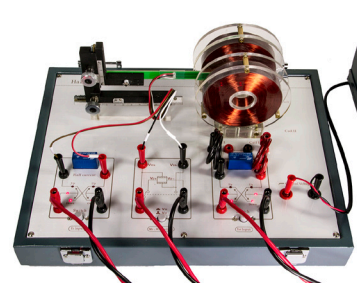
- Explores the Hall Effect in a GaAs semiconductor
- Explores systematic errors and their elimination
- Determines the conductivity of the semiconductor
- Uses the semiconductor to plot the coils' magnetic field

The **Hall Effect** is the generation of a side-to-side voltage in a conductor or semiconductor carrying a current when it is placed in a magnetic field. The effect is widely used in magnetic field sensors. It is associated with several well-known systematic errors, some of which can be eliminated by special measurement techniques.

This **Hall Effect Apparatus** consists of a mounted n-type semiconductor chip on a traverse mechanism, a pair of coils, relay-controlled reversing switches, and a control unit with connecting cords.

### Features:

- n-type GaAs Hall sensor chip
- Helmholtz coil pair 75mm effective diameter, 11.25mT central magnetic induction at 0.5A
- Two-axis mechanical traverse for field plotting
- Constant current sources for magnet (0-0.5A) and Hall driving current (0-3mA)
- Reversing switch for exploring the elimination of systematic error
- 3-1/2 digit current and voltage meters
- Metal storage case for the Hall Effect board



Hall Effect Board with Coils, Traverse & Switches



Hall Effect Control Unit

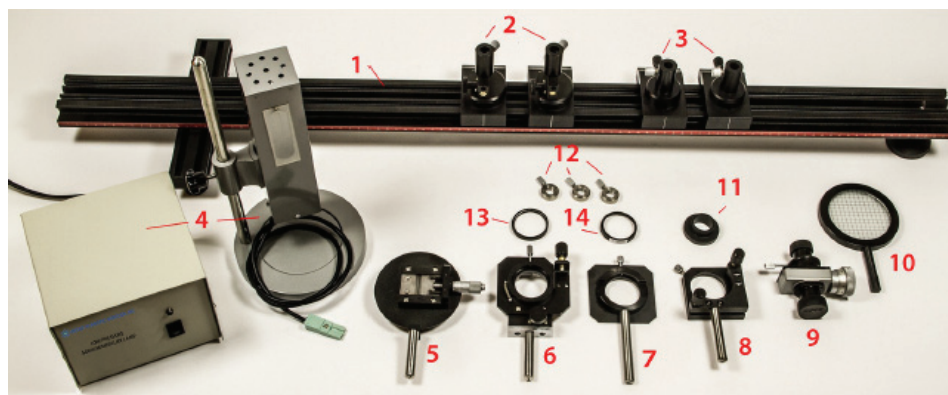


Hall Effect Board in Case

Item No.	Description
HLEF01	Hall Effect Apparatus



## Precision Fresnel Biprism Interference Apparatus



- **Perform Fresnel's Biprism Experiment on a 1m optical bench**
- **Precision optics allow fringe position measurements to 1/100mm**
- **Easy alignment and adjustment of the two virtual light sources**

**Fresnel's Biprism Experiment is the fundamental example** of common path interference by division of wavefront. Light from a slit passes through side-by-side prisms with very shallow angles to separate it into two almost parallel beams. When these beams are brought to overlapping by a convex lens, they interact as if they originated from two virtual sources side by side and generate equally-spaced fringes. The original version of the experiment by Fresnel is difficult to perform because it requires precise adjustment of the slit and prisms, a dark room, and a large amount of space to separate the fringes for easy viewing.

**This apparatus allows these issues to be resolved by** using a precision angle-adjustable slit, a prism carrier with both lateral and angular adjustment, and a micrometer eyepiece to allow fringe separation measurements to 1/100mm. The experiment can be carried out on a 1m optical bench with only dimmed lighting.

**The micrometer eyepiece has a range** of  $\pm 4.00$  mm with a backlash-free, easy-to-read drum scale.

During setup, the two virtual sources are focused onto a ground glass screen for easy alignment and adjustment so that the sources are parallel and of equal intensity.

The fringes show good contrast and separation for dark-dark position measurements.

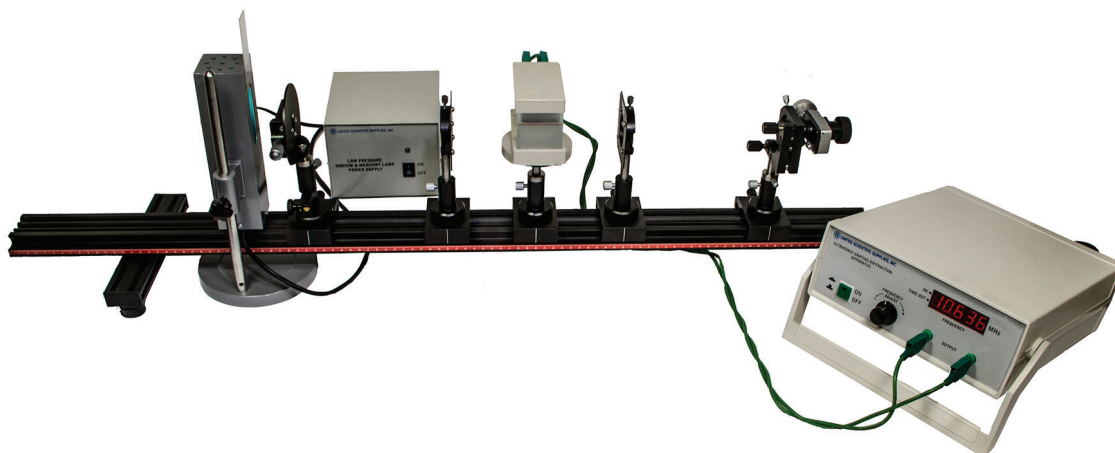
### Contents:

1. Optical Bench, 1000mm	1
2. Riders, Lateral Adjustment	2
3. Riders, Plain	2
4. Sodium Lamp, 20W, 110V	1
5. Adjustable Slit	1
6. Biprism Carrier, Adjustable	1
7. Lens Carrier, Plain	1
8. Eyepiece Carrier, Adjustable	1
9. Micrometer Eyepiece	1
10. Ground Glass Screen	1
11. Eyepiece Adapter Ring	1
12. Height Fixing Collar	3
13. Biprism	1
14. Lens, $f = +150$ mm	1

Item No.	Description
PFB001	Precision Fresnel Biprism Interference Apparatus



## Ultrasonic Grating Apparatus



### Contents:

1. Optical Bench, 1000mm	1
2. Rider, Lateral Adjustment	1
3. Riders, Plain	4
4. Micrometer Eyepiece	1
5. Eyepiece Adapter Ring	1
6. Glass Tank for HF Grating	1
7. HF Generator and Frame	1
8. Optical Table	1
9. Connecting Cords	2
10. Lenses, $f = +170\text{mm}$	2
11. Height Fixing Collar	1
12. Eyepiece Holder, Adjustable	1
13. Lens Holders, Plain	2
14. Adjustable Slit	1
15. Mercury Lamp, 20W, 110V	1

- Demonstrate the interaction of longitudinal sound waves and transverse light waves
- Precisely determine the speed of sound in liquids
- Use with any clear, non-aggressive liquid of low electrical conductivity

The Ultrasonic Grating Apparatus is both a unique demonstration of the interaction of longitudinal sound waves and transverse light waves and also a method for the precise determination of the speed of sound in liquids, which is otherwise difficult to achieve in the undergraduate lab.

The core of the apparatus is a parallel-sided glass tank that houses the liquid sample and contains a lead zirconate titanate (PZT) ultrasonic transducer. The transducer is energized by an RF signal in the 8-12 MHz range. Resonances can be found to set up a standing wave field in the liquid, which results in a periodic variation of the liquid's refractive index along the tank.

If a parallel light beam is now shone through the tank normally to the standing wave field, the liquid acts as a diffraction grating, producing fringes that can be measured with a micrometer eyepiece. In practice, the eyepiece is focused on the source slit and the exciting RF frequency is adjusted until the interference fringes appear.

The apparatus can be used for any clear, non-aggressive liquid of low electrical conductivity. For aqueous solutions, the speed of sound is significantly affected by the dissolved matter. Distilled water and ethanol are suitable starting liquids.

Item No.	Description
UGA001	Ultrasonic Grating Apparatus





## Michelson and Fabry-Pérot Interferometer



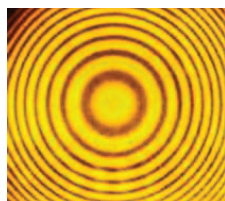
- **Precise, solidly constructed instrument for advanced studies**
- **Easily interchangeable Michelson and Fabry-Pérot configurations**
- **Precision geared mirror drive for 0.0001mm resolution**

**The Michelson/Fabry-Pérot Interferometer base** consists of a substantial casting that supports a machined and ground lathe bed at a convenient height for observation. The lathe bed has a precise 1mm pitch geared lead screw to adjust the movable mirror carriage. The large coarse adjustment knob sets the mirror position to within 0.01mm, read on a 205mm divided steel scale and a numbered dial for fractions of a millimeter. A further graduated fine adjustment knob reads to 0.0001mm, and is an excellent control for precise displacements and ring counting.

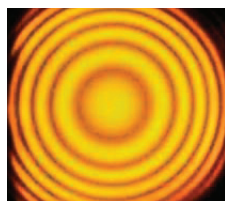
**The interferometer optics** fixed parts are mounted on vertical steel plates that attach to the side of lathe bed, while the movable mirrors for both configurations are fitted directly onto the moving carriage. Each mirror carries three coarse adjustment screws, and the fixed mirrors also have a two-dimensional flexion bar fine adjustment system. The optical elements themselves are of high-quality optical glass, with surfaces flat to within 1/4 wavelength of green light, giving high-quality images across the visible spectrum.

**The instrument includes** a 3x fixed focus telescope with diopter adjustment for viewing remotely located fringe patterns. Its 70mm diameter ground glass screen with a 5mm pitch grid allows for easy setup and viewing projected localized fringes. An operator's manual is also included.

**Due to its precise construction,** large range of mirror movement, and high-quality optics, this instrument is ideal for precise wavelength determinations, refractive index measurements, and other demanding optical work.



Sample Fabry-Pérot interference pattern using sodium light.



Sample Michelson interference pattern using sodium light.

Item No.	Description
MFPI01	Michelson and Fabry-Pérot Interferometer

### Specifications

#### Optics

Michelson mirror diameter: 34mm

Beam splitter & compensation plate: 35 x 40mm, 7.5mm thick

Distance, beam splitter to fixed mirror: 70mm

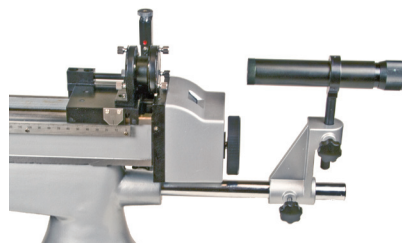
Fabry-Pérot mirror diameter: 24mm

#### Mechanical

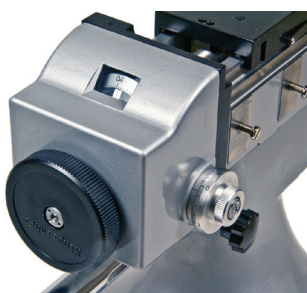
Maximum mirror travel: 175mm (Michelson), 195mm (Fabry-Pérot)

Gearing: Coarse: 2.00mm per turn; Fine: 0.01mm per turn

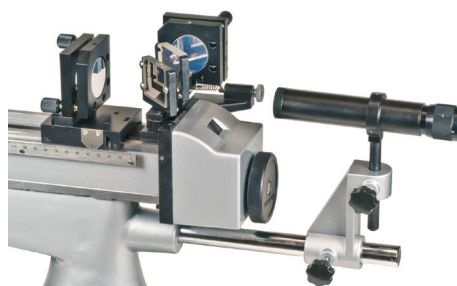
Dimensions: 55 x 22 x 40cm, weight: 19.4 kg



Fabry-Pérot configuration.



Fine control gearbox



Michelson configuration.



## Laser Optics Demonstrator



- **Comprehensive optical demonstration system with built-in HeNe laser**
- **Top-quality optical components for over 75 demonstrations**
- **Demonstrate both ray optics and selected wave phenomena in a lighted room**

**The Laser Optics Demonstrator** consists of a base unit with a built-in He-Ne laser, deflection system and ray optics board. The included accessory case with 30 optical quality glass components mounted on carriers, three magnetic base supports, and a mechanical stage for wave optics experiments. An extensive operator's manual describes 51 ray optics demonstrations and 27 interference and diffraction experiments.

**The illumination system** consists of an enclosed horizontal HeNe laser whose beam is diverted upwards at the left side of the instrument. A removable cylindrical lens on the top of the base fans the beam out for ray optics demonstrations. The beam then enters a series of five graded, partially silvered mirrors that generate five equally intense beams. The mirror case is adjustable vertically and horizontally for positioning the ray bundle on the ray optics board; the mirrors are independently adjustable to allow direct demonstrations of image formation (see illustration) and to allow a single beam to be generated for wave optics experiments.

**The ray optics board** carries a flush, 360° graduated table at its center. The table can be rotated by a knob on the back of the board and has a central recessed magnet for holding optical elements in place. Each ray optics element is mounted on a chrome-plated steel carrier rod that fits into the table recess. The collection of elements includes convex and concave lenses; plane, spherical, and angled mirrors; blocks and prisms; and simple optical instruments. A fiber optics demonstrator is also included.

**For wave optics experiments**, magnetic base supports fit onto the base to carry lenses and a polarizer, as well as an air wedge and Fresnel's biprism and mirror. For other diffraction and interference arrangements, a mechanical stage attaches to the right side of the ray optics board to support and adjust three diaphragms that carry 34 different diffraction and interference apertures and obstacles. The diaphragms are mounted glass plates with an evaporated aluminum film, giving excellent contrast in the images. An additional film diaphragm carries nine more complex diffraction objects. Many interference and diffraction experiments can be viewed comfortably in a lighted room, but more extended patterns or diffraction at very small apertures require darkening.

A fitted metal carrying case accommodates the base unit, the molded accessory case, and the operator's manual.

### Specifications

#### Dimensions:

**Base unit:** 37cm L x 12.5cm W x 33cm H

**Carrying case:** 15" x 15" x 13"

**Weight:** 12kg

The unit operates on 110V/60 Hz



Scan to view  
demonstration video

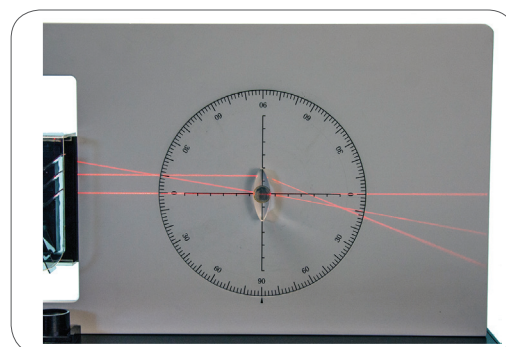


Image formation by a convex lens.

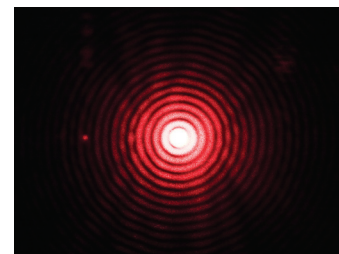


Photo of circular aperture diffraction pattern.

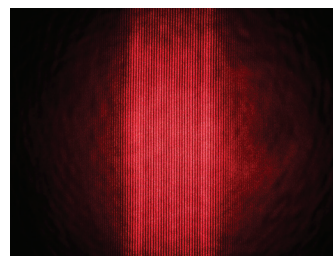


Photo of Fresnel's Mirror fringes.

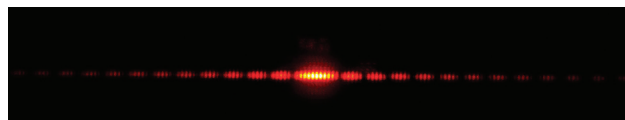


Image of Young's Double Slit experiment.

Item No.	Description
LOD001	Laser Optics Demonstrator



## Photoelectric Effect Apparatus



- Study electron photoemission from a metal surface
- Obtain the characteristic curves of a vacuum photocell
- Explore the effect of illumination intensity using the inverse square law

**The Photoelectric Effect Apparatus** allows the photoelectric emission from a mixed metal cathode in vacuum to be studied. It consists of a light-tight box connected to a control and measurement unit by shielded cables.

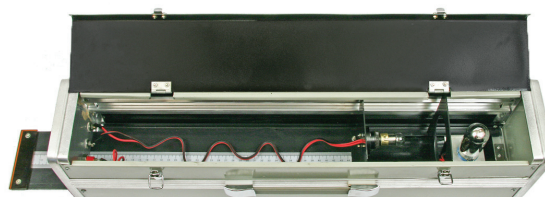
**The light-tight box** contains a vacuum phototube with a Cs-Sb cathode and a current-controlled incandescent lamp, mounted on a slide operated from outside the box to vary the illumination of the phototube.

**The control and measurement unit** contains an adjustable, highly stabilized lamp power supply. The current is indicated on a three-digit display. A second, independent, highly stabilized voltage source controlled by a multi-turn potentiometer applies a precise DC extraction voltage to the phototube electrodes. The applied voltage is indicated on a three-digit display. The resulting photocurrent is measured by a sensitive amplifier and indicated on a 3-1/2-digit display.

**The apparatus shows** the linear relation between light intensity and emission current. It also demonstrates the space charge dominated and saturation regions of the emission current relationship to the extraction voltage.



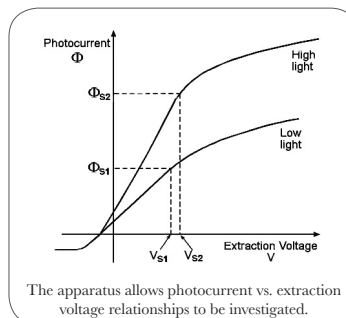
The control and measurement unit contains a highly stabilized lamp power supply adjusted by a multi-turn potentiometer.



The light-tight box contains a vacuum phototube mounted on a slide operated from outside the box to vary the illumination.

### Specifications

<b>Phototube:</b>	Type GD-51 Mixed metal vacuum tube (Cs-Sb), rated voltage: 24V Integral sensitivity (white light): 100 $\mu$ A/Lm
<b>Lamp:</b>	Incandescent lamp, 12V/5W
<b>Control Unit:</b>	Lamp supply: 185mA—665mA; display resolution: 1mA Electrode voltage supply: -25.5V—+23.5V; display resolution: 0.1V Photocurrent amplifier ranges: 0—19.99 $\mu$ A x 0.01 $\mu$ A; 0—199.9 $\mu$ A x 0.1 $\mu$ A Dimensions: 35cm x 26cm x 12cm Weight: 4.5 kg
<b>Light-tight Box:</b>	Slide range: 0.5 - 40.0cm, mm scale Dimensions: 60.5cm x 12cm x 15cm Weight: 3.8 kg



Item No.	Description
PEEA01	Photoelectric Effect Apparatus





## Planck's Constant Apparatus



Scan to view demonstration video

- Compact, easy-to-use apparatus
- Accurate results with less than 5% error
- Measures Planck's constant and estimates the work function of cesium

The **Planck's Constant Apparatus** is a compact unit containing an enclosed vacuum photocell with an attachment for illuminating light sources, a high stability power supply for applying a variable stopping voltage to the cell and a nanoammeter for measuring the resulting photocurrents.

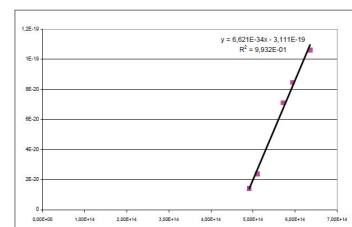
A **second integrated power supply** applies light from five interchangeable narrow-spectrum LEDs to the photocell, via an enclosed fiber-optic cable that plugs into the photocell enclosure. This configuration ensures that ambient illumination is excluded.

A **maximum energy of the photons** from each of the five LEDs in turn is measured by determining the stopping voltage for which the photocurrent becomes zero. This occurs for the peak wavelength of each LED.

**Results are evaluated** by combining the wavelength and energies to allow a value for Planck's constant to be found. The work function of the photocell cathode material can also be estimated. This can be performed graphically, analytically, or using the included Microsoft Excel® spreadsheet.



The main unit includes a voltmeter, nanoammeter, and light/voltage adjustment knobs.



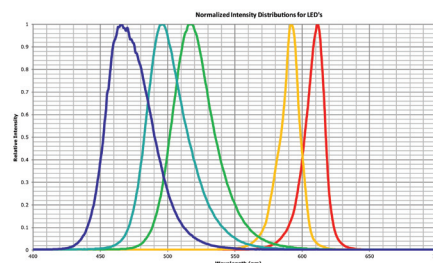
A file to automatically calculate regression lines is included with the unit.

### Specifications

<b>Photocathode Material:</b>	Cesium (Cs)
<b>Voltmeter Display:</b>	3½ digit, LCD, precision 0.5% (typical)
<b>Ammeter Display:</b>	3½ digit, LCD, precision 1% (typical)
<b>Dimensions:</b>	28cm x 12cm x 16cm
<b>Weight:</b>	Approx. 1 kg

Item No.	Description
PLCN01	Planck's Constant Apparatus

Each of the five LEDs carries an identifying color band and a color patch with the wavelength maximum.



Graph showing the spectra of the LEDs.



## Thermoelectric Effects Apparatus



The sample oven contains a cooling fan, a massive metal block with an electric heater, three samples, and a control system sensor.

The sample heating assembly can be raised out of the oven on the telescoping support rod.

The control unit provides the heating current, connectors to the three sample devices, and the digital temperature controller.

- Investigate the thermal characteristics of three electrical thermometry devices
- Explore the features and behavior of a closed-loop digital temperature control system

**The Thermoelectric Effects Apparatus** consists of an oven containing a cooling fan; a massive metal block and electric heater supported on two thin struts; the three samples; and the control system sensor. A control unit provides the heating current and houses the digital temperature controller. The oven and the control unit are connected by three multi-pole cables.

**The sample devices** are a thermocouple, a three-pole metal resistor, and a thermistor. An insulated flask is provided to hold ice water for the cold junction of the thermocouple. The signals from the three sample devices can be read by any suitable, user-provided measuring device connected to the outputs of the control unit (for example, digital multimeters).

**The digital control system** can be operated in P, PI, PD, or PID mode to show their characteristics when controlling the oven temperature with or without fan cooling. A wide range of parameters and alarms can be set to explore their effects.

### Specifications

#### Samples:

Thermocouple: Type K (chromel/alumel, approx.  $41\mu\text{V}/^\circ\text{C}$ )  
Resistor: Three-pole, approx.  $50\Omega$  and  $100\Omega$  at  $0^\circ\text{C}$ , (PT100+PT50).  
Thermistor:  $12\text{k}\Omega$  NTC element; Approx. curve:  
 $\text{Ln}R (\Omega) = 3655/T (K) + c$

#### Oven Dimensions:

Brass heating block: 40mm diameter, 67mm high  
Oven assembly: 37cm high, 14cm wide, 22cm deep  
Weight: 5.1 kg

#### Control Unit:

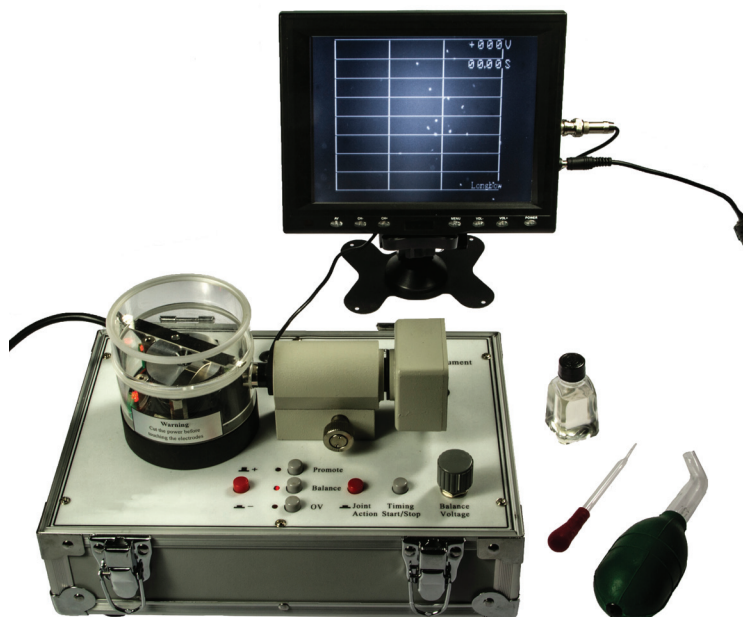
Heater supply: Regulated voltage source: 0—36V DC 10-turn potentiometer;  
Digital current display, 0.000—1.999A  
Cooling fan: 12V DC 0.14A, On/off switch control  
Digital controller: Configurable for P, PI, PD, or PID mode;  
Process value (PV) range: 0—400°C (default—settable);  
Set value (SV) range: same as PV range;  
PV temperature display: 4-digit, resolution  $1^\circ\text{C}$  or  $0.1^\circ\text{C}$ ;  
SV temperature display: 4-digit, resolution matches PV;  
24 settable parameters;  
2 parameters determined by apparatus configuration

Power input: 110VAC/60Hz, 65W  
Dimensions: 13cm x 35cm x 31cm  
Weight: 5.2 kg

Item No.	Description
THEA01	Thermoelectric Effects Apparatus



## Millikan Oil Drop Apparatus



- **Improved Oil Drop Injection for Easier Capture**
- **Built-In Video Camera and Included Monitor for Better Results**
- **Compact Unit - No Setup Needed**

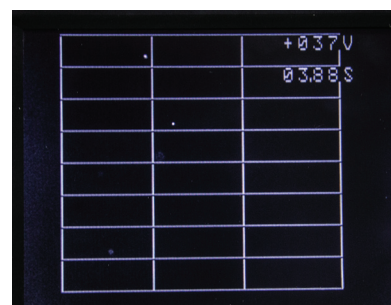
This compact Millikan Oil Drop Apparatus has been upgraded for enhanced performance and convenience. It includes a permanently installed video camera on the observing microscope, digital readouts for the capacitor voltage and timer, and an 8" monitor for observation and control. The unit comes in a sturdy metal case, and includes silicone oil, an atomizer, a dropper for filling the oil, and a full operator's manual.

The measuring chamber arrangement consists of the capacitor chamber with a double illuminator and observation hole built into the side wall, and two outer acrylic chambers (see schematic). A cloud of oil drops from the atomizer is sprayed directly into the upper chamber where the turbulence is allowed to die out. A metal shutter is now opened to permit a small stream of drops to fall into the lower settling chamber and draft shield. A smaller selection of the drops falls through a small hole into the measuring chamber. This arrangement reliably produces a stream of charged droplets moving smoothly down the axis of the capacitor.

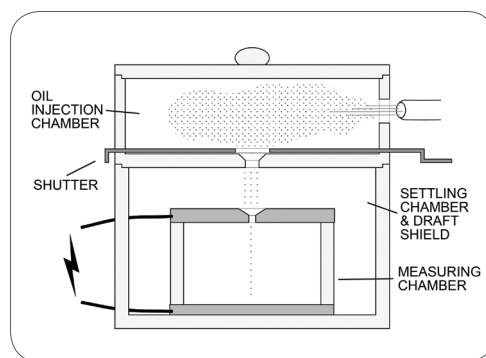
The charged drops' location and the light color of the silicone oil make the drops easy to capture, alleviating a common problem with other Millikan apparatus designs. Oil drops generally carry fewer electronic charges than the latex spheres sometimes used. This makes the analysis histogram easier to interpret.

The microscope and camera arrangement are designed for precise measurement and ease of use. The combined drop observation system is calibrated so that one division on the grid displayed on the computer monitor corresponds to 1mm at the focus of the microscope. The illuminator consists of two bright red LEDs whose reflected light is readily detected by the camera. The resolution of the system is sufficient that the slight Brownian motion of the falling drops is readily observable.

The measuring system consists of a high-voltage power supply controlled by a potentiometer and pushbutton reversing switch, as well as a timer. Measurements can be made using either the balancing technique or the rise time/fall time technique.



View of screen showing plotted oil drops.



Schematic of Millikan Oil Drop Apparatus.

### Specifications

#### Measuring chamber:

Diameter: 32mm  
Plate separation: 5.00mm

#### Balancing voltage:

0 — 370V

#### Case (includes lid):

27cm x 20cm x 18cm

#### Weight:

4.4 kg

Operates on 110VAC

Item No.	Description
MODA02	Millikan Oil Drop Apparatus





## Franck-Hertz Apparatus II

NEW PRODUCT



Franck-Hertz Apparatus II (with user-supplied Oscilloscope)

- Argon-filled Franck-Hertz tube achieves 5-7 current maxima
- Anode current range 0.1nA—1 $\mu$ A
- Automatic scan to oscilloscope or chart recorder, or manual scan
- Adjustable, stabilized filament, grid, and anode voltages
- 3-1/2 digit voltage and current readouts

The Franck-Hertz Apparatus II is an improved model of the well-known Franck-Hertz Apparatus (FHA001), featuring updated electronics with better stabilization and digital readouts for voltage and current (more robust, easier to read correctly). New fully shielded coax cables reduce electrical noise.

The Franck-Hertz Experiment yields basic evidence for the existence of quantum states. Inside a vacuum tube filled with a trace of argon gas, a beam of electrons is generated and accelerated towards a counter-electrode. A voltage barrier ahead of the counter electrode only allows electrons with a certain minimum energy to get through and make a detectable current. As the accelerating energy is increased, changes in the current are observed. On the way to the counter electrode, the electrons collide with argon atoms. At first, nothing happens, but as the electron energy rises, it reaches enough to give one quantum of energy to the argon to ionize it. Now the electron can't pass the voltage barrier and the current drops. The multiple valleys in the current curve are evidence of the donations of a quantum of energy

**Note: Requires user-supplied dual-channel oscilloscope for automatic scan.**

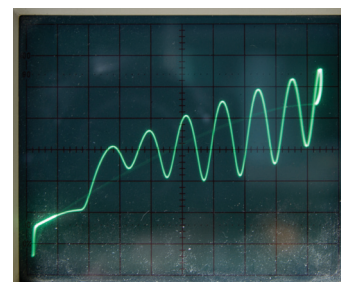
Item No.	Description
FHA002	Franck-Hertz Apparatus II



Scan to view  
demonstration video



Franck-Hertz Control Unit with Internal FH Tube



Oscilloscope Trace—Automatic Scan



## Zeeman Effect Apparatus



- **Complete Equipment Set for Studying Light Emission in a Magnetic Field**
- **Includes Video Capture Equipment and Computer Analysis Program**
- **Magnet Allows Transverse and Longitudinal Viewing**

**The Zeeman Effect Apparatus** examines the effect of a strong magnetic field on the green emission line of mercury at 545.1nm wavelength. A magnetic field splits the degenerate 7s and 6p levels into three and five levels respectively, giving nine allowed transitions. The energy shifts of the splitting are tiny compared to the transition energy, so a high resolution spectrometer is necessary to observe them at the magnetic field strengths achievable in the laboratory. This resolution is usually achieved by using a high quality Fabry-Pérot étalon. The combination of these requirements has often discouraged the provision of Zeeman effect apparatus in the student laboratory. This apparatus addresses this issue.

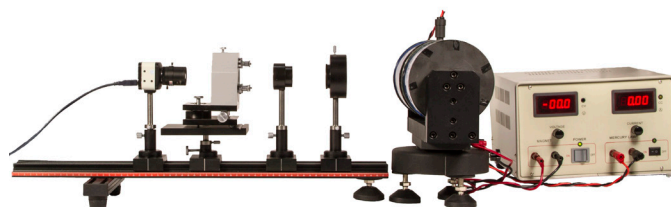
The emitted light is polarized, and the nature and direction of the polarization depends on the orientation of the propagation direction to the magnetic field. For light emitted transversely to the field, the polarization is linear ( $\pi$ ), with the polarization direction parallel to the electric field for one group of three transitions, and perpendicular to the field for the remaining two groups. The components of these groups are usually not resolved sufficiently for easy measurement in practice due to overlap of their interference fringes. Light emitted parallel to the magnetic field is circularly polarized ( $\sigma$ ), with only two groups of transitions emitted, showing opposing directions of polarization.

**The electromagnet is mounted on a swivel** next to a power supply that also powers the slim, low-pressure mercury discharge lamp fitted between the magnet's pole pieces. A removable steel rod fills a long hole through one pole for transverse viewing; for parallel viewing, the magnet and lamp are swiveled 90° and the rod is replaced by a quarter-wave plate to observe the circular polarization.

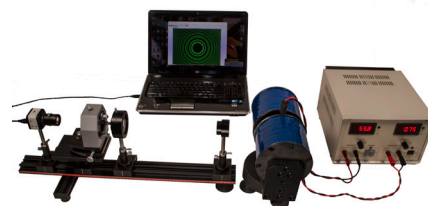
**The optical system** contains four elements and an optical bench. A polarizer and a 40mm diameter lens are mounted in a common housing. The polarizer can be rotated 360° and clamped in any orientation. It serves as an analyzer to detect the polarization state of the emitted light. The lens focuses the light for the spectrometer. An interference filter selects the emission line at 545.1nm, and a Fabry-Pérot étalon with a fixed spacing of 2.0mm acts as the resolving element. The étalon can be rotated in its housing and has three fine adjustment screws to set exact parallelism of the mirrors. The étalon mount is a heavy steel block attached to a base plate with leveling screws. The steel lathe-bed style optical bench is equipped with four riders, and the support rods for the optical elements carry height setting collars for easy fine alignment.

A CCD video camera with a mounting rod, power supply and PCI video capture card are supplied for direct live observation of the interference fringes. This makes measurement of fringe shifts on the computer monitor much easier than by visual observation using a conventional telescope arrangement.

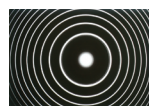
**Video capture and image analysis software** is included in the equipment set. The software provides a live image of the Fabry-Pérot fringe pattern to easily view the fringe splitting as the magnetic field is increased, and to verify the polarization states of the lines. Additionally, images can be captured and stored for later analysis. The analysis module allows circles to be drawn on the image to exactly coincide with the positions of the fringes. To reduce image noise and improve positioning accuracy, a grayscale filter can be applied to the image before analysis. The software records the positions and radii of the circles drawn and, after circles have been added for all of the components of three successive fringes, calculates the wavelength shift for correlation with the magnetic field strength.



The étalon generates an interference pattern of concentric rings which is observed by a video camera.



Interference patterns are observed when the Zeeman apparatus is connected to a computer.



The initial appearance of the pattern with no imposed magnetic field.



This pattern shows the full range of Zeeman-split lines emitted in the transverse direction.



Triple fringes are strong  $\pi$ -polarized components that are used for measurement.



Fringes arising from the  $\sigma$ -polarized components are noticeably less intense.

### Specifications

#### Lamp and Magnet:

Low pressure mercury discharge lamp, approx. 6mm diameter x 60mm long

Electromagnet with power supply in base, swivels 90° for transverse or longitudinal viewing

Current: 0, 0.3—2A

Field strength: 1 T (max)

Includes removable steel rod in one pole piece and plug-in quarter-wave plate

**Dimensions:** 14cm x 29cm x 35cm

**Power:** 110 VAC

**Weight:** 43 kg.

#### Optical system:

Diameter of optical elements: 40mm

Interference filter: Central wavelength: 546.1nm  
Transmission bandwidth: < 10nm

#### Fabry-Perot etalon:

Quartz mirror plates with 2.0mm spacing  
Central wavelength: 589.3nm  
Resolution ( $\lambda/\delta\lambda$ ):  $>2 \times 10^6$   
High reflection bandwidth: 100nm

#### Computer and software requirements:

Requires a Windows-based computer with one available PCI slot running Windows 7 or 8, with at least 64MB of RAM and up to 1GB of hard disk space (for storing images)

Item No.	Description
ZEAA01	Zeeman Effect Apparatus



## Nuclear Magnetic Resonance Apparatus



- Demonstrate the basic phenomena of nuclear magnetic resonance
- Measure the nuclear magnetic moments of hydrogen and fluorine
- Determine gyromagnetic ratios

The NMR Apparatus is a set of equipment for introducing students to the basic phenomena of nuclear magnetic resonance using the CW (continuous wave) technique. It allows the hydrogen proton resonance to be observed in six different chemical environments. A fluoride sample also permits the fluorine resonance to be observed and compared to the hydrogen values.

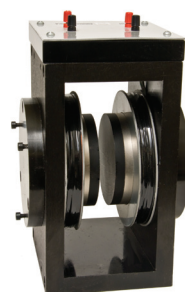
Further investigations allow the nuclear magnetic moments of the hydrogen proton and the fluorine nucleus to be measured, and the use of NMR for the precise determination of magnetic fields to be demonstrated. If a gaussmeter is available, values for the gyromagnetic ratios of hydrogen and fluorine can be independently determined.

The apparatus set includes a large permanent magnet with flat pole pieces and soft iron pads. The field strength at the center of the gap is about 0.5T. The exact value is marked on each unit. Helmholtz coils surround the pole pieces. A scan control unit supplies an adjustable AC signal to the Helmholtz coils to scan the "fixed" magnetic field over a narrow range.

The samples, contained in small plastic vials, are placed inside the coil of an RF boundary oscillator. The coil is mounted in the end of a long shielded tube positioned at the center of the permanent magnet's air gap.

An oscillator control unit carries coarse and fine frequency adjustments and produces an RF signal of very high frequency stability, which is measured by an included frequency counter. At a certain RF frequency determined by the nuclear species present in the sample and the strength of the fixed magnetic field, the magnetic moments of the nuclei in the sample resonate with the fields and absorb energy from the RF oscillator by quantum transitions of the nuclear magnetic moment. This causes a large change of the oscillator's amplitude, which can be observed on a user-supplied oscilloscope.

Five aqueous samples are included: copper sulfate, ferric chloride, hydrofluoric acid, pure water, and manganese sulfate. A glycerin sample is also provided.



The permanent magnet generates a homogeneous field of approximately 0.5 T and is equipped with a pair of 300-turn scan coils in approximate Helmholtz arrangement.



The oscillator control unit carries coarse and fine frequency adjustments and produces an RF signal of very high frequency stability.



The scan control unit supplies an adjustable AC signal to the Helmholtz coils to scan the fixed magnetic field through a narrow range.

### Specifications

- Magnet module:** Permanent magnet with flat soft iron pole pads, air gap 16.5mm  
Field strength: Approximately 0.5 T, exact value marked on magnet  
Field uniformity: Better than 0.1% over central region  
Scan coils: Helmholtz arrangement, 300 turns each, 0.15mA—200mA  
Dimensions: 18 x 15 x 26cm  
Weight: 24.7 kg
- Scan Control Unit:** Provides power to the scan coils and oscillator unit, provides scan output to the oscilloscope with amplitude and phase adjustment.  
Scan frequency: 60 Hz.  
Oscilloscope output: Amplitude 0—19Vp-p  
Phase adjustment  $\pm 90^\circ$ .  
Power: 115 VAC/60 Hz  
Dimensions: 24.5 x 12 x 20cm  
Weight: 2.3 kg
- Oscillator Unit:** RF boundary oscillator with probe coil, range 15.8 MHz—24.6 MHz  
Dimensions: 24.5 x 21 x 10.5cm
- Weights:** Oscillator unit: 2.3 kg, probe: 113 g

Item No.	Description
NMRA01	Nuclear Magnetic Resonance Apparatus





## Force Between Conductors Demonstrator



- **Convincing demonstration of a basic electromagnetic phenomenon**
- **Enclosed power supply and momentary switch for safety**
- **Simple, clear arrangement of the electric circuit**

A basic property of electromagnetism is the mechanical force that exists between two neighboring, current-carrying conductors. However, observing the small force with simple conductors requires large currents.

The Force Between Conductors Demonstrator offers a simple, direct method for accomplishing this usually difficult and often unsatisfying demonstration. The device consists of a metal frame that supports two long straight conductors that can pivot about vertical axes. The base of the frame contains a power supply to energize the conductors.

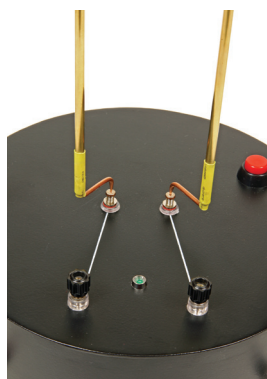
Voltage can be applied to the conductors in various configurations – series or parallel, same sense or opposite sense – by connecting the supplied heavy-duty cords to the appropriate binding posts. Two adjustable indicator arrows show the direction of the current in each conductor.

After the connections are made, a pushbutton applies the voltage, allowing a large current to flow momentarily in the conductors. The conductors swing either towards each other or apart, and their movement indicates the generation of a magnetic force between them and its direction.

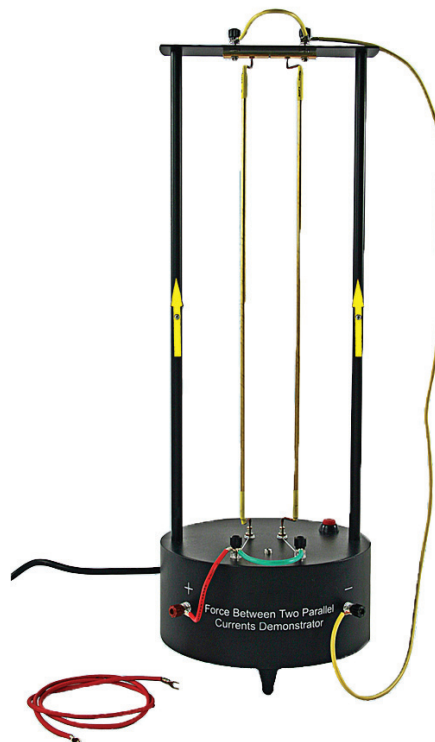
### Specifications

<b>Conductors:</b>	Thin wall brass tubes with copper end pieces. Length: 39.5cm; lever arm: 2.5cm Cold resistance (each): approx. $0.013\Omega$
<b>Power supply:</b>	Input: 110VAC/60 Hz, 345W (max., operate for < 5 seconds) Output: Operating voltage 0.5—1.5 V  Approx. operating currents: 55A in series, 2 x 37A in parallel  Fuse: Miniature fuse, 250V/3A
<b>Dimensions:</b>	Height: 56.5cm Base diameter 19cm Weight: 4.25 kg

Item No.	Description
FBCD01	Force Between Conductors Demonstrator



Pointed ends of the conductors fit into dimples in the top and bottom bearing contacts.



Force Between Conductors Demonstrator shown with parallel connection yielding currents traveling upward.



Force Between Conductors Demonstrator shown with anti-parallel connection yielding currents traveling clockwise.

## Cavendish Gravitational Balance



- Demonstrates the existence of gravitational forces between masses
- Measures the Universal Gravitational Constant,  $G$
- Verifies the Inverse Square Law for gravitational forces

**This innovative apparatus**, developed from the traditional Cavendish pattern, is substantially less expensive than earlier models, making the measurement of the tiny but significant Universal Gravitational Constant more accessible to students. It is precisely constructed and allows measurements of  $G$  to be made to better than 15% relative error using either the initial acceleration method or the equilibrium displacement method.

**In the initial acceleration method**, the value of  $G$  is derived from the angular acceleration of the balance during the first 90 seconds after moving the large attracting lead spheres mounted on the swivel from one side of the apparatus to the other (see diagram).

**The equilibrium displacement method** derives  $G$  from the change in the equilibrium rest position of the balance after a reversal of the position of large attracting spheres from one side to the other. This yields a more accurate result, but takes much longer to accomplish because of the long period of the balance (about 10 minutes) and the tiny forces involved. The built-in oil damping system reduces the settling time of the balance by more than 100%, to approximately one hour.

**The pendulum system** consists essentially of a suspended central rod carrying a small mirror for the optical lever detection system, a light aluminum cross-piece with two 20g lead balls 10cm apart, and a light damping vane. The suspension wire is a very fine beryllium bronze torsion wire that is 15cm long. This configuration gives the pendulum a torsional period of  $590 \pm 10$  seconds.

**The system is mounted in a massive aluminum case**, 25mm thick, with glass windows to eliminate drafts. An adjustment screw with an angle scale at the top of the housing allows the pendulum's rest position to be centered before adding the attracting masses. A supplied magnet uses the diamagnetic properties of lead to speed the settling process when centering. A fork operated by an outside screw secures the pendulum against the housing to protect the sensitive suspension during transportation. Damping oil is added to the internal system from an outside glass reservoir. Silicone damping oil is supplied.

**The large attracting masses** are two 1.5 kg plastic-coated lead balls that rest atop light aluminum cylinders. The cylinders fit onto a swivel that enables the balls to be swung from one side to the other of the apparatus. They can also be placed onto two circular sliding mounts on the base that allow the distance between the pendulum and the attracting masses to be varied for Inverse Square Law investigations. The base rests on three leveling feet. The unit operates on 110V/60 Hz.

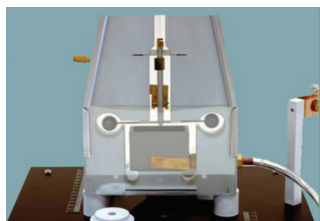
**Overall dimensions** are 30 x 30 x 42cm; weight is 12 kg.

### Accessories needed:

- Laser pointer, scale and windup tape for the optical lever
- Balance (2000g capacity) and vernier caliper to determine the exact masses and diameters of the lead balls
- Stopwatch for timing the oscillation in the initial acceleration method



Scan to view demonstration video



The innovative pendulum system uses a central rod carrying a small mirror.

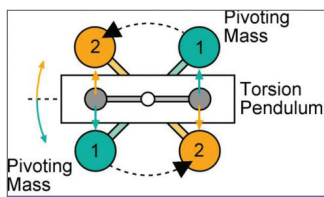
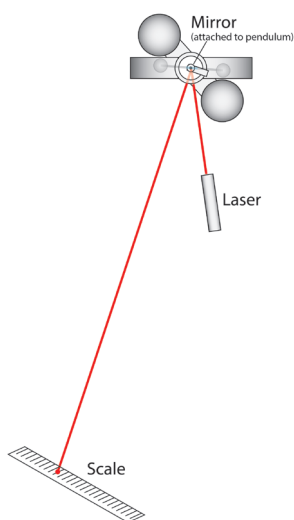


Illustration shows the equilibrium displacement method.



Optical lever arrangement for Cavendish Balance.

Item No.	Description
CGB001	Cavendish Gravitational Balance



## Foucault's Pendulum Apparatus



- **Precise Demonstration Model Shows Earth's Rotation**
- **Electrically Maintained — Needs no Attention**
- **Ideal Display Item for Science Rooms, Foyers, and Museums**

**Léon Foucault's** famous 1851 experiment in the Panthéon in Paris used a 27 kg pendulum bob suspended on a 67m wire to demonstrate that the pendulum's plane of swing precessed with the rotation of the Earth. This was the first direct dynamic evidence that the Earth rotates about a polar axis, and the phenomenon has been a popular topic of discussion ever since.

The precession of Foucault's pendulum is often poorly explained. At the Earth's poles, the plane of the swing remains constant relative to the fixed stars and appears to an Earth-based observer to rotate once every sidereal day. At the equator, the plane of swing co-rotates with the Earth and the pendulum does not appear to precess. At other latitudes, the behavior is intermediate between these extremes and the pendulum precesses with respect to both the Earth and the fixed stars. At 30°, the apparent precession takes two days. If the motion is analyzed using a co-rotating coordinate system, then the force causing the precession is just the Coriolis force experienced by the moving bob.

**This Foucault's Pendulum Apparatus** is a carefully constructed miniature version of Foucault's device. Since the forces causing the precession are small, the effect is easily disturbed by other small environmental forces. To eliminate drafts, the pendulum is enclosed in a glass case, and the heavy vibration-damping base is equipped with leveling feet. The pendulum is electrically maintained to counter air resistance damping, and the swing amplitude can be adjusted using a potentiometer.

**The suspension device** ensures accurate centering of the pendulum's rest position over the graduated circle below the bob.

**The graduated circle** carries an adjustable, double-ended marker bar for precise measurement of the plane of swing when tracking the precession rate.

**The durable steel case** is attractively finished, suitable for permanent display, with a plaque carrying a brief description of Foucault's experiment.

### Specifications

**Overall dimensions** are 16" x 16" x 57" high; weight is 110 lb.

Requires 110VAC.



Scan to view  
demonstration video



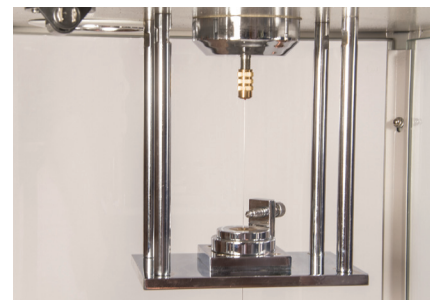
Item No.	Description
FCPN01	Foucault's Pendulum Apparatus



The durable steel case includes a plaque with a brief description of Foucault's experiment.



The graduated circle carries an adjustable double-ended marker bar for precise measurement of the plane of swing.



The suspension device ensures accurate centering of the pendulum's rest position.





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