

Mechanics System 1

4861.19

An introductory system to study basic mechanics

Our high quality Mechanics System 1 comes in a heavy duty carry-case for ease of storage.

Simple to set-up with all components easily accessible. The system consists of: balance, inclined plane, friction block, weights, simple machines, pulleys, levers, springs and scales. A variety of experiments can be carried out using this kit.

Specifications

Size: 50x45x15 cm – Weight: 7,4 kg
Track Length 60 cm - Weight: 1,20 kg
Packing: external suitcase in aluminium, internal foam for prevention accidental breakage.

Equipment suggested

Electronic Balance (code 2219.30)
Dual Range Force Sensor (code 2311.10)
Motion Detector (code 2310.10)
or Go!Motion (code 2320.10)
LabPro (code 2300.10)
or LabQuest (code 2300.30)
or Go!Link (code 2320.30)



MAIN COMPONENTS

- Sectional universal base with 3 knobs
- Pulley with hook
- Plastic Pulley, with metal rod
- Scale pan hooked, with metal suspension
- Friction block
- Tubular Spring Balance (Metal) 3N, 6N, 10N
- Lever, Holed Rod, with pair of threaded cylinders
- Double Side Scale, silk screen printed
- Inclined plane, with 3 different track terminals
- Spring leaves
- Extension Clamp with Rod
- Cart for Inclined Plane
- Differential pulleys
- Goniometric Circle
- Tape Measure
- Vernier caliper, scale 0÷160 mm, accuracy 0.05 mm
- Cylindrical mass 10 g, 25 g, 50 g
- Mass 1g, 2g, 5g, 10g, 20g, 50g, 100g
- Flat mass 300 mg, 500 mg
- Steel spring with pointer
- Hook for Cart
- Rod with clip
- Red pointer with clip
- Suspension ring
- Axle with fixing screw for differential pulley
- Metal bossheads
- Bossheads
- Mass hanger with slotted masses



EXPERIMENTS DETAILED IN THE MANUAL

- Belt drive systems
- Composition, decomposition and transmission of forces including the parallelogram law
- Analytical balance and the investigation of weight as a force
- Levers: including first, second and third class type
- Pulley systems: including fixed, mobile and differential pulleys
- Simple pendulum and spring pendulum
- Hooke's Law with spring and with spring leaf
- Inclined plane and friction
- Kinetic and potential energy
- The concept of experimental error
- Springs in series and in parallel

PHYSICS SYSTEM

Mechanics



LAWS AND PRINCIPLES INVESTIGATED

- Balance oscillation measurements
- Balance sensitivity
- Belt wheel drive
- Composition and decomposition of forces
- Concurrent forces
- Decomposition of a force into its components
- Determination of the acceleration due to gravity by means of the simple pendulum
- Elongation of a leaf spring
- Elongation of a spring
- First-class levers
- Fixed pulley
- Hooke's Law
- Inclined plane
- Investigation of an oscillation of a simple pendulum
- Measurement of length
- Mobile and fixed pulley
- Momentum of a force
- Parallelogram of forces
- Second and third-class levers
- Static and dynamic friction
- Spring pendulum
- Springs in series and parallel
- Static measurement of a force
- The concept of kinetic energy
- The concept of potential energy
- Transmission of a force along a cable
- Weight as a force

• Many of these experiments will also be suitable for applied mathematics.



Assembled analytical balance

Full set of basic measuring instruments



General hardware for experiments

EXAMPLE OF USE

Analytical Balance

In-depth investigation of the analytical balance

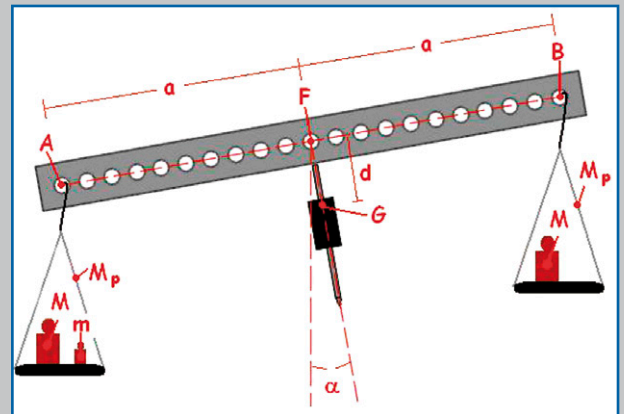
The balance is an instrument that allows, in a gravitational field, to measure the unknown masses by comparison with sample masses. One sample experiment is the determination of the sensitivity of a balance which has arms of equal length. The more sensitive a balance is, the smaller the variation in a mass (m) the balance can detect and measure. If the test mass (m) is lesser in magnitude than the sensitivity of the balance, it will not be detected. With reference to the diagram, if load a test mass (M) on each pan of the balance and assuming that the distance between each of the pans is equidistant and represented by " a ", we can vary weight on one of the pans which will result in a displacement through an angle defined by α .

$$\sigma = \frac{a}{m}$$

Formula defining balance sensitivity

Therefore, we can see that the sensitivity of a balance depends on several design characteristics as well as the patience of

the experimenter. For example, the more stable the design of a balance, the more mass is needed to move the balance noticeably. Additionally, the more friction at the locations where movement is required, the less sensitive the balance will be.



Schematic of analytical balance

Inclined plane with cart, pulleys, friction block and scale pans



Accessory box with part of its contents

PHYSICS SYSTEM

Mechanics

Mechanics System 2

4861.29

An advanced low friction dynamics system to study elastic and inelastic collisions between carts

The Mechanics System 2 allows us to verify many kinematics and dynamics principles by using a low friction system.

The basic theory involves topics such as Newton's Laws of Motion, Conservation of Energy and Momentum, Friction and many others.



◀ Mechanics system 2

Specifications

Size: 50x45x15 cm - Weight: approx. 8 kg
Track Length 117 cm - Weight 2,40 kg
Packing: external suitcase in aluminium, internal foam to prevent accidental shock

Equipment suggested

Electronic Balance (code 2219.30)
Motion Detector (code 2310.10)
or Go!Motion (code 2320.10)
LabPro (code 2300.10)
or LabQuest (code 2300.30)
or Go!Link (code 2320.30)

MAIN COMPONENTS

- Aluminium Track
- Electronic Timer
- Cart
- Reflection Photogate
- Release Electromagnet
- Brake/Bumper for Cart
- Fixed Support for Track
- Adjustable Support for Track
- Pulley with metal rod
- Aluminium Flag for Cart
- Bubble Level
- Neodymium-Iron-Boron Button Magnet
- Massholder for Cart
- Slotted Masses Set
- Plumb Line on Scale
- Spring Bumper
- Spring Bumper for Electromagnet
- Trigger for Cart
- Pair of Velcro Bumpers
- Hook for Cart



▲ Contents of accessories boxes



▲ Electronic timer with electromagnet and photogates

LAWS AND PRINCIPLES INVESTIGATED

- Conservation of momentum and energy
- Acceleration and velocity
- Eddy currents
- Elastic and inelastic collisions
- Friction
- Law of Inertia
- Kinetic and potential energy
- Newton's 1st Law
- Newton's 2nd Law
- Rectilinear uniform motion
- Rolling friction
- Uniform accelerated rectilinear motion

EXPERIMENTS DETAILED IN THE MANUAL

- Concept of inertia
- Conservation of momentum and energy
- Determination of velocity and acceleration
- Laws of dynamic
- Elastic and inelastic collisions
- Energy conservation
- Inclined plane
- Kinetic and potential energy
- Laws of motion (accelerated, linear uniform)
- Rolling friction
- Eddy currents in an aluminium track

PHYSICS SYSTEM

Mechanics

► EXAMPLE OF USE

Impulse – momentum theorem • Experimental verification of the theorem

Using the Altay Mechanics System 2 we can induce a collision between two carts.

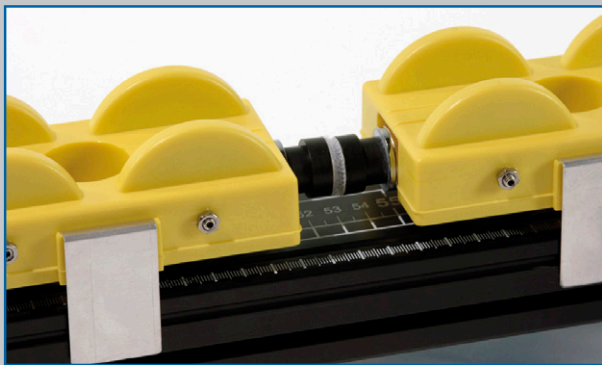
The carts experience a force for a given amount of time, resulting in its mass undergoing a change in velocity. Another way of expressing this is to say that this results in a change of momentum.

There are four physical quantities which can be investigated: force, time, mass and velocity change. The force multiplied by the time is known as the impulse and the mass multiplied by the velocity change is known as the change in momentum. The impulse experienced by the cart is always equal to the change in its momentum. This can be approximated as follows:

$$F \Delta t = m \Delta v$$

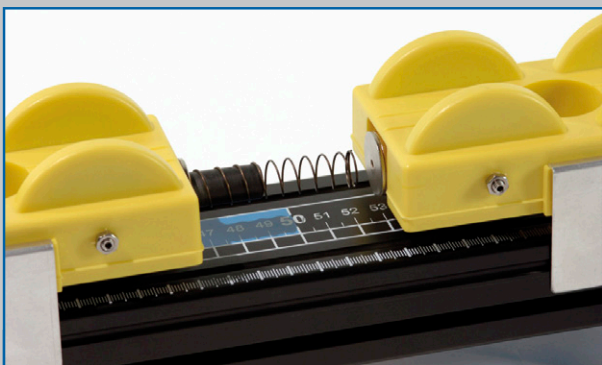
◀ Impulse – momentum theorem

Further examples of workable experiments



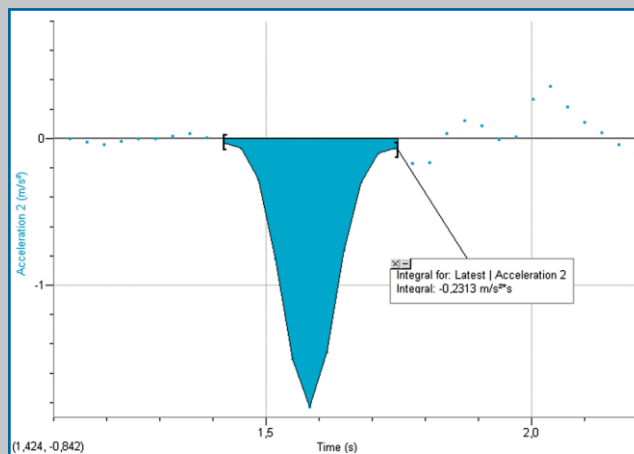
▲ Inelastic collision between two carts

▼ Elastic collision between two carts

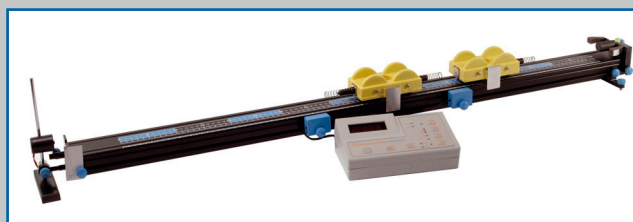


▲ An example of how to assemble the experiment

The area enclosed by the curve represents the rate of change of momentum.

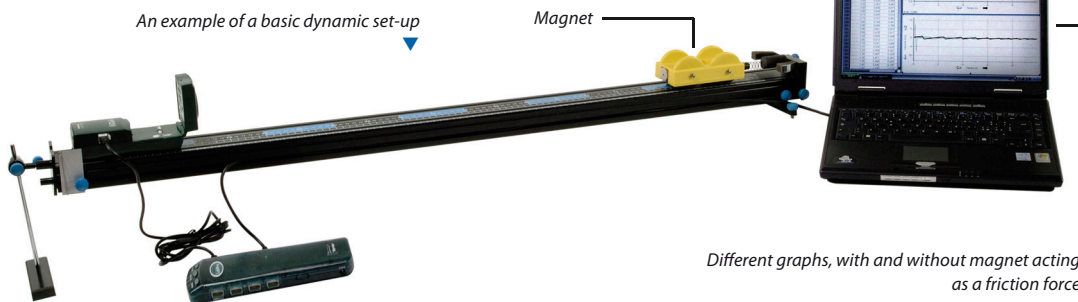


▲ Experimental data acquired with a datalogger



▲ Setup for study different types of collisions

An example of a basic dynamic set-up ▼



Different graphs, with and without magnet acting as a friction force

Mechanics System 3

4861.39

A basic introductory mechanics system for mechanics of fluids



◀ Mechanics system 3 case 1, hardware case

▶ Mechanics system 3 case 2, glassware case



Mechanics System 3 introduces the basic concepts of fluid dynamics.

The system provides a useful framework to understand and study quantitatively many fluid dynamics experiments.



◀ Hardware case content



MAIN COMPONENTS

- | | | |
|----------------------------|------------------------------|-------------------------|
| • Universal base | • Air Blower | • Communicating Vessels |
| • Bosshead | • Pascal Apparatus Ball | • Capillary Tubes |
| • Swivel bosshead | • Viscosity Tube | • Drying Tube |
| • Extension Clamp with Rod | • Mariotte's Bottle | • Force Pump |
| • G Clamp | • Tube for Mariotte's Bottle | • Hare's apparatus |
| • U-Tube manometer | • Cartesian Diver | • Venturi's tube |

PHYSICS SYSTEM

Mechanics



LAWS AND PRINCIPLES INVESTIGATED

- Adhesion and cohesion
- Archimedes' principle
- Bernoulli's theorem
- Boyle's Law
- Buoyant force
- Capillarity
- Cartesian diver
- Communicating vessels
- Density of a solid body
- Density of two immiscible liquids
- Drag coefficient
- Force pump
- Hagen-Poiseuille Law
- Hare's apparatus
- Hydraulic brake
- Hydrostatic pressure
- Jurin's Law
- Mariotte's bottle
- Ostwald viscometer
- Pascal's Law
- Perfect gas Law
- Relative density of two non-mixable fluids
- Reynold's number
- Siphon
- Stevino's Law
- Stoke's formula
- Surface tension
- Terminal velocity
- The Archimedes' principle
- The Gamow, Oppenheimer, Bloch puzzle
- Torricelli's theorem
- U-tube manometer
- Venturi tube



EXPERIMENTS DETAILED IN THE MANUAL

- Principles of the manometer
- Communicating vessels
- Hydrostatic pressure and Pascal's Law
- Stevino's Law
- Archimedes' Law
- Bernoulli's equation
- Torricelli's theorem
- Determination of the volume of a solid body
- Determination of density and of specific weight of a solid body
- Determination of density of immiscible liquids
- Capillarity
- Boyle's Law
- Pumps and siphons
- Adhesion and cohesion
- Cartesian diver
- Measurement of surface tension
- Viscosity



▲ Force pump, capillary tubes, communicating vessels, Venturi's tube and Ostwald viscometer.



▲ Mariotte's bottle, cartesian diver, Hare's apparatus

EXAMPLE OF USE

Hare's apparatus • Find the relative density of a liquid

Hare's apparatus consists of an inverted U-Tube immersed in two vessels of fluid.

One vessel is filled with water and the other with a fluid of unknown density.

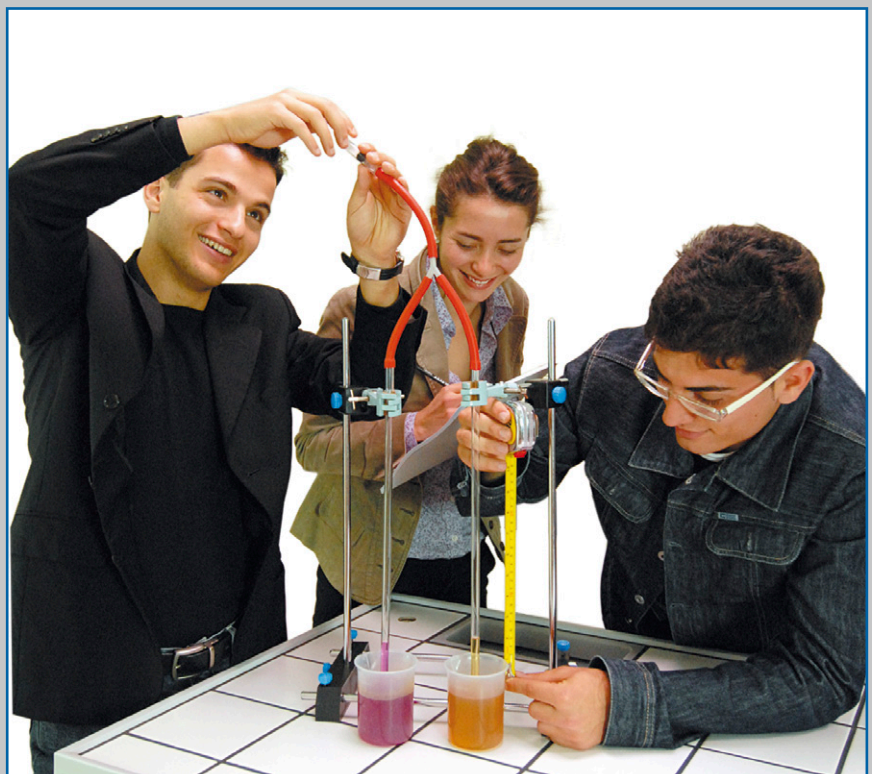
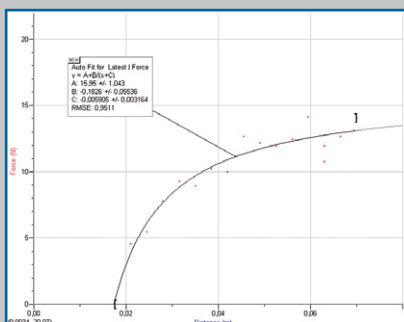
By pinching the tube at any point higher than the Y Piece, you will notice both liquids rise to a certain height in each tube.

Therefore, when air is removed from the top of the apparatus, the liquids rise in the tubes to heights which are inversely proportional to their densities.

Therefore, Hare's apparatus is used to compare the density of two liquids.

$$\frac{\rho'}{\rho''} = \frac{h''}{h'}$$

Formula of the relative density of a liquid with respect to another



▲ Students acquiring data from Hare's apparatus

▲ Pressure force graph vs. syringe piston position

PHYSICS SYSTEM

Thermodynamics

Heat System

4862.19

Study thermology with this compact and easy to use system

Specifications

Size: 75x55x20 cm- Weight: approx. 12 kg

Packing: durable aluminum carry case with foam inserts

Equipment needed

Methane/Butane Cylinder

Power Supply 10 A (code 2407.75)

Equipment suggested

Stainless Steel Temperature Probe
(code 2314.20)

or Thermocouple (code 2314.10)

Go!Temp (code 2320.20)

Gas Pressure Sensor (code 2311.40)

LabPro (code 2300.10)

or LabQuest (code 2300.30)

or Go!Link (code 2320.30)



◀ Heat system in case



MAIN COMPONENTS

- Universal base
- Bosshead
- Swivel bosshead
- Digital multimeter
- Thermocouple
- Beakers
- Cylinder graduated
- Centrifuge Tube
- Filtering Flask
- Drying Tube
- Extension clamp with rod
- Alcohol thermometer, range: $-10^{\circ}\text{C}/+110^{\circ}\text{C} \times 1^{\circ}\text{C}$
- Calorimeter
- Joule's law unit
- U-shaped rods
- Specific heat cylinders
- Bunsen Burner
- Micrometer Dial Gauge
- Pulse glass
- Food Coloring
- Bimetallic strip with electric contact

This system introduces basic concepts of thermodynamics and heat experiments.

It provides a framework for understanding and quantitatively assessing introductory thermo-dynamics questions and problems.

▼ Hardware components for experiments

Calorimeter with Joule's Law Apparatus ▼



PHYSICS SYSTEM

Thermodynamics



LAWS AND PRINCIPLES INVESTIGATED

- Thermal radiation
- Boiling and condensation
- Calorimeter and Joule's Law
- Dalton's Law of Partial Pressures
- Equilibrium temperature of mixed liquids
- Evaporation of two different liquids
- Expansion of ice
- Thermometer's time constant and fixed points of a thermometer
- Fourier's Equation and Fourier's Law
- Heat sensitivity and Locke's Law
- Linear expansion of a solid
- Wet and dry bulb hygrometer, relative humidity, psychrometry and moisture content
- Newton's Law of Heating or Cooling
- Phase transition
- Pulse glass functioning principle
- Saturated and supersaturated solutions
- Different solution phenomena at different temperatures
- Specific Heat
- Thermal agitation, conduction and expansion
- Thermostat and thermocouple
- Peltier-Seebeck effect



▲ In holding a pulse glass in your hand, you can observe some surprising phenomena and experience the effects of Thermal Energy



EXPERIMENTS DETAILED IN THE MANUAL

- Heat sensitivity and thermal equilibrium
- Measurement of the coefficient of volume expansion of water
- Fixed points of a thermometer
- Temperature measurement with a T type thermocouple
- Linear expansion of a solid
- Coefficient of expansions of iron and brass
- Example of the use of a thermostat
- Measurement of the boiling point of alcohol
- Boiling at below and above atmospheric pressure
- Measurement of the heat of evaporation
- of water
- The graph for the solidification of paraffin
- Saturated and supersaturated solutions
- Wet and dry bulb hygrometer
- Expansion of air at constant pressure and volume
- Thermal convection in fluids
- Thermal conductivity of iron, brass, aluminium and copper
- Conduction of heat by water
- Absorption of thermal radiation
- Thermal insulation
- Construction of a simple Dewar vessel
- Heating different quantities of liquid
- Specific heat capacity of liquids and solid bodies
- Equilibrium temperature of mixed liquids
- Heat capacity of the calorimeter
- Conversion of mechanical energy into thermal energy
- Joule's effect
- Expansion of ice
- Latent heat of fusion of ice
- Latent heat of vaporisation of water
- Evaporation of two different liquids
- Boiling point elevation



▲ Centrifuge tube, beakers, filtering flask and graduated cylinder

▶ EXAMPLE OF USE

Wet and dry bulb hygrometer

The basics concepts of psychrometry can be demonstrated in this experiments

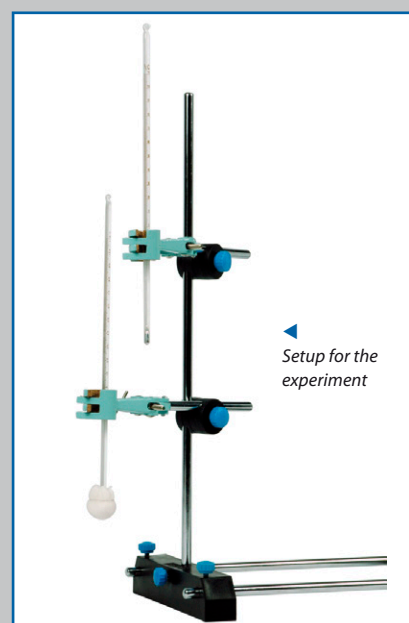
The amount of water vapour in the air at any given time is usually less than that is required to saturate the air. The relative humidity is the percent of saturation humidity, generally calculated in relation to saturated vapour density.

The psychrometer or Wet & Dry bulb hygrometer is an important instrument used for measuring the water vapour content (Relative Humidity) per unit of air at a given temperature. The instrument is made up of two identical thermometers: one being a wet bulb, the other a dry bulb.

The wet bulb thermometer has its bulb wrapped in a tight fitting wicking material such as cotton, which is soaked in distilled water. When the thermometers are ventilated, the wet bulb temperature will be lower than the dry bulb temperature.

$$\text{Relative humidity} = \frac{\text{Actual vapour density}}{\text{Saturation vapour density}} \times 100 \%$$

▲ Relative humidity definition formula



Optics System 1

4864.19

A complete system to study the principal laws of geometric optics

Specifications

Size: 50x45x15 cm - Weight: 7 kg
Track Length: 102 cm - Weight: 1,2 kg
Packing: durable Aluminium carry case with foam inserts

Equipment suggested

Light Sensor (code 2315.10)
LabPro (code 2300.10)
or LabQuest (code 2300.30)
or Go!Link (code 2320.30)

The Optics System 1 can be used for the study of many aspects of geometric optics, including photometry, luminous intensity, focal length of a lens and many other experiments.

Optics system 1



▲ Set of lens – mirror holder

▼ Set of mirrors, lenses and prism holder



MAIN COMPONENTS

- Lampholder, single
- Lampholder, quadruple
- Transformer
- Prism table
- Projector with halogen lamp
- White metal screen
- Set of 4 Biconvex Spherical lenses
- Set of 4 Biconcave Spherical lenses
- Set of 4 Concave Spherical mirrors
- Set of 4 Convex Spherical mirrors
- Optical bench with supports
- Shadow rod
- Joly photometer on stem
- Set of diaphragms
- Equilateral glass prism



LAWS AND PRINCIPLES INVESTIGATED

- Concave and convex mirror
- Convergent and divergent lens
- Focal length
- Gauss approximation
- The eye, hyperopic and myopic eye
- Inverse square law
- Joly photometer
- Lens power
- Luminous intensity
- Magnifier and magnifying power
- Photometry
- Prism
- Ray tracing
- Refractive index
- Umbra and penumbra
- System of lenses
- The microscope
- The telescope
- Thin lens equation



EXPERIMENTS DETAILED IN THE INSTRUCTION MANUAL

- Photometry
- Luminous intensity
- Shadow and penumbra
- Magnifier
- Lenses
- Mirrors
- Thin lens equation
- Focal length
- System of lenses
- Prism
- The eye
- Microscope
- Telescope

A complete set of diaphragms



General hardware of the system



EXAMPLE OF USE

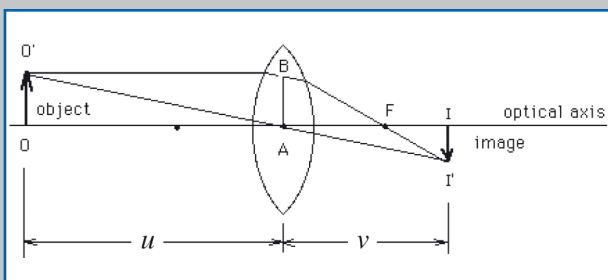
Focal length of a converging lens • How to find the exact focal length of a converging lens

If the converging lens has a focal length such that the system of the converging plus diverging lenses is still converging, it is possible to recover the focal length of the system by using the thin lens equation (valid in the "Gauss approximation").

$$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$

Thin lens equation: u is the object distance, v is the image distance and f is the focal length

Schematic view of symbols and sign



Assembly for the determination of the focal length of a converging lens

Optics System 2

4864.29

An intermediate system for geometrical and physical optics

Specifications

Size: 50x45x15 cm - Weight: 6,5 kg
Track Length: 61 cm - Weight: 0,70 kg
Packing: durable Aluminium carry case with foam inserts

Equipment needed

Dextrose

Equipment suggested

Light Sensor (code 2315.10)
LabPro (code 2300.10)
or LabQuest (code 2300.30)
or Go!Link (code 2320.30)

Optics system 2

The Optics System 2 is designed to study composition of light, light polarization, refraction index as well as many additional aspects of light reflection and refraction.

The system contains a Hartl apparatus, which allows the student to perform many experiments related to the reflection of light on mirrors and to the refraction through transparent bodies.

Also included is our specially designed Altay Optics Box, designed to investigate polarisation in various solutions. Additionally you can study photoresistance, photometry and verification of Malus' Law.



MAIN COMPONENTS

- Hartl Disk
- Optical Bench
- Universal Base with knob
- Biconvex Lens for Hartl Disk
- Biconcave Lens for Hartl Disk
- Trapezoidal Prism for Hartl Disk
- Triangular Prism for Hartl Disk
- Deformable Mirror for Hartl Disk
- Plane Mirror for Hartl Disk
- Refraction Index Vessel for Hartl Disk
- Polarization Tank
- Pair of polarizing filter
- Photometer
- Transformer
- Ray optics and colour mixing box with lamp, coloured filters, slits, mirrors
- White metal screen



Pair of polarising filters, photometer, screen and plexiglas cylinder with support



Ray box with coloured filters, slits, two side parts with mirror and transformer



Lens set with flexible mirror and Hartl disk

PHYSICS SYSTEM

Optics



LAWS AND PRINCIPLES INVESTIGATED

- Principles of bi-concave, bi-convex lenses and mirrors
- Mixing colours
- Fermat's principle
- Determine the focal length of a lens
- Hartl apparatus
- Inverse square law of light
- Light reflection and refraction
- Malus' Law
- Photometry
- Prism
- Refraction index of a glass and a liquid
- Rotation of light
- Snell's Law
- Total reflection



EXPERIMENTS DETAILED IN THE MANUAL

- Light reflection of a plane mirror and flexible mirror
- Light refraction in a prism and through a converging or a diverging lens
- Light refraction through different shaped materials
- Refraction index of a liquid and glass
- Polarisation of light
- Total refraction prism
- Rotation of the polarisation plane in a sugar solution
- Investigating mixing of colours
- Focal length of a lens
- Malus' Law
- Investigations in quantitative photometry



▲ Using data logging system with light sensor.

EXAMPLE OF USE

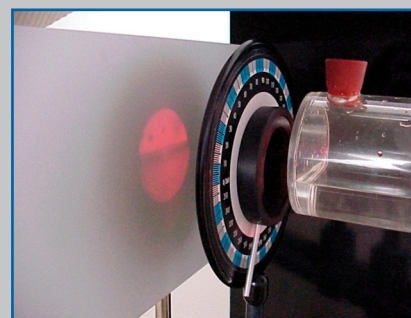
Optical activity • Observe the rotation of light using a sugar solution

Some substances such as sugar will react when a beam of light is incident on it. They rotate the polarisation plane of the light around its direction of propagation.

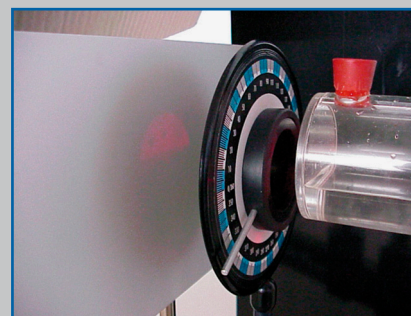
This optical activity is a phenomenon connected with the "asymmetry by reflection" of the molecules of many substances. The degree of rotation is determined by the rotational power of the optically active solution present and by the amount of molecules of the solution that interact with the beam of light. The directional change of the light is also affected by degree of concentration of the solution and distance the light must travel through it. Other features such as temperature and wavelength of light are also important.



▲ Optics system 2 experimental setup to show rotation of light using a sugar solution



▲ For a given angle, all the polarised light is collected on the screen



▲ The angle is adjusted until all light is blocked out

$$P_{\lambda}^T = \frac{\theta}{Lc}$$

The above formula defines the specific rotatory power of a substance at a given temperature and wavelength.

Optics System 3

4864.39

An advanced optics system with diode laser



▲ Optics system 3 in its own box

Specifications

Size: 30x25x10 cm - Weight: 1,5 kg

Packing: comes with a durable Aluminium carry case with foam inserts

Equipment needed

Vernier Caliper (code 2213.10)

Tape Measure (code 2211.10)

The Optics System 3 includes everything needed for a complete course in advanced optics.

Our system will take students through reflection, lens theory, diffraction, interference, diffraction grating and multiple slit diffraction.

You can also study many aspects of modern optical technology.

The equipment is easy to use and durable, and the experiments are substantive, yet conceptually easy to conduct.

Areas of study including geometric principles of optics, polarisation of laser beams, investigating basic and study advanced diffraction principles. The results will be accurate and repeatable every time!



MAIN COMPONENTS

- Laser on stem
- Cylindrical lens
- Polaroid filter
- Slide with 1 slit (width 0.06 mm, separation 0.20 mm)
- Slide with 2 slit (width 0.06 mm, separation 0.20 mm)
- Slide with 3 slit (width 0.06 mm, separation 0.20 mm)
- Slide with 4 slit (width 0.06 mm, separation 0.20 mm)
- Slide with 5 slit (width 0.06 mm, separation 0.20 mm)
- Slide with 6 slit (width 0.06 mm, separation 0.20 mm)
- Coarse grating 1 (4 lines per mm, line/space ratio 3:1)
- Coarse grating 2 (4 lines per mm, line/space ratio 6:1)
- Coarse grating 3 (8 lines per mm, line/space ratio 3:1)
- Metal gauze 300 mesh for bidimensional diffraction grating
- Diffraction grating with three different rulings (100, 300 and 600 lines per mm)



◀ Grating on plastic holder



▶ Multiple diffraction grating mounted on holder



PHYSICS SYSTEM

Optics



Solid state laser with cylindrical lens and polariser



LAWS AND PRINCIPLES INVESTIGATED

- Diffraction
- Diffraction grating
- Interference
- Multiple slit diffraction
- Optical activity
- Single slit diffraction



EXPERIMENTS DETAILED IN THE MANUAL

- Introduction to Ray Optics
- The Law of Refraction
- The Diffraction Grating
- Single-slit Diffraction
- General Diffraction
- Using Diffraction gratings
- The effects of Double slit on diffraction (Two-slit Interference)
- Investigating Optical activity
- Overview of interference and diffraction
- Single slit diffraction
- Polarization
- Introduction to Optical Instruments

EXAMPLE OF USE

Fraunhofer diffraction • Using a diffraction grating to create a diffraction pattern

Diffraction of light occurs when a light wave passes by a corner or through an opening or slit that is physically the approximate size of, or even smaller than that light's wavelength.

Diffraction describes a specialized case of light scattering in which an object with regularly repeating features (such as a diffraction grating) produces an orderly diffraction of light in a diffraction pattern.

These phenomena can be described through the Huygens-Fresnel's Principle. Huygens postulated that as a wave propagates through a medium, each point on the advancing wavefront acts as a new point source of the wave.

For instance, the points inside a slit become sources of virtual elementary spherical waves. The observed real wave is the result of the interference of the elementary waves.

This suggests that diffraction and interference are phenomena that can be referred to only in a theoretical interpretation.

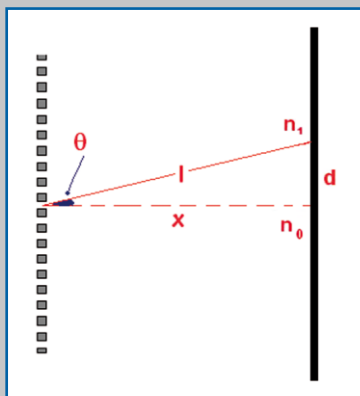


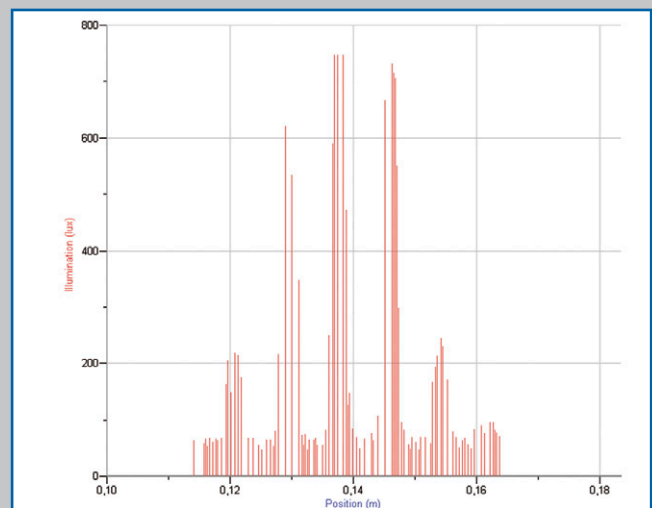
Diagram shows constructive and destructive interference of the light coming from the diffraction grating



Assembly example for the diffraction grating experiment

By using a motion detector and a light sensor you can show a graph of the light intensity vs. the light sensor position (i.e., distance). This is possible by moving the light sensor around the positions of maximum intensity while sampling its position with the motion detector.

For a distance $x = 173 \text{ cm}$ and a diffraction grating with a pitch (p) of 0.13 mm we get the following result.



$$\pm n\lambda = p \sin \theta$$

Constructive interference

Where (p) is the pitch of the diffraction grating.

Electrostatics System

4865.19

A qualitative and quantitative overview of the concepts of electrostatics

Specifications

Size: 75x55x20 cm - Weight: approx. 6,5 kg

Packing: Aluminium carry case with foam inserts

Equipment suggested

Charge Sensor (code 2313.10)

LabPro (code 2300.10)

or LabQuest (code 2300.30)

or Go!Link (code 2320.30)



The Electrostatics System introduces basic concepts of electrostatics and provides a good basis for understanding and quantitatively assessing electrostatics.

A full set of accessories are supplied to study charge by friction, conduction and induction.

Electrostatics system in its case

Hollow sphere, conductive sphere, pith ball electroscope and Volta's electrophorus



Full set of materials for electrostatics experiments



MAIN COMPONENTS

- Leaf Electroscope
- Hollow and conductive spheres
- Pith Ball Electroscope
- Neon Tube
- Polyethylene strip
- Wool and silk clothes
- Glass ebonite and perspex rods
- Electrophorus disk
- Proof plane
- Polyethylene tile
- Faraday's Well

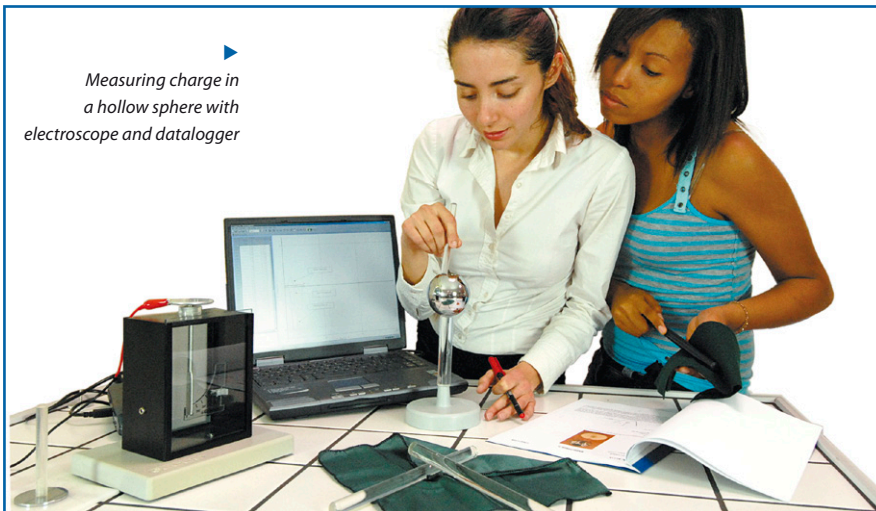


LAWS AND PRINCIPLES INVESTIGATED

- Charging by conduction
- Charging by friction
- Charging by induction
- Conducting sphere
- Investigating electric charge
- Principles of the electroscope
- Faraday ice pail experiment
- Volta's electrophorus experiment

Leaf electroscope with accessories





Measuring charge in a hollow sphere with electroscope and datalogger



EXPERIMENTS DETAILED IN THE MANUAL

- Concept of static charge
- How to use the electroscope
- Charges on an electroscope
- Electrophorus principles using electrostatic induction
- Investigating different kinds of electric charge
- Production of charges, equal and opposite
- Charge transfer
- Charging by conduction, friction and induction
- Hollow sphere
- Charge distribution in electric fields
- Charge distribution in a hollow sphere and in a conducting sphere

EXAMPLE OF USE

Electroscope usage • Using the electroscope to measure the charges by induction and conduction

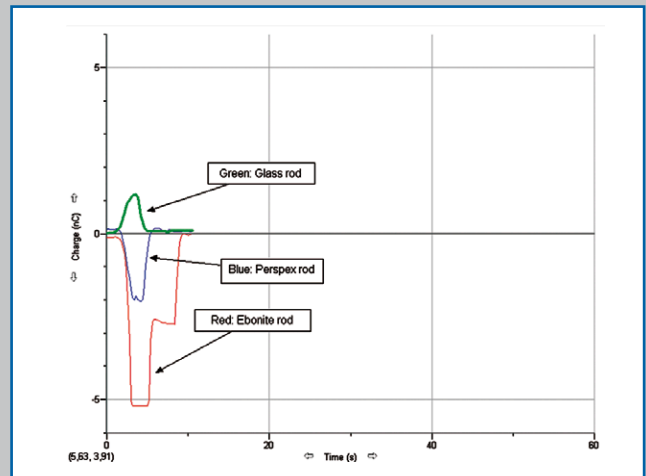
An electroscope is an instrument for detecting the presence of static electricity. It consists of two thin metal leaves suspended from a metal hook. When the hook is brought near a source of static electricity, some of the electrons in the hook are pushed to the leaves (if the source is negative) or pulled up to the hook from the leaves (if the source is positive).

Either way, the leaves are now charged the same way as each other so they repel each other. The amount they open up is proportional to the charge of the source (if the sources are always held at the same distance from the hook).

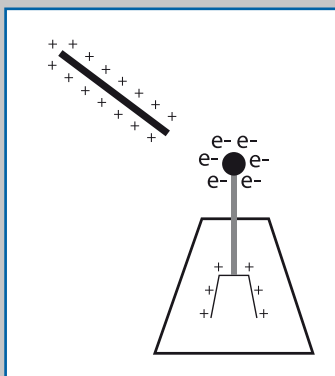
Induction charging is a method used to charge an object without actually touching the object to any other charged object. If such a charged rod is brought near to the hook of an electroscope, it will induce the similarly charged electrons to move away from the rod and the leaves. Since both leaves will have the same charge they will repel each other and move apart.

Charging by conduction means that the charging rod actually touches the electroscope's hook.

Since there is contact, electrons from the knob would flow onto a positive rod or off of a negative rod.



▲ Different charges induced by rubbing ebonite, Perspex and glass with wool

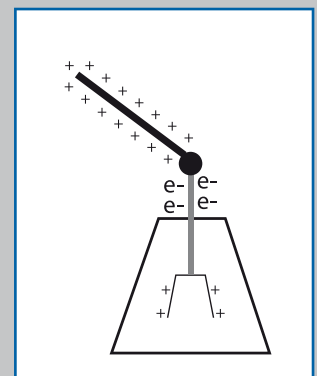


◀ Conduction

Charging by conduction leaves the electroscope, with a residual charge identical to that of the charging rod.

When the electrified rod touches the electroscope, it is possible to observe that the leaves of the instrument move apart one from the other.

The negative charge induced by the metallic rod causes a repulsive action that moves them apart. Using the graduated scale we can measure the size of this charge.



Induction ▶

PHYSICS SYSTEM

Magnetism & Electromagnetism

Magnetics System 1

4867.19

A basic introductory system to study the magnetism produced by various permanent magnets

Specifications

Size: 50x45x15 cm - Weight: 5 kg
Packing: external suitcase in durable Aluminium, internal foam to prevent accidental shock

Equipment suggested

Overhead Projector
Magnetic Field Sensor (code 2313.50)
LabPro (code 2300.10)
or LabQuest (code 2300.30)
or Go!Link (code 2320.30)



Magnetics system 1

The Magnetics System 1 permits the demonstration of the characteristics of various shaped magnets.



▲ Magnetic field lines of force demonstrated by series of plotting compasses

In this system we study basic magnetic flux lines (of various shaped permanent magnets in 2D and 3D), deflection of a magnetic needle, compasses, magnetic dipoles, magnetic hysteresis, eddy currents, Earth's magnet, etc.



► Plastic coated bar magnets with plotting compasses



MAIN COMPONENTS

- Floating magnets with base support
- Neodymium magnet
- Aluminium foil for eddy currents
- Magnetic field chamber 2D
- Magnetic field chamber 3D
- Pocket compass
- Plotting compass
- U-shaped magnet
- Horseshoe magnet
- Pair of cylindrical magnets
- Earth's magnetic model
- Pair of plastic cased bar magnets
- Bar magnets
- Ring magnets
- Cylindrical iron bar
- Cylindrical steel bar
- Hook
- Ferromagnetic chain
- Iron filings
- Stainless steel sphere



EXPERIMENTS DETAILED IN THE MANUAL

- Magnetic field lines in 2D and 3D
- Deflection of a magnetic needle
- Compasses
- Magnetic dipole interactions
- Magnetic hysteresis of a steel bar
- Eddy currents in an aluminium tube
- The Earth's magnetic field

PHYSICS SYSTEM

Magnetism & Electromagnetism



◀ Magnetism system with all components



LAWS AND PRINCIPLES INVESTIGATED

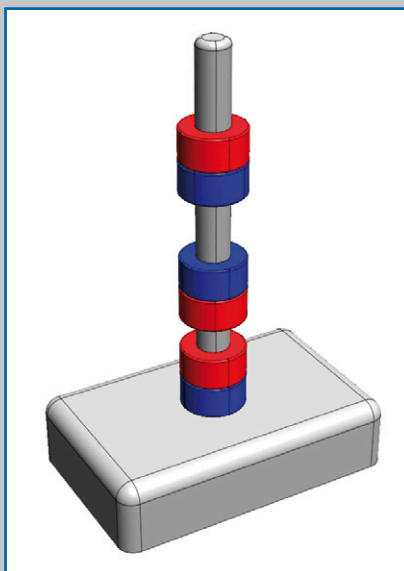
- | | | | | | |
|--|--------------------------|--|---|--------------------------------------|---|
| • Ampère's Equivalence Theorem | • Biot-Savart Law | • Image charge method | • Magnetic dipole vs. magnetic monopole | • Magnetic moment determination | • Ohm's Law |
| • Attractive-Repulsive magnetic forces | • Earth's magnetic field | • Lenz's Law | • Magnetic field | • Magnetic and Electrostatic Mapping | • Magnetisation and demagnetisation of steel and iron |
| | • Eddy currents | • Magnetic dipole and its interactions | • Magnetic force | | |
| | • Faraday's Law | | • Magnetic hysteresis | | |

► EXAMPLE OF USE

Floating magnets

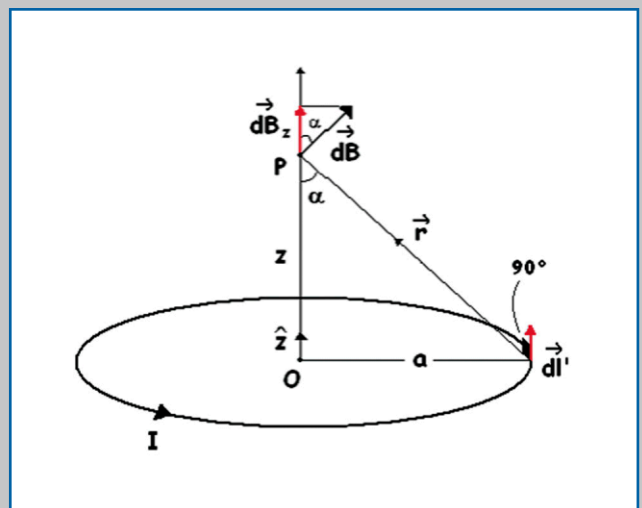
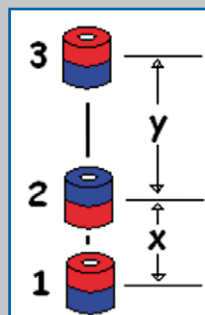
A simple experiment demonstrating the interaction between magnetic dipoles

Andre Marie Ampère hypothesised (the so called "elementary current hypothesis"), that a small permanent magnet (magnetic dipole) behaves as a coil in which is flowing a direct electric current (Ampère's Equivalence Theorem).



◀ Floating magnets experiment

Variables used in the floating magnets experiment



$$\frac{x}{y} = \frac{1}{2^{1/4}} \approx 0.84$$

▲ Biot and Savart diagram for the calculation of the magnetic field produced by a magnetic dipole

A force experienced an intermediate magnetic dipole is defined as the inverse of the fourth power of the distance between the lower and upper dipole. We can then use a near approximation of this force and ignore the interactions between the dipoles.

A very interesting result since the ratio is evidently independent of the mass and dipole moment of the magnets (as long as all three are the same and by using the next nearest approximation).

PHYSICS SYSTEM

Magnetism & Electromagnetism

Magnetics System 2

4867.29

An intermediate lab system to investigate the magnetic field produced by permanent magnets and electric currents

Specifications

Size: 50x45x15 cm - Weight: 5 kg

Packing: comes with a durable aluminium carry case

Equipment needed

Power Supply 30 A (code 2407.65)

Equipment suggested

Overhead Projector

Magnetic Field Sensor (code 2313.50)

LabPro (code 2300.10)

or LabQuest (code 2300.30)

or Go!Link (code 2320.30)



The Magnetics System 2 is designed to demonstrate the basic principles electromagnetic flux lines (of current carrying conductors), deflection of a magnetic needle, the magnetic field produced by a permanent magnet and paramagnetic and ferromagnetic substances, etc.

The Magnetics System 2 is also suitable for use with an overhead projector.

▲ Magnetics system 2 comes in a durable aluminium case with foam inserts



MAIN COMPONENTS

- Pair of bar magnets
- Iron filings (package of 300 g)
- Support for acrylic discs
- Clear acrylic disc for permanent magnet experience
- Magnetic needle probe
- Plastic funnel
- Clear acrylic disc with straight wire conductor
- Clear acrylic disc with long solenoid conductor
- Clear acrylic disc vertical coil conductor
- Pair of ferromagnetic bars
- Aluminium ring



LAWS AND PRINCIPLES INVESTIGATED

- Ampère's Law
- Biot-Savart Law
- Investigation of Magnetic circuits
- Magnetic field produced by permanent magnets
- Magnetic field produced by a current
- North-south poles of a magnet
- Investigation of paramagnetic and ferromagnetic substances

PHYSICS SYSTEM

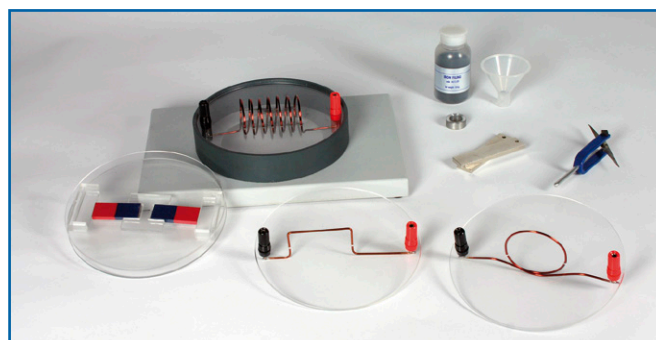
Magnetism & Electromagnetism



EXPERIMENTS DETAILED IN THE MANUAL

- | | | |
|--|--|---|
| • Magnetic field produced by permanent magnets | • Magnetic field produced by an electric current in a wire | • Paramagnetic and ferromagnetic substances |
| • Magnetic field produced by an electric current in a coil | • Magnetic field produced by an electric current in a solenoid | |

With a datalogger and a magnetic field sensor it is easy to gather and manipulate data with a computer.



▲ Magnetism system 2 components

◀ Experiment data being taken using a magnetic field sensor

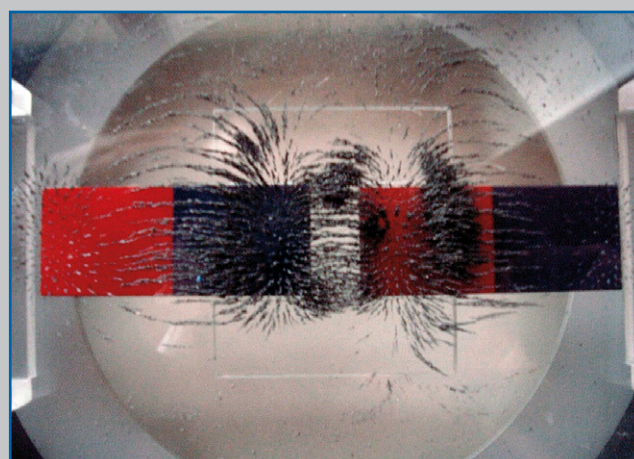
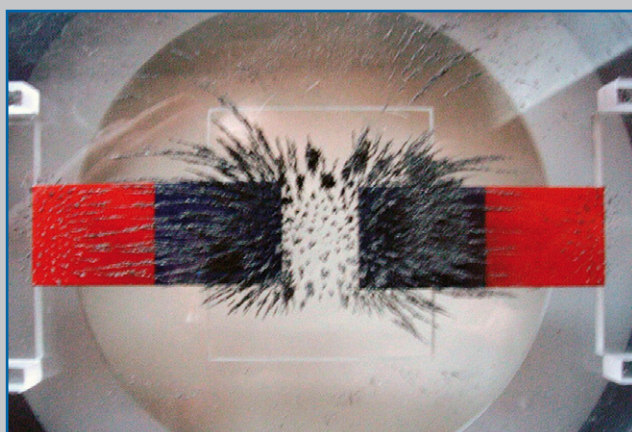
▶ EXAMPLE OF USE

Magnetic field produced by a permanent magnet

This classic experiment shows magnetic lines of force produced by various combinations of bar-shaped magnets

One of the simplest ways for showing the behaviour of the lines of force of a magnetic field is the use of iron filings. The small iron fragments orient themselves like small magnetic needles along the direction of the field, demonstrating the actual lines of force.

▼ Magnetic field produced by two bar-shape magnets with same polarity



▲ Magnetic field produced by two bar shape magnets with opposite polarities

This is a very interesting demonstration showing the lines of force of a magnet using iron filings. Students can easily see where lines of force are greater, simply by the greater density of the iron filings and how they line up, and a very simple way to show how the North and South poles of a magnet differ.

Electricity System 1

4866.19

This comprehensive system provides a strong foundation for studies in electricity and electronics



Electricity system 1 in a durable carry case

Electricity System 1 is designed as a perfect introduction to the basic fundamentals of electricity and provides a good platform for more advanced study.

The system is designed to be assembled quickly and with ease. Each connection block contains a description of the component housed inside it. Connectors are made of special metal alloys that allow excellent conduction of current to give accurate results. Electricity System 1 can be mounted on the Altay Magnetic Board (code 4114.30), for class demonstration experiments.

Specifications

Size: 50x45x15 cm - Weight: approx. 5,5 kg
Packing: durable carry case aluminium with internal foam

Equipment needed

Power Supply 1.5 A (code 2407.70)

Equipment suggested

Oscilloscope (code 2280.70)
Magnetic Field Sensor (code 2313.50)
LabPro (code 2300.10)
or LabQuest (code 2300.30)
or Go!Link (code 2320.30)

MAIN COMPONENTS

- Board
- Voltmeter 0÷15 V and 0÷1.5 V
- Ammeter, 0÷500 mA and 0÷50 mA
- Resistors
- Potentiometer
- Lamp holders for E10 bulbs
- Capacitor 1000 mF
- Two cell holder
- Coil 10 mH
- Compass
- Bridging plugs
- Push-button switch
- Toggle switch, single pole
- Lamp bulbs
- Cylindrical magnet
- Ferromagnetic core

LAWS AND PRINCIPLES INVESTIGATED

- Voltage and current measurement
- Ohm's Law
- Kirchhoff's Laws
- Resistance, capacitance and inductance in circuits
- Investigating the Potentiometer
- Charge and discharge of a capacitors in circuits
- RC, RL and RLC circuits
- Magnetic energy and mechanical forces in circuits
- Mutual-induction in circuits
- Series parallel circuit
- Electromagnetism in circuits

EXPERIMENTS DETAILED IN THE MANUAL

- Investigating the Voltmeter
- Investigating the Ammeter
- Electric resistance
- Ohm's Laws
- Series versus Parallel Circuits
- Kirchhoff's Laws (nodes and loops)
- Investigating the Capacitor
- Charging and discharging of a capacitor in a circuit
- Investigating capacitors in series and in parallel in a circuit
- Investigating electric cells
- Investigating the electric bulb
- A study of the electromagnet

EXAMPLE OF USE

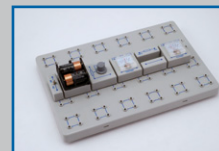
Ohm's Law • The fundamental principle of electricity

The Ohm's Law is the fundamental law of electricity and it helps us understand the relational between current, voltage and resistance. Ohm's Law explains that the amount of electrical current flowing through a metal conductor of a circuit is directly proportional to the voltage across it, for any given temperature. Ohm derived this relationship in a simple mathematical form as follows: current (**I**), voltage (**V**) and resistance (**R**):

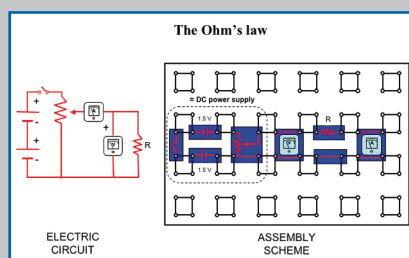
$$V = IR$$

◀ Ohm's Law

This law can be verified by means of the circuit above. The student can calculate the value of the resistance by applying a voltage value and measuring the corresponding current value and their results can be graphed. The student can also vary the value of the resistance and verify investigate the consistency of Ohm's Law.



The setup used to explain Ohm's Law



Circuit schematics

Electricity System 2

4866.29

An advanced electricity lab for electrical circuit projects



The Electricity System 2 is an advanced system designed to teach practical applications in circuits.

Electricity system 2

Specifications

Size: 50x45x15 cm - Weight: 5 kg
Packing: external suitcase in a durable Aluminium carry case

Equipment needed

Electricity System 1 (code 4866.19)

Equipment suggested

Digital Multimeter (code 2275.10)
Magnetic Field Sensor (code 2313.50)
LabPro (code 2300.10)
or LabQuest (code 2300.30)
or Go!Link (code 2320.30)

The system completes and can be used with our Electricity System 1. Our system consists of a set of plastic blocks which house the electrical components (such as motors, buzzers, etc). Each block connects to the base by two or four plugs with 4 mm sockets. Once inserted into the board, the circuit starts to build. All the components of the kit are stored in a foam cushioned durable storage case.



MAIN COMPONENTS

- Relais
- Motor
- Propellers
- Coils
- Switches (toggle, push-button,
- reversing)
- Buzzer



LAWS AND PRINCIPLES INVESTIGATED

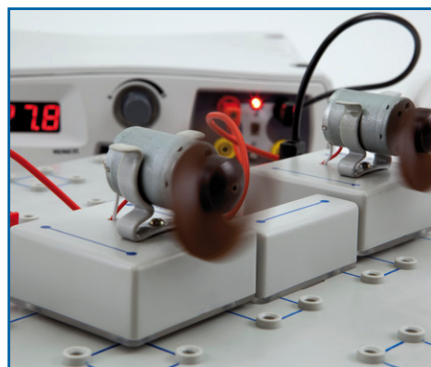
- What is a transformer
- Investigating the behaviour of electric motors
- Looking at
- electric energy transformation into mechanical energy
- The principle of the dynamo
- Looking at
- mechanical energy transformation into electrical energy
- Experiments with luminosity



EXPERIMENTS DETAILED IN THE MANUAL

- Using a transformer
- Experiments with a relay
- The electric motor
- Electric energy transformation into mechanical energy
- Mechanical energy transformation into electrical energy e.g. the dynamo
- Controlling the luminous intensity of a lamp
- Controlling the speed and direction of an electric motor
- Using a buzzer in a circuit
- Use of a relay in a circuit

Electricity System 2 is easy to use and quick to set up. Using the experiment circuit board in System 1, you can now perform advanced electricity experiments.

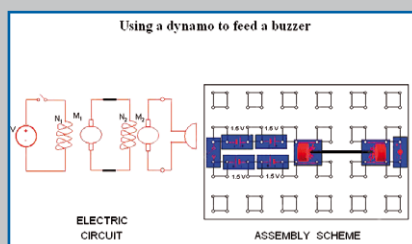


Mounting detail for a sample experiment

EXAMPLE OF USE

Dynamo • How to transform mechanical into electrical energy

A dynamo can be described as a kind of DC motor used in reverse. Also known as an electrical generator, it is a device for converting mechanical energy into electrical energy. There are two types of generator or dynamo. Both turn rotational energy into electrical energy. One type involves rotating a coil inside a magnet. The other involves rotating a magnet inside a coil (like a dynamo found on a bicycle). Both types produce alternating current. Therefore, a DC motor is a dynamo operating in reverse.



The electrical energy can then be used to power a buzzer

In this experiment, the student can verify that the first motor is supplied with an electric voltage and transfers the mechanical motion to the second motor by means of a rubber band. The motion produced by this motor is then used to produce an electric voltage which in turn can power the buzzer. The buzzer will then produce an audible sound.

Electronics System 1

4868.19

A comprehensive system introducing the principles of electronics



Electronics system 1 in durable aluminium carry case

Specifications

Size: 50x45x15 cm - Weight: 4.5 kg
Packing: external suitcase in aluminium, internal foam for prevent accidental shock

Equipment needed

Electricity System 1 (code 4866.19)
Power Supply 1.5 A (code 2407.70)

Equipment suggested

Digital Multimeter (code 2275.10)

The Electronics System 1 is designed to be rugged and easy to use.

Electronics System 1 has modular design: each block contains a fully functional electronic component, from a potentiometer to a photo resistor. Using this system, it's possible to observe and to understand how semi-conductor components work and how they behave in static and dynamic circuits. Electronics System 1 can be mounted on the Altay Magnetic Board (code 4114.30), for class demonstration experiments. The system includes a durable Aluminium carry case with foam inserts.



MAIN COMPONENTS

- Board
- Si diode
- Signal transistor PNP
- Signal transistor NPN
- Power transistor PNP
- Power transistor NPN
- LED Infrared LED diode
- Unijunction transistor UJT
- Silicon controlled rectifier SCR
- Triac
- Photo transistor
- Photoresistance v
- Zener diode 6.2 V
- PTC resistor
- NTC resistor
- Potentiometer



LAWS AND PRINCIPLES INVESTIGATED

- Characteristics of diode
- Investigating transistors
- Comparing PNP and NPN transistors
- Characteristics LED diodes and Infrared LEDs
- Looking at photoresistors versus phototransistors
- Experiments on power dissipation
- Investigating Signal versus Power transistors
- Transistors in power applications: thyristors (SCR, UJT and TRIAC)
- Theory of rectification in circuits
- Theory of reflection in circuits
- Temperature and the use of thermistors in circuits
- Looking at Zener diodes in circuits
- The astable multivibrator (or flip-flop circuit)



EXPERIMENTS DETAILED IN THE MANUAL

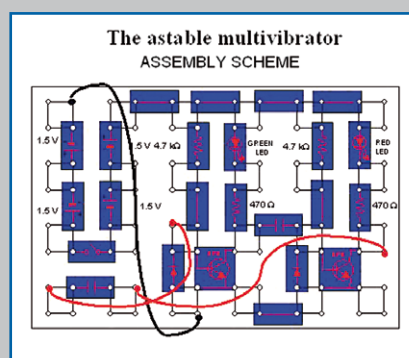
- Investigating the diode and the PN junction
- LED diodes
- Experiments with rectifier diodes
- Working with Zener diodes
- Experiments with the PNP transistor
- Experiments with the NPN transistor
- Comparison between the signal and power transistor
- Experiments with the unijunction transistor UJT
- Experiments with the silicon controlled rectifier SCR
- Investigating the TRIAC
- Working with the phototransistor
- What is photoresistance?
- Experiments with the PTC (positive temperature coefficient) resistor
- Experiments with the NTC (negative temperature coefficient) resistor
- Experiments with the astable multivibrator



EXAMPLE OF USE

The Astable Multivibrator • Building a flip-flop circuit

An astable multivibrator is a two-stage switching circuit where the output of the first stage is connected to the input of the second and vice-versa. The outputs of both stages are complementary. This multivibrator generates square waves without any external triggering pulse. The circuit has two stable states and switches back and forth from one state to another, remaining in each state for a period depending upon the discharging of the capacitive circuit. The multivibrator is an example of a relaxation oscillator, whose frequency may be controlled by external synchronizing pulses.



Flip-flop circuit

Electronics System 2

4868.29

An advanced electronics system for circuit projects, analysis and circuit testing



Electronics system 2 comes with durable aluminium carry case with foam inserts

Each component can easily be interconnected with each other through our specially developed lab circuit board



MAIN COMPONENTS

- Microphone
- Loudspeaker
- Bridge rectifier
- Signal transistor NPN
- Power transistor NPN
- Capacitor
- Resistors
- Bridging plugs
- Plugs, 90°
- Potentiometer



LAWS AND PRINCIPLES INVESTIGATED

- Investigating the diode's physical behaviour in a circuit
- Looking at the transistor's physical behaviour
- Polarization within a circuit
- Stability of a transistor
- Experiments looking at the amplification in a circuit



EXPERIMENTS DETAILED IN THE MANUAL

- The bridge rectifier
- The voltage follower
- The common emitter amplifier
- The common base amplifier
- The common collector amplifier
- The current mirror amplifier
- The audio amplifier

EXAMPLE OF USE

Bridge rectifier • Using a diode as a full-wave rectifier

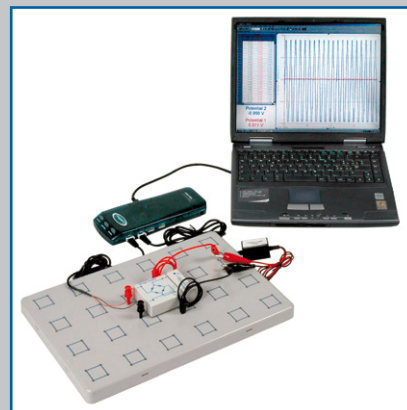
One of the most famous applications of the diode is rectification, which is the conversion of an alternating current (AC) to a direct current (DC). The simplest rectifier is the half-wave rectifier; a single diode allows only one half of an AC waveform to be transferred to the load. In some applications, half-wave rectification has a high inefficiency due to the large harmonic content and to the limitation of supplying power to the load once every half-cycle. If one needs to rectify AC power in order to obtain the full usage of both half-cycles of the sine wave, a more efficient circuit can be obtained by simply doubling the half-wave rectifier. The resulting circuit is called full-wave rectifier; one diode only works during the first half-wave, the other in the next half-wave, and so on. But this two-diode rectifier has a large disadvantage: the necessity to use a transformer with a centre-tapped secondary winding, which is generally cumbersome and expensive, especially in high-power applications.

Example of using a diode to rectify an input signal

Usually, a four-diode bridge configuration is preferred. While one set of two parallel diodes is forward biased, the other set is reverse biased and can be considered as eliminated from the circuit.

By using a datalogger we can easily study rectification in a circuit.

The datalogger is used for recording the signal traces of the input and output.



CHEMISTRY SYSTEMS

General Chemistry

General Chemistry System

7615.01

An introductory system to chemical phenomena

Specifications

Size: 75x55x20 cm

Weight: approx. 9 kg

Packing: Durable aluminium carry-case with foam inserts



General Chemistry System



MAIN COMPONENTS

- Safety goggles
- Safety gloves
- Iron stand with universal clamps and ring
- Spirit burner
- Wire gauze
- Electronic balance
- Plastic test tube rack
- Test tubes
- Beakers of various capacities
- Conical flask
- Measuring cylinders



LAWS AND PRINCIPLES INVESTIGATED

- Chemical and physical properties:
- Law of mass conservation
- Solubility and temperature effects
- Diffusion
- Enthalpy
- Colloids
- Acid-base reactions
- Coordination complexes
- Combustions
- Simple analysis
- Reactions of elements:
- Hydrogen
- Carbon
- Nitrogen
- Oxygen
- Sulphur
- Iodine
- Sodium
- Metals
- Organic Molecules:
- Methane preparation
- Soap preparation
- Sugar experiments
- Proteins experiments
- Tests on sugars





A series of effective demonstrations can be performed easily in a few minutes, using the equipment included in the set.



▶ EXAMPLE OF USE

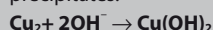
Coordination complex

When a substance dissolves in water, its molecules/ions are surrounded by water molecules. In some cases, it is possible that water molecules coordinate with the solute ions, i.e. water molecules become part of a chemical structure with the solute called a coordination complex. Not only water can coordinate with ions but also other substances form coordination complexes.

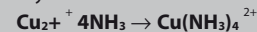
The electronic structure of the transition elements allows the formation of coordination complexes in which the metal ions bond with other ions or molecules to form a structure with a characteristic 3-dimensional geometric shape.

The shape adopted by the complex may be associated with a characteristic colour. Copper forms easily coordination complexes with water and other substances. Anhydrous copper sulphate has a dirty white colour, whereas the hydrate $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ has a blue colour because copper is coordinated with water in the crystals. Dissolving either of these salts in water gives a blue solution because the copper ions coordinate with water molecules.

Adding a small quantity of ammonia raises the pH of the solutions shift towards alkaline values and some copper hydroxide precipitates.



Copper hydroxide has a pale blue colour. If ammonia is added in excess the precipitate dissolves because a tetraammine complex of copper is formed with the ammonia and a royal blue solution is obtained.



Adding some sodium chloride to the starting copper sulphate solution causes a bright green due to the formation of copper(II) chloride complexes.



LIST OF EXPERIMENTS

- Investigating the law of mass conservation
- The effect of temperature on solubility
- Supersaturated solutions
- Diffusion in a solution
- Colloids
- Properties of colloids
- Coordination complexes
- Water of crystallization
- Density
- Melting of sulphur
- Acid base reactions
- Enthalpy of solution
- Enthalpy of crystallisation
- Enthalpy of neutralisation
- Combustion of magnesium
- Combustion of sulphur
- Hydrogen production
- Properties of hydrogen
- Carbon dioxide production
- Properties of carbon dioxide
- Sodium carbonate and bicarbonate
- Calcium carbonate and bicarbonate

- production
- Ammonia production
- Ammonia solubility
- Ammonia equilibrium
- Ammonium chloride production
- Ammonium chloride dissociation
- Ammonia–ammonium chloride buffer
- Sodium nitrate decomposition
- Nitric acid production
- Oxygen production and properties
- Oxygen production II
- Allotropic states of sulphur
- Sulphur dioxide production and properties
- Sulphurous acid production and properties
- Iodine and starch detection
- Reduction of potassium manganate(VII) (permanganate)
- Metallic salts
- Metallic salts II - production of sodium sulphate
- Precipitation of metallic hydroxides
- Properties of metallic hydroxides

- Zinc and strong bases
- Copper complexes
- Air analysis – oxygen percentage
- Air analysis II
- A water analysis
- Analysis of the products of combustion
- Production of methane
- Combustion of ethanol
- Production of soap
- Soap properties
- Trommer's test on aldehydes
- Fehling's test on glucose
- Inversion of sucrose
- Copper complex with glucose
- Carbonization of sucrose
- Degradation of starch
- Degradation of cellulose
- Nitrogen in proteins
- Sulphur in proteins
- Coagulation of egg albumen

Advanced Chemistry System

7610.01

The perfect complement for the General Chemistry System

Specifications

Size: 75x55x20 cm

Weight: approx. 8,5 kg

Packing: Durable Aluminium carry-case with foam inserts



Advanced Chemistry System

Iron stand, metal jack elevator, water vacuum pump, tubing and combined electrode digital pH meter.



MAIN COMPONENTS

- Iron stand with universal clamps
- Round flasks with joints
- Liebig condenser with joints
- Distillation head
- Distillation tail – vacuum adapter
- Conical vacuum flask
- Water jet vacuum pump
- Tubing
- Jointed glassware clamps
- Mini Magnetic stirrer
- Magnetic teflonated anchors
- Hand-held pH meter
- Combined single pH electrode
- Burette clamp
- Glassware grease
- Pipettes of various capacities with three-way
- Rubber pump



LAWS AND PRINCIPLES INVESTIGATED

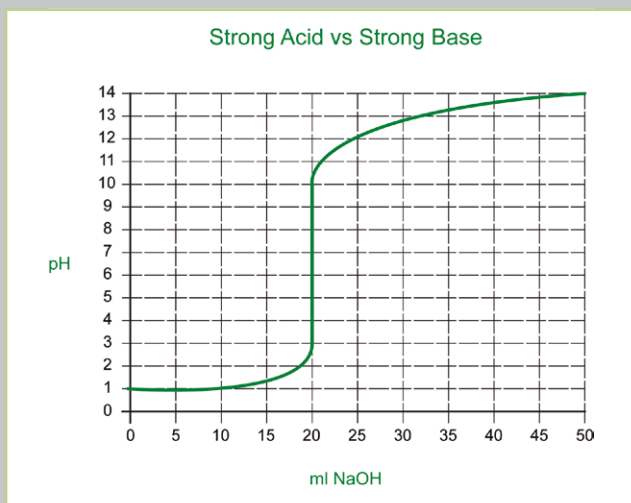
- Purification techniques:
- Gravity filtration
- Vacuum filtration
- Chromatography
- Room pressure and reduced pressure distillations
- Crystallization
- Chemical and physical properties and analysis :
 - Boiling point
 - Polarity of solvents
 - Brönsted acids and bases
 - Strong and weak acids
 - pH indicators
 - Double exchange reactions
 - Redox reactions
 - Acids and metals
 - Oxidation states of metals
 - Transition elements
 - Titration curves
 - Analysis of water
 - Analysis of food
 - Organic chemistry experiments



Vacuum Filtration

Extraction and separation techniques are explained in the Instruction Manual to introduce students to fundamental laboratory operations. Our Advanced Chemistry System includes specific equipment for carrying out room-pressure and reduced-pressure distillation together with vacuum filtration and paper chromatography experiments.





Specific tables-spaces on the instructions allow students to record data and plot the titration curve.

▶ EXAMPLE OF USE

Plotting a Titration Curve

This experiment allows students to study the progression of a titration of a strong acid with a strong base. Titration is a technique used to discover the concentration of a solution. In a titration, the test substance (the analyte) reacts with a reagent added as a solution of known concentration. The volume of titrant required to completely react with the analyte is measured. The end point of a titration can be detected instrumentally using a pH meter, in the case of an acid-base titration, or by exploiting the electric properties of the solutions. A chemical indicator, which changes colour in basic or acidic environments, is usually added to the analyte to indicate the turning point. It is possible to observe the progression of a titration, such as the neutralization of a strong acid with a strong base, by recording the pH values as titrant is added and then plotting these values on a graph. The curve is shown by joining the points drawn on the graph. This experiment also introduces students to computer analysis of data.



LIST OF EXPERIMENTS

- Gravity filtration
- Vacuum filtration
- Solvent and Solute Separation
- Extraction with solvent
- Recrystallization
- Boiling Point
- Solubility and miscibility
- Polarity of solvents
- Brønsted's Acids and Bases
- pH of Strong Acids and Bases
- pH of Weak Acids
- A natural pH indicator
- Metals with Acids
- Acid Base Titration
- Plotting a Titration Curve
- Weak Acid and Strong Base Titration
- Thermometric Titration
- Redox Reactions I
- Redox Reactions II
- Iron Oxidation States
- A double Exchange Reactions
- Molar Volume of a Gas
- Preparing a Standard Solution
- Investigating Hardness of water
- Determining Hardness of Water
- Vitamin C in Fruit Drinks
- Chromatography
- Distillation of an Azeotropic Mixtures
- Vacuum Distillation
- Crystallization of Benzoic Acid
- Analysis of an Aspirin Tablet



Electrochemistry System

7620.01

Investigating the electrochemical phenomena

Altay's Electrochemistry System is a powerful instrument to introduce students to the chemical reactions that involve electrical phenomena.

How is electric current produced? Can we store this electric current somehow?

Why does iron rust? Is it possible to protect metals from corrosion? Altay's Electrochemistry System will answer all these questions and many more, through practical demonstrations.

The complete set of equipment has been selected to perform the 21 experiments included in the Instruction Manual plus a wide range of additional electrochemistry experiments. The manual helps easily to set up all demonstrations.



Electrochemistry system

Specifications

Size: 77x55x20 cm

Weight: approx. 8,5 kg

Packing: Durable aluminium carry case with foam inserts



Digital multimeter with testing cords.



MAIN COMPONENTS

- Stand with universal clamps
- Digital multimeter
- Hand-held pH meter
- Hoffmann voltmeter
- DC power supply
- Long red and black connecting wires
- Short red and black connecting wires
- Crocodile clips
- Iron electrodes
- Copper electrodes
- Silver electrodes
- Zinc electrodes
- Lead electrodes
- Aluminium electrodes
- Platinum electrodes
- Graphite electrodes
- 25 ml burette
- Burette clamp
- Test cell module
- Beaker
- Glass rods
- Measuring cylinder
- Glass funnel
- Bulb lamp set
- Filter paper



Combined electrode digital pH meter.



CHEMICAL AND PHYSICAL PROPERTIES

- Conductivity and electrolytes
- Effect of concentration on conductivity
- Dissolution of metals
- Reference electrodes
- Reduction potentials
- Cells
- Daniell cells
- Volta cells
- Concentration cells
- Connection of cells in series and parallel
- Practical use of reference electrode:
- Measuring pH experiments
- Electrolytic processes
- Effect of pH on Water electrolysis
- Corrosion and protection of metals

CHEMISTRY SYSTEMS

Electrochemistry



Glass beakers, connecting wires, various electrodes, crocodile clips, test cell module with covers, bulb lamp, universal metal clamp, safety goggles.



LIST OF EXPERIMENTS

- Electrolytes and conductivity
- Conductivity and concentration
- Electrolytic processes
- Salt solution cell
- An unusual source of electric current the lemon cell
- The standard hydrogen electrode
- The Daniell cell
- Connection of Daniell cells
- The Volta cell
- Galvanic cells concentration cells
- Galvanic cells with different redox couple
- Water electrolysis
- Water electrolysis basic environment
- Accumulators
- The silver /silver chloride reference electrode
- Standard potentials and the silver/silver chloride reference electrode
- Plotting a titration curve
- Weak acid and strong base titration
- Corrosion and cathodic protection
- Protection against corrosion: galvanizing
- Aluminium anodizing

▶ EXAMPLE OF USE

Water Electrolysis

Demonstrates the composition of water thanks to an electrolytic process.

Water is composed of hydrogen and oxygen in a proportion of 2:1.

The passage of an electric current through a weak acidic or basic water solution causes the decomposition of water into its component gases.

Direct electric current causes the following reactions in the acidified water at the platinum electrodes:

At the cathode (–) $4\text{H}^+ + 4\text{e}^- \rightarrow 2\text{H}_2$

At the anode (+) $6\text{H}_2\text{O} \rightarrow \text{O}_2 + 4\text{H}_3\text{O}^+ + 4\text{e}^-$

At the anode, water molecules are oxidised because their electrode potential

($E^0_{(\text{O}_2/\text{H}_2\text{O})} = +1.23\text{ v}$)

is lower than that of the sulphate ions SO_4^{2-} ($E^0_{(\text{SO}_4^{2-}/\text{S}_2\text{O}_8^{2-})} = +2.05\text{ v}$).

At the cathode, H_3O^+ ions are reduced because their potential ($E^0_{(\text{H}^+/\text{H}_2)} = +0.00\text{ v}$) is greater than that of water molecules H_2O ($E^0_{(\text{H}_2\text{O}/\text{H}_2)} = -0.83\text{ v}$).

In the basic environment OH^- ions and Na^+ ions are present which migrate towards the anode and cathode respectively.

At the cathode, water molecules are reduced because their potential

($E^0_{(\text{H}_2\text{O}/\text{H}_2)} = -0.83\text{ V}$)

is greater than that of the sodium ions

($E^0_{(\text{Na}/\text{Na}^+)} = -2.73\text{ V}$)

Sodium ions will not undergo any reduction given their very negative reduction potential.

At the anode, OH^- ions are oxidised because their potential

($E^0_{(\text{O}_2/\text{OH}^-)} = +0.40\text{ V}$)

is lower than the potential of the redox couple

($E^0_{(\text{O}_2/\text{H}_2\text{O})} = +1.23\text{ v}$).

So the reactions will be :

At the cathode (–) $4\text{H}_2\text{O} + 4\text{e}^- \rightarrow 2\text{H}_2 + 4\text{OH}^-$

At the anode (+) $4\text{OH}^- \rightarrow \text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^-$

Hydrogen and oxygen collect in the limbs of the Hoffmann Voltameter. The volume occupied by oxygen and hydrogen in the limbs will show the ratio between the two gases. Hydrogen will occupy double the volume of oxygen.

Hoffman apparatus for water electrolysis.



Plant Physiology

7810.01

An introduction to plant physiology mechanisms

Atlay's Plant Physiology System is designed to introduce students to the basic phenomena that regulate plant life.

The plastic cushioned box contains a complete set of glassware and laboratory items for investigating plant physiology. The experiments described in the Manual will lead students through the various phases of a plant's life from germination to photosynthesis and transpiration. The physical principles which regulate a plant's development, such as capillarity and osmosis, are explained first and then observed in living plants.



Plant Physiology System

Specifications

Size: 75x55x20 cm

Weight: approx. 9 kg

Packing: Durable aluminium carry-case with foam inserts



MAIN COMPONENTS

- Iron stand
- Universal clamp
- Iron ring
- Spirit burner
- Wire gauze
- Rubber tubing
- Set of glass beakers
- Conical flasks
- Volumetric flasks
- Set of graduated cylinders
- Set of graduated pipettes
- Rubber three-way pump for pipette
- Set of Petri dishes
- Test tube rack
- Test tubes
- Set of watch glasses
- Set of glass tubes
- Plastic funnel
- Glass funnel
- Thermometer
- Osmosis apparatus
- Capillarity apparatus
- Mohr clips
- Magnifier lens
- Tweezers
- Scalpel
- Pipette with nipples
- Porcelain mortar with pestle
- Double-ended spatula
- Metal spoon
- Cork driller set
- Dropping bottles



LAWS AND PRINCIPLES INVESTIGATED

- Germination
- Germination rate
- Water absorption
- Effect of light
- Geotropism
- Respiration of plants
- Photosynthesis
- Transpiration
- Osmosis
- Capillarity
- Analysis of substances
- Chromatography of chlorophyll
- Starch

Accessories' box

Osmotic pressure demonstration





LIST OF EXPERIMENTS

- Preparing a germination bed
- Germination rate of seeds
- Oxygen in water
- Seeds water absorption
- Effects of geotropism roots orientation
- Effect of light on germinating plants
- Plant cell respiration
- Photosynthesis
- Photosynthesis carbon dioxide consumption
- Oxygen consumption: plant respiration
- Transpiration - stomatas
- Transpiration
- Osmosis
- Osmosis in cells
- Osmosis in roots
- Osmosis in potatoes
- Osmosis in potatoes - effect of the concentration
- Cell turgor practical implications
- Capillarity
- Capillarity - the stem
- Chromatography
- The pulp of fruits
- Starch in leaves
- Pollen germination

▶ EXAMPLE OF USE

Capillarity Experiment

Capillarity is one of the causes for the upward flow of water in the soil and in plants. This phenomenon can be observed as a spontaneous movement of liquids up or down narrow tubes, or capillaries.

It can be seen, for example, when the surface of water in a clean drinking glass is slightly higher at the edges, where it is in contact with the glass, than in the middle thus forming a concave meniscus.

The molecular interaction between the liquid and the tube, or glass, are responsible for this phenomenon.

In fact, if the force of attraction between the material of the tube and the liquid is stronger than the force of attraction between the liquid molecules, the liquid tends to rise in the capillary.

On the contrary, if the force of attraction between the liquid molecules is stronger than the attraction between the liquid and the



Capillarity apparatus

material of the tube, the liquid will fall.

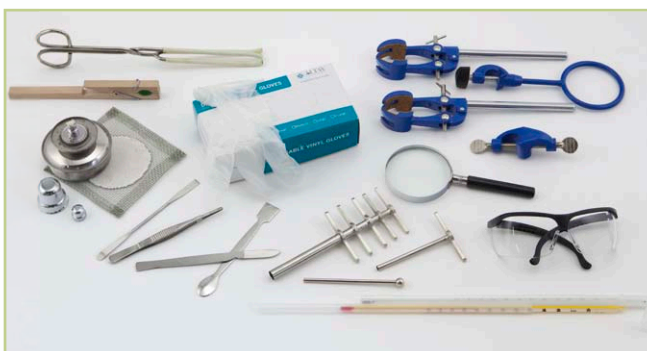
Naturally, the force of gravity also plays a role in the whole process by balancing the force that pulls the water up.

In this experience we will see how the dimensions of the tubes influence the level of the water.

The capillarity apparatus demonstrates how narrow tubes of different gauges cause different liquid levels.



Dissolved oxygen in water experiment.



Universal clamp, magnifier lens, cork driller set, mohr clips, test tube clamp, safety goggles, vinyl gloves.

A complete set of laboratory glassware: test tubes with rack, beakers, conical flasks, glass and plastic funnels, pipettes, measuring cylinders, porcelain mortar.



Alternative Energy Sources System

4869.09

Explore easily hydrogen fuel cell and wind, solar and hydraulic power



Specifications

Size: 50x45x15 cm - Weight: 5,5 kg

Packing: durable Aluminium carry case with foam inserts

Equipment suggested

Digital Multimeter (code 2275.10)

Does the World really need the fossil fuels?

The Altay Alternative Energy Sources System provides all the equipment needed to perform several experiments to study renewable energies, such as solar, hydraulic and wind power. All these apparatus can be connected to the hydrogen fuel cell, to understand how chemical potential energy could be converted in electric power.



MAIN COMPONENTS

- Solar panel
- Wind turbine
- Hydraulic turbine
- Hydrogen fuel cell
- Examples of use (fan, wheel)



EXPERIMENTS DETAILED IN THE MANUAL

- Photovoltaic cell
- Electrolysis
- Electrolysis with Photovoltaic cell
- Hydrogen fuel cell
- Using wind turbine to power a LED light
- Turning wind energy into hydrogen
- Water turbine
- Efficiency of the Photovoltaic cell
- Efficiency of a fuel cell



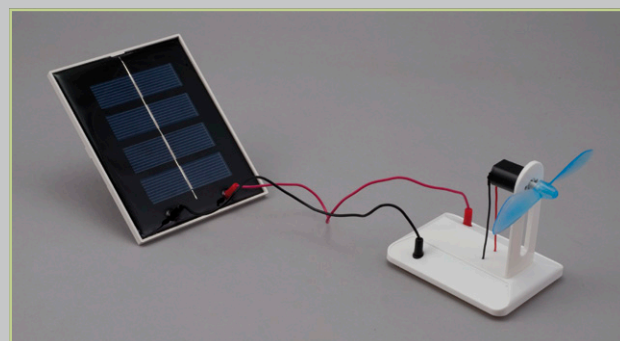
LAWS AND PRINCIPLES INVESTIGATED

- Solar power
- Wind power
- Hydraulic power
- Electrolysis
- Fuel cell

▶ EXAMPLE OF USE

Photovoltaic panel • Powering a fan using a photovoltaic panel

Using a photovoltaic panel it's possible to power every apparatus using electric energy (in this case a fan); the photovoltaic effect generates electrons which are transferred from one material to another resulting in a voltage between two electrodes. In this way it's possible to produce electric energy without pollution or side-effects for the environment.



The Altay Multiuse System

A new and unique Altay physics bench that can be used for mechanics and optics Experiments



▲ Multiuse System overview



▲ Multiuse System used as a dynamics track



MAIN COMPONENTS

* Minimum Order Quantity 5 pcs

With Altay Multiuse System you can add the following upgrades and convert your bench to a complete dynamics, mechanics or optics system:

- Altay Track Set 4954.12
Aluminium track with accessories
- Mechanics Upgrade 1 4941.14
Two Altay Carts, new design, track's terminals and accessories
- Mechanics Upgrade 2 4941.21
Spheres for free fall and pendulum experiments, electromagnet and accessories
- Optics Upgrade 1 4944.11
Lenses, mirrors, prism and general hardware for the optical bench
- Optics Upgrade 2 4944.20
Hartl disk, optical bodies for geometric optics experiments and accessories
- Optics Upgrade 3 4944.30
Laser, diffraction gratings and accessories

Additional items

- Timing Set 4922.10
Electronic timer with photogates
- Ball Launcher for Cart* 4941.60
Ball Launcher for Altay Cart, with accessories
- Altay Cart without Plunger* 4941.12
- Altay Cart with Plunger* 4941.13
- Eddy Current Set* 4941.51
A powerful magnet and a set of solid and slitted flags to discover the eddy currents
- Coupled Pendulum Set 4941.16
- EM Trigger&Launcher for Cart 4941.17

The Multiuse System has been devised as a multipurpose system that can be used for kinematics, pendulum, free fall and optics experiments.

As the result of a modular design, multiple experiments can be set up easily and quickly. All you need is one Multiuse System, then purchase whatever upgrade kit you require. You need only to buy the bench once!



LAWS AND PRINCIPLES INVESTIGATED

- Using our Upgrade Systems and the Track Set you can perform many experiments in mechanics and optics. Some of the experiments are as follows:
- **Mechanics**
 - Conservation of momentum and energy
 - Laws of dynamics
 - Determination of velocity in dynamics systems
 - Determination of acceleration in dynamics systems
 - Elastic and inelastic collisions
 - Impulse - momentum theorem
 - Concept of inertia
 - Investigating kinetic and potential energy
 - Newton's 1st Law of
- **Motion**
 - Newton's 2nd Law of Motion
 - Newton's 3rd Law of Motion
 - Rolling friction
 - Rectilinear uniform motion
 - Uniform accelerated rectilinear motion
 - Projectile motion
 - Free fall motion
 - Law of the pendulum
 - Drag force
 - Determination of the earth's gravity acceleration with free fall using the pendulum
- **Optics**
 - Convergent and divergent lenses
 - Concave and convex mirrors
 - Magnifier and magnifying power
 - Focal length
 - Gauss approximation
 - Hyperopic eye
 - Myopic eye
 - Inverse square law of light
 - Lens power
 - Luminous intensity
 - The prism
 - Ray tracing
 - Refractive index
 - System of lenses
 - The microscope
 - The eye
 - The telescope
 - Thin lens equation
 - Light reflection and refraction
 - Colours mixing

Multiuse System used as an optical bench ▼



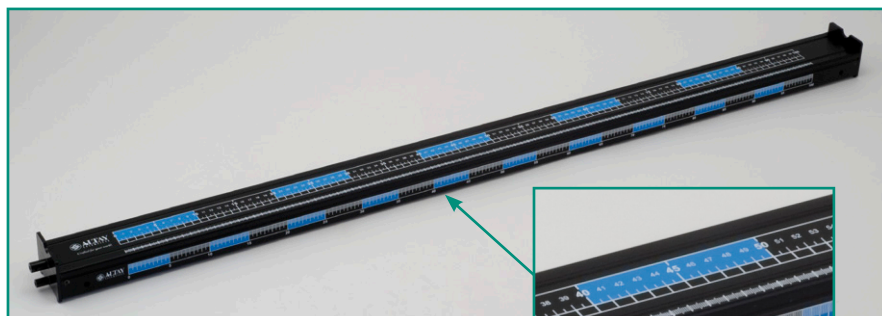
MODULAR SYSTEMS

Tracks

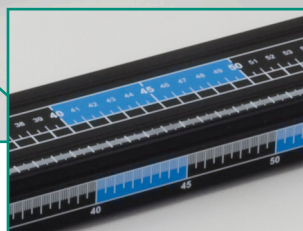
Track Set

4954.12

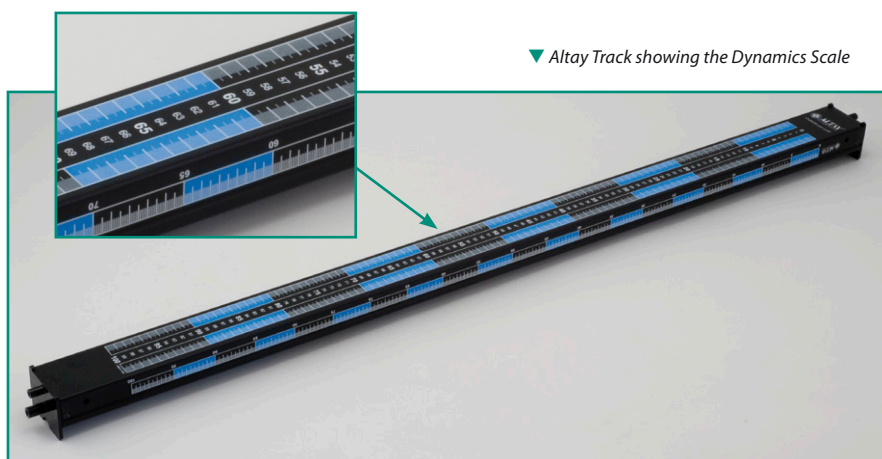
The Altay Multipurpose Track Set



▲ Altay Track



▼ Altay Track showing the Dynamics Scale



Specifications

Length: 116x7x4 cm

Weight: 2,4 kg

Also available

Altay Track Set (code 4954.11)

Size: 145x7x4 cm Weight: 2,8 kg

Designed to produce an almost frictionless track for the Altay Carts, it is also an Optical Bench, a Free Fall Stand for determination of "g" and a Pendulum Stand.

The Track Set has clearly defined scales printed on an attractive black anodised base.



MAIN COMPONENTS

- Altay Track
- Track terminals
- Fixing nuts

The Altay Track is designed to be easily integrated with data logging sensors, such as motion sensors and photogate sensors.

This is truly a versatile addition to any physics lab and underlines Altay's commitment to quality products at affordable prices. Our Multiuse Track solution is designed to use only one track in multiple setups as a track in mechanics experiments, as an operating desk in free fall and pendulum experiences and as an optical bench. The Altay Multiuse System allows you perform dynamics as well as optics experiments.

If you already have the bench, you can obtain our "Upgrade Systems" to convert from optics to dynamics and vice-versa.

Track Coupler

4941.70*

Join together the Multiuse Tracks, to expand the didactic experience



Specifications

Size: approx. 15 x 7x 4 cm

Weight: 0,6 kg

Equipment Needed:

Altay Track Set (code 4945.12) (2x)

Specifications

* Minimum Order Quantity 5 pcs

The Track Coupler allows to join together two Multiuse Track Sets, without any gap between: in this way it's possible to perform mechanics and optics experiments with a length of 230 cm, expanding the possibilities of making in-depth experimental analysis.

Easy to use and to mount, it's a "must have" for Multiuse users.

Mechanics Upgrade 1

4941.14

The Mechanics Upgrade 1 will give you a complete Dynamics System

Equipment Needed

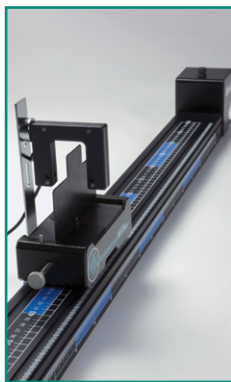
Altay Track Set (code 4954.12)
Timing Set (code 4922.10)
or LoggerPro Data Logger (code 2300.10)
or Labquest (code 2300.30)
with Two Motion Sensors (code 2310.10)



Multiuse System used with the Mechanics Upgrade 1 and a datalogger with two motion detectors



Example of use of the Mechanics Upgrade 1 with the Timing Set



Altay Cart passing under the Photogate

The Mechanics Upgrade 1 will give you a complete Dynamics System, with low friction carts and full accessories.

It is designed to perform experiments such as energy and/or momentum conservation, elastic and inelastic collisions, rolling friction, coupled harmonic oscillators, etc. If you add further accessories to the Altay Carts, you can perform many more experiments as well as interesting demonstrations.



MAIN COMPONENTS

- | | | |
|-----------------------------------|---|--------------------------|
| • Altay Cart without Plunger | • Additional Weight: for Cart - Same Mass as Cart | • with Screw |
| • Altay Cart with Plunger | • Additional Weight: for Cart - Double Mass of Cart | • Ziggurat Flag |
| • Track Terminals | • Low Friction Pulley | • Spring Holder for Cart |
| • Slotted Masses with Hanger 250g | | • Springs |
| | | • Support for Photogates |



LAWS AND PRINCIPLES INVESTIGATED

- | | | |
|--|--------------------------------|---|
| • Conservation of momentum and energy | • Impulse-momentum theorem | • Newton's 3rd Law of Motion |
| • Coupled harmonic oscillators | • Law of Inertia | • Qualitative and quantitative rolling friction |
| • Determination of acceleration and velocity | • Kinetic and potential energy | • Rectilinear uniform motion |
| • Elastic and inelastic collisions | • Acceleration | • Uniform accelerated rectilinear motion |
| | • Newton's 1st Law of Motion | |
| | • Newton's 2nd Law of Motion | |

Main components



EXAMPLE OF USE

Two coupled harmonic oscillators • With two carts and three springs it is possible to produce coupled harmonic oscillators

The motion of Dynamics Carts in this system is quite complicated. The motion of the system as a whole, can be split up in two components: the motion of the centre of mass and the relative motion of the carts (called the normal modes of oscillation).

By using a datalogger and a motion detector you can graph the movement of one cart. You can then quickly determine the normal modes of the system.

We can see two coupled harmonic oscillators (neglecting effects of friction).



Coupled harmonic oscillators experiment setup

MODULAR SYSTEMS

Mechanics

Mechanics Upgrade 2

4941.21

With our Mechanics Upgrade 2 you can use the Altay Track in a vertical plane to study free fall and motion of the pendulum

Also available with Remote Control
(code 4941.21-RC)

Equipment Needed

Track Set (code 4954.12)
Timing Set (code 4922.10)
Electronic Oscillation Counter (code 2237.12)



▲ Students acquiring data from Multiuse System in free fall configuration



MAIN COMPONENTS

- | | | |
|---|---------------------------------|--------------------------------------|
| • Bench Clamp for vertical mount support | • Electromagnet | • Stainless Steel Sphere, 25 mm |
| • Support for Vertical Mount | • RCA Cable for electromagnet | • Polyester inelastic cord |
| • Track Supports for Magnetics attachment | • Basket for Falling Spheres | • Three Spheres with Hook set |
| • Free Fall | • Stainless Steel Sphere, 19 mm | • Magnetic Support for Pendulum Cord |
| | | • Plasticine® |



LAWS AND PRINCIPLES INVESTIGATED

- | | | |
|--|--------------------|----------|
| • Determination of the acceleration of gravity | • Drag force | Pendulum |
| | • Free fall motion | |
| | • Law of the | |



▲ Free fall accessories

The study of free fall and the pendulum is one of the most fundamental studies in mechanics.

A free-falling object is an object which is falling under the influence of gravity. That is to say that any object which is moving and being acted upon only by the force of gravity is said to be "in a state of free fall". Determining and measuring free fall is made easy with our Mechanics Upgrade 2. You simply mount the Track in the vertical position and gather your data. The acceleration of gravity is studied by measuring the time necessary for a falling body to travel a fixed distance on the graduated scale. With this upgrade you can also verify the Pendulum Law.

Using the Altay Oscillations Counter and Electronic Timer the period of the pendulum can be easily and accurately measured.



▲ Pendulum accessories

▶ EXAMPLE OF USE

Free fall motion

Explore free fall motion with Altay Mechanics Upgrade 2

When the Altay Track is placed vertically you simply mount the photogate and connect it to the timer.

By placing the photogate at a chosen distance from the electromagnet, you can quickly measure the speed at which the body falls through the photogate and verify that the body is in free fall.

Whether the object is falling downward or rising upward towards its peak, if it is under the sole influence of gravity, its acceleration value is 9.8 m/s^2 .

This value is usually referred to as 'g'.

$$v_y = gt$$

$$y = \frac{1}{2} gt^2$$

Free fall motion equations

From this law you can experimentally determine the acceleration due to gravity 'g'. We can simply solve the formula to determine 'g' as a function of time (t).

MODULAR SYSTEMS

Mechanics

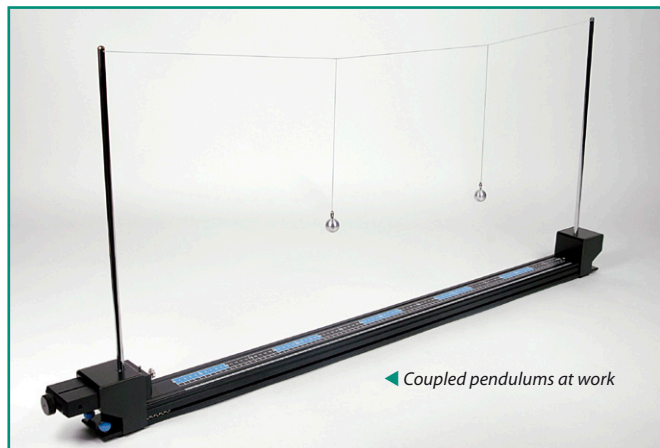
Coupled Pendulum Set

Equipment Needed

Mechanics Upgrade 1 (code 4941.14)

4941.16

Studying the coupled oscillators effect



Simple to set up and highly effective, the coupled pendulums transfer energy one to the other thanks to a thin string that couples them.

This system allows teachers to introduce the normal modes of oscillation. The resultant motion corresponds to the composition of two oscillations: the centre of mass motion and the relative motion of the pendulums.



▲ Coupled oscillators components



LAWS AND PRINCIPLES INVESTIGATED

- Pendulums
- Harmonic motion
- Resonance
- Energy transfer
- Couplement



MAIN COMPONENTS

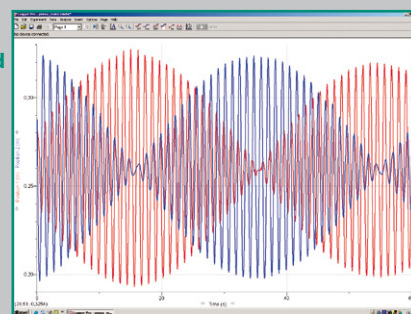
- Rods
- Spheres with Hook

EXAMPLE OF USE

Normal modes • Introduce the normal modes in the simplest way, the coupled pendulum motion

The normal modes of oscillations is a milestone concept in physics. The behaviour of the system can be deduced from the data plot. At first sight, students can notice that the motion of pendulum one (red plot) is symmetric to the motion of pendulum two (blue plot). After, we should see that the maximum amplitude of the first one corresponds to the second staying still and vice-versa. From our plot (e.g. the red one) we immediately note the presence of two frequencies superimposed which are related to the normal modes of oscillation.

Data from the coupled motion of pendulums



Eddy Current Set

Equipment Needed

Track Set (code 4954.12)

Mechanics Upgrade 1 (code 4941.14)

or Altay Cart with Plunger (code 4941.13)

4941.51*

Studying the Foucault Currents

Eddy Current Set ▶



* Minimum Order Quantity 5 pcs

Eddy current (also known as Foucault current) is a phenomenon caused by a moving magnetic field intersecting a conductor or vice-versa.

The relative motion causes a circulating flow of electrons, or currents, within the conductor. With this kit, students can easily study "electromagnetic brakes" (also called eddy current brakes), to retard motion or cause deceleration in a moving system. This type of brake converts kinetic energy to heat without contact between the moving parts. Heat is generated in the screen as a direct result of the electrical resistance of the material and the current flow induced in it; this heat represents the kinetic energy being absorbed, and it's analogous to heat generation in a friction brake.

The Altay Eddy Current Set is the simplest and more effective way to study Eddy Currents and all the principles concerning them.

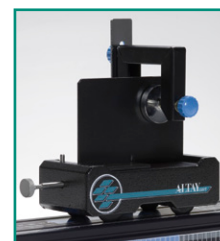
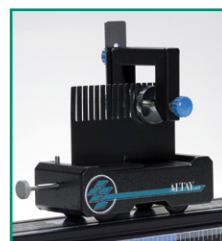
An eddy current is reproduced by using a "C" shaped magnet affixed to the track and then passing one of the screens through it.



MAIN COMPONENTS

- Aluminium flag with slits
- without slits
- Magnetic poles
- Aluminium flags
- Flag for motion sensor

Observe the different behaviour of the slitted and the solid flag



MODULAR SYSTEMS

Optics

Optics Upgrade 1

4944.11

The Optics Upgrade 1 is designed to convert the Altay Track into an optical bench

Equipment Needed

Altay Track Set (code 4954.12)

Transformer 12 V (code 2403.64)

The Optics Upgrade 1 allows students to configure the Altay Track as an optical bench.



▲ The Optical Bench using Altay Track

Projector and optical bench accessories



MAIN COMPONENTS

- Set of 4 Biconvex Spherical Lenses
- Set of 4 Biconcave Spherical lenses
- Set of 4 Concave Spherical Mirrors
- Set of 4 Convex Spherical Mirrors
- Equilateral glass prism
- Set of seven diaphragms
- White metal screen
- Projector



LAWS AND PRINCIPLES INVESTIGATED

- Convergent and divergent lenses
- Concave and convex mirrors
- Focal length
- Gauss approximation
- The eye (hyperopic and myopic eye)
- Inverse square law for light
- Lens power
- Luminous intensity
- Magnifier and magnifying power
- Photometry
- The prism
- System of lenses
- The compound microscope
- The telescope
- Thin lens equation



▲ Focal length experiment detail.

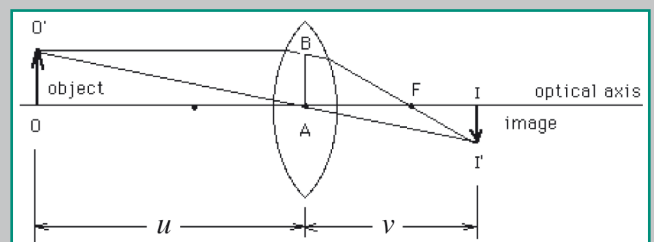
EXAMPLE OF USE

Focal length of a lens • An experiment illustrating how to determine the focal length of a converging lens

The mirror equation expresses the relationship between the object distance (u), the image distance (v) and the focal length (f). The equation is stated as follows and is known as the Gauss approximation.

$$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$

Thin lens equation, where u is the object distance, v is the image distance and f is the focal length



▲ Light propagation through a converging lens

The example below shows an experimental setup to determine focal length of a lens. Once the image is clearly focussed on the screen the measurement you can easily measure the distance of the object from the lens and the distance of the screen to the lens using the graduations on the bench. Thanks to this simple law, involving only three variables, it is easy to calculate f . The Altay Optics Bench makes it easy to set up an experiment to determine a value for f .

Optics Upgrade 2

4944.20

The advanced upgrade on geometric optics

Equipment Needed

Altay Track Set (code 4954.12)

Transformer 12 V (code 2403.64)



The Optics Upgrade 2 completes the equipment for geometric optics studies.

The kit demonstrates refraction and reflection of light using an Hartl disk, and introduces composition of the colours of light.

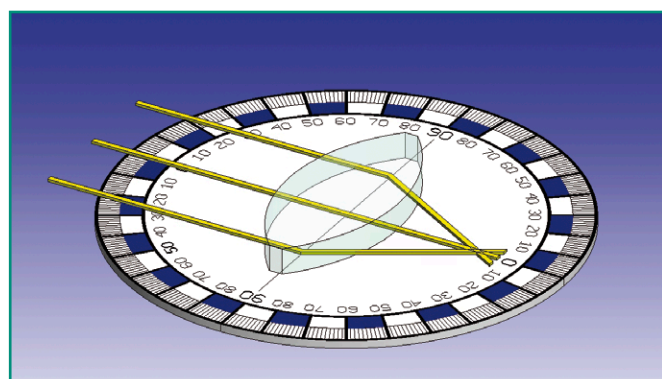
The optical bench is based on Altay Track.

Optics Upgrade 2 components on the optical bench

Lenses set with flexible mirror and Hartl disk

MAIN COMPONENTS

- Hartl Disk on stem
- Biconvex Lens for Hartl Disk
- Biconcave Lens for Hartl Disk
- Trapezoidal Prism for Hartl Disk
- Triangular Prism (90°, 45°, 45°)
- Deformable Mirror
- Plane Mirror
- Refraction Index Vessel
- Ray optics and colour mixing box



Path of light through a biconvex lens on the Hartl disk

LAWS AND PRINCIPLES INVESTIGATED

- Principles of biconcave, biconvex lenses and mirrors
- Mixing of colours
- Fermat's principle
- Determination of the focal length of a lens
- Hartl apparatus
- Inverse square law of light
- Light reflection and refraction

A biconvex lens placed on the Hartl disk



EXAMPLE OF USE

Hartl Disk • How to use the Hartl disk for geometric optics studies

The Hartl disk is designed to demonstrate many optical principles such as reflection, refraction, critical angle, principle rays, dispersion and how a rainbow is made. The light coming from the raybox provides a bright point source and is parallel to the disc. The raybox is for stand alone use or with the optical bench. When mounted on the linear bench, it provides an accurate and stable experimental setup. The Optics Upgrade 2 supplies various lenses of different shapes. Every lens shows a different behaviour of light rays. The behaviour of rays of light passing through the various lenses can be seen readily. Using the diaphragms set in front of the raybox, it is possible to obtain multiple rays of light in order to easily measure the refraction effects on the Hartl disk.

Optics Upgrade 3

4944.30

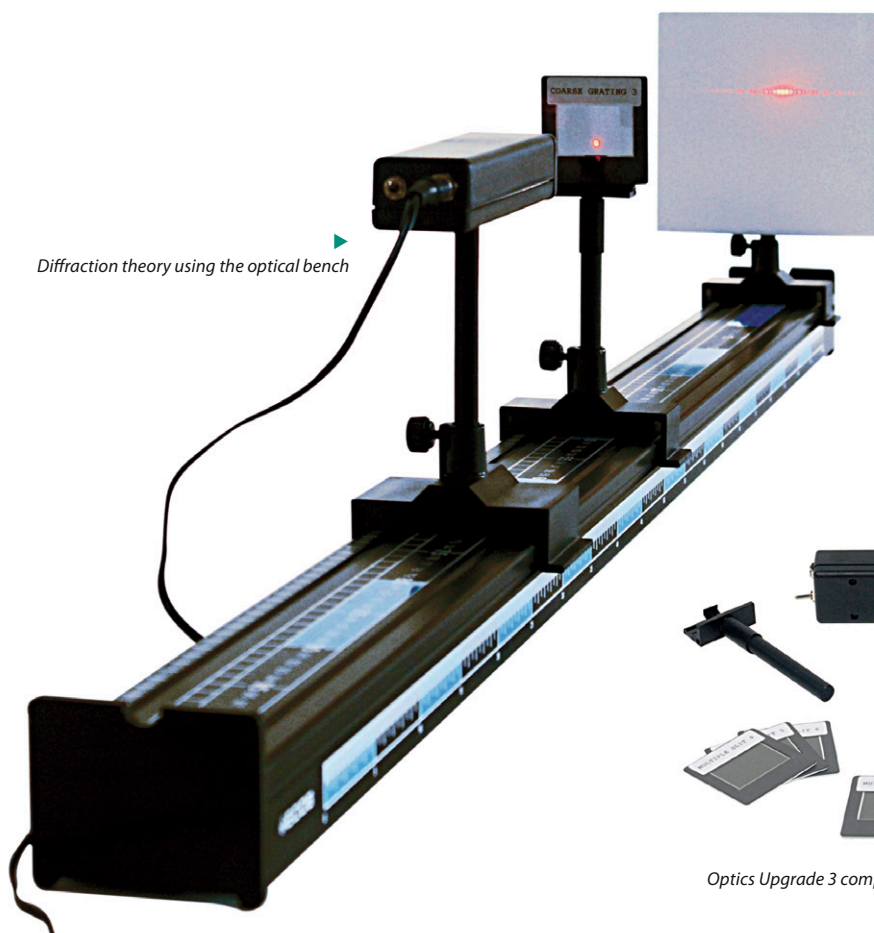
Diffraction using a laser

Equipment Needed

Optics Upgrade 1 (code 4944.11)
Track Set (code 4954.12)

Equipment suggested

White Metal Screen (code 4418.35)



Diffraction theory using the optical bench

With the Altay Optics Upgrade 3 you will complete your advanced optics experiments. Optics Upgrade 3 introduces further concepts of physical optics and allows study in advanced optics.

The diode laser allows you to study light as an electromagnetic wave and introduces the concept of diffraction. As in Optics Upgrade 2 all components are designed to work with the optical bench.



Optics Upgrade 3 components



MAIN COMPONENTS

- Laser on stem (630 – 670 nm), 1mW
- Slide with 1 slit (width 0.06 mm)
- Slide with 2 slit (width 0.06 mm, separation 0.20 mm, pitch 0.26 mm)
- Slide with 3 slit (width 0.06 mm, separation 0.20 mm, pitch 0.26 mm)
- Slide with 4 slit (width 0.06 mm, separation 0.20 mm, pitch 0.26 mm)
- Slide with 5 slit (width 0.06 mm, separation 0.20 mm, pitch 0.26 mm)
- Slide with 6 slit (width 0.06 mm, separation 0.20 mm, pitch 0.26 mm)
- Coarse grating 1 (4 lines per mm, line/space ratio 3:1)
- Coarse grating 2 (4 lines per mm, line/space ratio 6:1)
- Coarse grating 3 (8 lines per mm, line/space ratio 3:1)
- Metal gauze 300 mesh for bidimensional diffraction grating
- Diffraction grating



LAWS AND PRINCIPLES INVESTIGATED

- The Laser - principles of operation
- Investigating diffraction
- Experiments with interference patterns

▶ EXAMPLE OF USE

Light diffraction

Study the laser behaviour in a diffraction grating

A diffraction grating is a set of parallel slits used to disperse light. It is ruled with closely-spaced, fine, parallel grooves, typically several thousand per cm. It produces interference patterns in a way that separates all components of the incoming light. The Optics Upgrade 3 contains all that you need to study diffraction principles from single and multiple slits. With the help of the optical bench it is easy to verify optics laws measuring the distances between the diffraction grating and the screen.



▲ Optical bench helps measuring distances

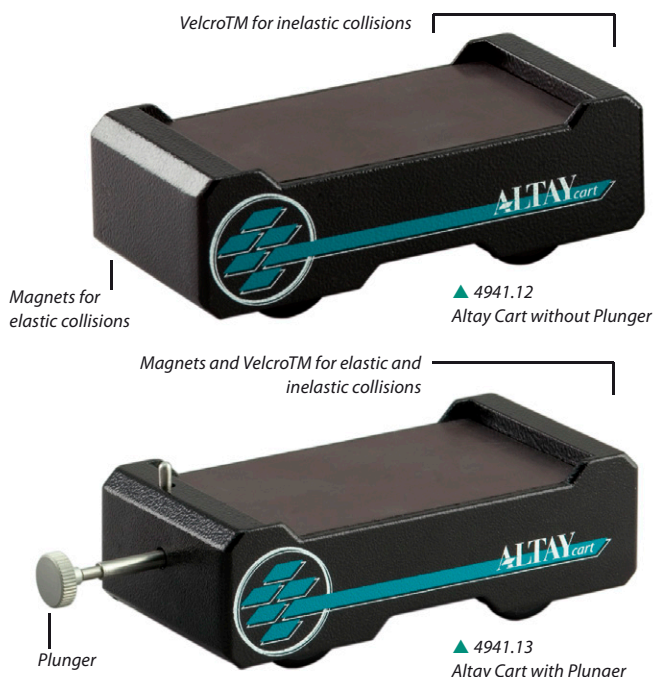
MODULAR SYSTEMS

Accessories

Altay Cart

4941.12* - 4941.13*

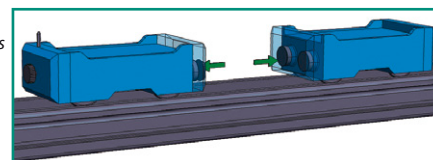
Elastic and inelastic collisions with our new cart



The brand new Altay Cart is ideal for all dynamics experiments.

Designed to be robust yet almost friction free, we have designed our cart so that it will withstand the rigours of any school laboratory. Manufactured from solid aluminium, we have used a special low friction wheel system. This system gives almost friction free movement and results which are accurate and repeatable time and time again. The carts are provided with two strips of Velcro™ and a pair of powerful neodymium magnets, which are designed for alternate elastic and inelastic collisions.

* Minimum Order Quantity 5 pcs



The cart (code 4941.13) includes a spring loaded plunger mechanism that can be released to provide an immediate impulse to set another cart in motion and to provide an initial impulse velocity. The plunger has two settings to allow a lesser or greater impulse depending on the mass of the adjacent cart.

Force Sensor Adapter for Altay Cart

4942.00

A new and unique way to use the Force Sensor



The Force Sensor Adapter allows the use of the Vernier Dual-Range Force Sensor (code 2311.10) on the Altay Carts (code 4941.12 and 4941.13), to have an easy and affordable way to acquire data when performing dynamics experiments. Using its magnetic attachment, it's extremely easy to use.

Specifications

Size: approx. 11x6x5 cm
Weight: 0,2 kg

Equipment Needed:

Altay Track Set (code 4945.12), Altay Cart without Plunger (code 4941.12) or Altay Cart with Plunger (code 4941.13); Dual-Range Force Sensor (code 2311.10)



EM Trigger & Launcher for Cart

4941.17

An automatic trigger/launcher for dynamics experiments

◀ EM Trigger & Launcher for Cart



The new Altay EM Trigger & Launcher for Cart is an ideal complement to the Mechanics Upgrade 1.

It allows a repeatability impossible to achieve by hand or any other method. The EM Trigger & Launcher for Cart can be used in dynamics experiments to investigate acceleration as a function of the impressed force and as a trigger for studying the motion on an inclined plane. Our specially designed, easy release mechanism, can give an impulse to the cart in an almost frictionless way, thus allowing repeatable and accurate results each time. Ideal for use with our Timing Set (code 4922.10).

Specifications

Specially designed to fit on Altay Track Set (code 4954.12)
Size: 12x7x9 cm - Weight: 0,50 kg

Equipment Needed

Altay Track Set (code 4954.12)
Mechanics Upgrade 1 (code 4941.14)
Timing Set (code 4922.10)

MODULAR SYSTEMS

Accessories

Ball Launcher for Cart

4941.60*

Ball Launcher for Cart can be used with Mechanics Upgrade 1 or with Altay Cart with Plunger



MAIN COMPONENTS

- Ball launcher
- Trigger flag
- Balls



LAWS AND PRINCIPLES INVESTIGATED

- Projectile motion
- component motions
- equation
- Determination of
- Resolution of
- gravity acceleration

An ideal accessory for the Mechanics Upgrade 1 to demonstrate the independence of vertical and linear motion.

* Minimum Order Quantity 5 pcs

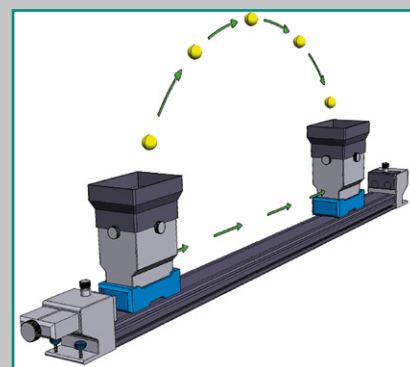


EXAMPLE OF USE

Composition of motion • Study the rectilinear uniform motion of the cart with the projectile motion in a unique way

Perform an interesting experiment that is not always intuitive. The Ball Launcher is designed to fit onto our low friction carts. The Launcher is triggered at a certain point to release the ball and assuming that the motion is a constant velocity the ball should then land back on the Launcher. This shows that vertical and horizontal motion are independent. The motion of the ball is a parabolic trajectory no matter how hard you push the cart. The ball has the same constant velocity of the cart on the x axis and is subjected to gravity acceleration in the vertical direction. At the end of the horizontal motion (x) the projectile falls again into the launcher because the vertical motion (y) remains the same.

▼ Ball Launcher experiment schema



Timing Set

4922.10



The Timing Set is an accessory pack for time measurements in dynamics Experiments and can be an alternative to data logging.

The brand new Timing Set can be also used as a chronometer.



MAIN COMPONENTS

- Electronic Timer
- Photogates

Fan for Cart

4941.65

Perform many experiments on pressure and thrust

Specifications

Size: approx. 15x15x23 cm - Weight: 1 kg

Equipment Needed:

Altay Track Set (code 4945.12)
Mechanics Upgrade 1 (code 4941.14)
or Altay Cart without Plunger (code 4941.12)



With the Altay Fan for the Altay Dynamics Cart, you can use your Multiuse System to perform several experiments on pressure and thrust.



LAWS AND PRINCIPLES INVESTIGATED

- Pressure
- Thrust

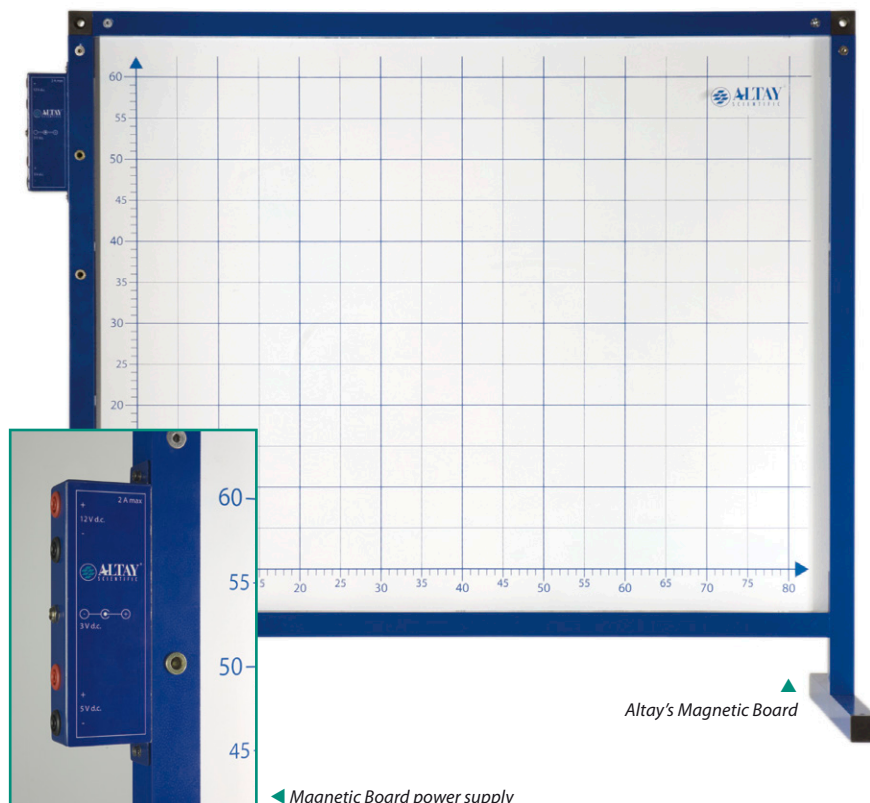
MODULAR SYSTEMS

Magnetic board

Magnetic Board

4114.30

A versatile solution to demonstrate mechanics, optics, electricity, electronics and radioactivity using a unique magnetic display board



Specifications

Size: 95x41x81 cm - Weight: 16 kg
Approx weight: 17.0 kg

Equipment Needed

External Power Supply 220AC 50Hz
(code 2402.56)

Embedded power supply

output 3.3 V – 5 V – 12 V DC, 1A

Compatible equipment

Mechanics Accessories Set (code 4114.35)
Falling Bodies Upgrade (code 4114.36)
Optics Accessories Set (code 4114.37)
Electricity System 1 (code 4866.19)
Electronics System 1 (code 4868.19)
Radioactivity Bench (code 4832.00)

The Altay Magnetic Display Board provides an excellent sturdy support for class demonstration of a wide variety of experiments in mechanics, optics, electricity, electronics and radioactivity.

Consisting of a large white magnetic board, all components in the Upgrade kits are fitted with a strong magnet which allows easy attachment to the board. The board is printed with a graduated x-y axis to allow each experiment to be easily quantified and measured. The board can be free standing or affixed to a wall with enclosed wall brackets. An integrated power supply is also included to allow attachment to accessories, such as a laser for example.

Mechanics Accessories Set

4114.35

Discover static forces with the Magnetic Board



Equipment Needed

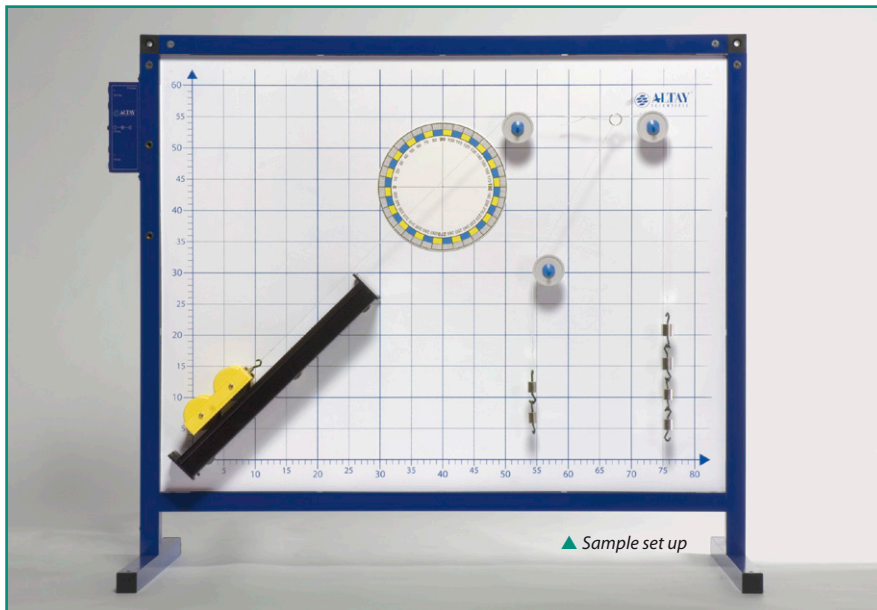
Magnetic Board (code 4114.30)

Together with the magnetic board, the Mechanics Accessories Set allows working demonstrations on: equilibrium, inclined plane, levers, pulley systems, simple machines and much more.

◀ Using Magnetic Board with mechanics accessories

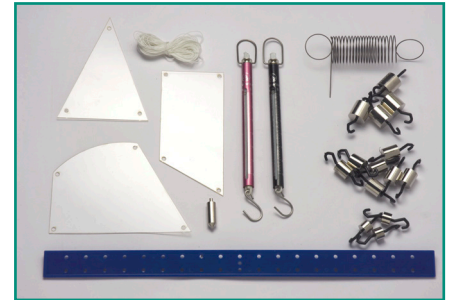
MODULAR SYSTEMS

Magnetic board



▲ Sample set up

The Mechanics Accessories Set give teachers and students the freedom to set up their own experiments. Thanks to the magnetic pins it's easy to place the inclined plane, pulleys, and all the other objects everywhere on the board and perform experiments in any configuration.



▲ Rule with holes, masses, spring, dynamometers, geometric objects and cord



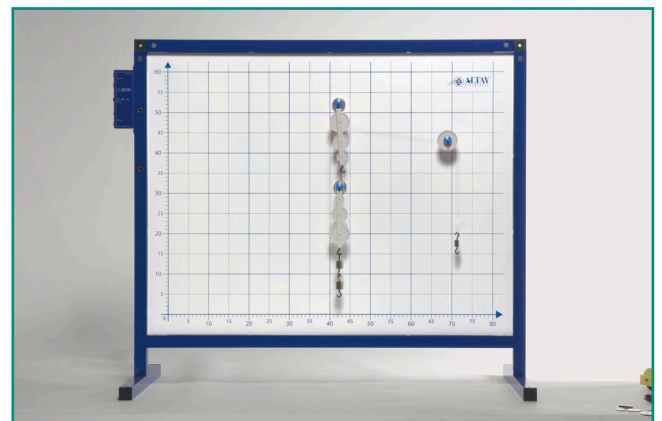
MAIN COMPONENTS

- Cart
- Inclined Plane
- Weinhold's Disk
- Tubular Spring Balances
- Pulley with Hook
- Triple-In-Line Pulley
- Triple-In-Axis Pulley
- Goniometric Circle
- Protractor 0-60°
- Rule 25 cm
- Steel Spring with
- Pointer
- Cylindrical Masses
- Magnetic Pin (long)
- Set of 3 Geometric Objects



LAWS AND PRINCIPLES INVESTIGATED

- Investigating balancing forces
- Balance of a heavy body on an inclined plane
- Determine the centre of gravity of a rod
- Build a block and tackle hoist
- Build a dynamometer, calibrate and use it to determine the torque and power
- Determining the centre of mass of a rod
- Understanding the concept of force, direction and intensity
- Measurement of the intensity of a force
- Equivalence between force couples of equal and different arm lengths
- Equilibrium of a material point
- Forces applied to a rigid body with fixed axes
- Build a Galileo Pendulum
- Investigate the resultant force of a system of convergent forces
- Determine the resultant force of two convergent forces
- Determine the resultant forces of two convergent forces applied to a rigid body
- Investigate a rigid and a heavy body suspended from a point
- Investigating Parallelogram Law
- Triple-in-axis pulley block
- Triple-in-line pulley block
- Study two forces applied to a fixed pulley
- Study two parallel forces applied to a mobile pulley
- Investigation forces applied to a material point suspended over an inclined plane

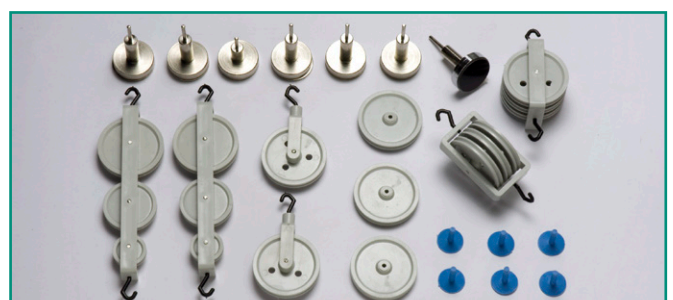


▲ Triple-in-line pulley block experiment

The set contains also multiple in-line and in-axis pulleys to study the mechanical advantage of a system of pulleys like the block and tackle as in the particular configuration of the triple-in-line pulley block.



▲ Track, cart, Weinhold's disk, protractor, rule and goniometer



▲ Various pulleys, pins and closing caps

MODULAR SYSTEMS

Magnetic board

Falling Bodies Upgrade

4114.36*

A simple and affordable way to observe laws of motion and energy conservation



▲ Falling Bodies Upgrade for Magnetic Board



MAIN COMPONENTS

- Diving Board
- Stainless Steel Sphere diam. 25 mm
- Stainless Steel Sphere diam. 19 mm



LAWS AND PRINCIPLES INVESTIGATED

- Conservation of energy in elastic collisions
- Momentum conservation in elastic collisions
- Laws of motion

With this accessory set the laws of motion and conservation became an easy subject. By using the silk-screen scale on the board and a videocamera it's possible to compare theory and experiments. This set can also be used to study elastic collisions.

▼ Example of use

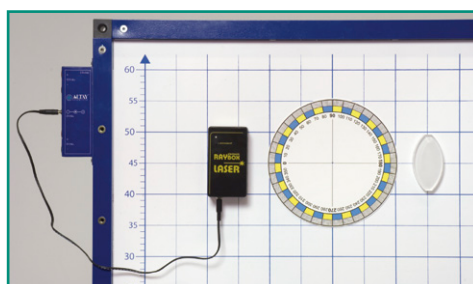


* Minimum Order Quantity 5 pcs

Optics Accessories Set

4114.37

Show to the whole class interesting optics experiment



◀ Optics Accessories Set

▲ Example of set up



MAIN COMPONENTS

- Five Beam Laser
- Magnetic Protractor
- Triangular Optical Body
- Biconvex Optical Body
- Body
- Biconcave Optical Body
- Trapezoidal Optical Body



LAWS AND PRINCIPLES INVESTIGATED

- Bi-concave and bi-convex lenses
- Focal length
- Refraction
- Refraction index
- Total reflection
- Snell's law

A five beam laser, a magnetic protractor and five optical bodies are the components of the optics accessories set. With this kit geometric optics is made simple.

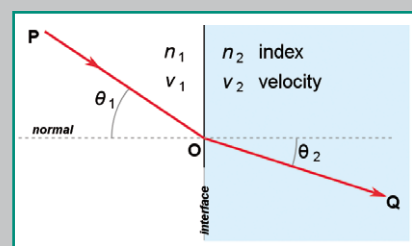
EXAMPLE OF USE

Snell's Law

Snell's Law describes the relationship between the angles of incidence and refraction of light, when it passes through a two different media (in example, air and glass). The law shows that the ratio of the sines of the angles of incidence and of refraction is a constant and that it depends on the media.

$$\frac{\sin \theta_1}{\sin \theta_2} = \frac{n_2}{n_1} \quad \text{◀ Snell's Law}$$

In optics, the law is used in ray tracing to compute the angles of incidence or refraction, and in experimental optics to find the refractive index of a material.



▲ Refraction of light

Hooke's Law Apparatus

4163.10

The Hooke's Law experiment set allows students to investigate the relation ship between the force applied to a spring and the amount of stretch on the spring

Specifications

Size: 30x20x80 cm - Weight: 2 kg

This rugged experiment features a heavy base to allow student to stretch springs without toppling the unit. We have printed an easy to read measuring scale on the side for easy of use.



LAWS AND PRINCIPLES INVESTIGATED

- Hooke's Law
- Determination of the elastic constant of a spring
- Hydrostatic balance



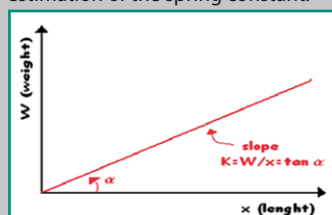
MAIN COMPONENTS

- Hooke's Law Apparatus
- Cylindrical Masses with Hook
- Spring

EXAMPLE OF USE

Hooke's Law Experiment

The force applied to a spring is directly proportional to the distance it will stretch. This behaviour is regulated by Hooke's Law, valid in a limited range of elongation of the spring. The same law allows for the estimation of the spring constant.

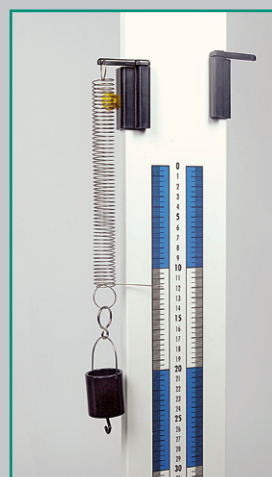


▲ Theoretic plot showing the Hooke's Law

$$F = -kx$$

Elastic constant formula

Our Hooke's Law Apparatus contains a tightly wound spring designed for easy determination of the formula. Graph the force needed to slightly stretch the spring and from the slope of the graph "force vs. elongation" we can determine the spring's constant.



▲ The elongation is proportional to the strain

Different Bodies with Equal Mass

4230.97

A set of cylinders to perform various experiments

Specifications

Diameter: 3 cm

Mass: 0,4 kg



Set of four cylinders of equal diameter and mass but different height in iron, brass, aluminium, copper, for experiments on calorimetry and for density measurements.



LAWS AND PRINCIPLES INVESTIGATED

- Density
- Specific heat

SINGLE ITEMS

Mechanics • Dynamics

Inclined Plane

4115.10

The most famous simple machine, revisited by Altay



MAIN COMPONENTS

- Inclined plane
- Bottle
- Balance pan
- Cylindrical mass
- Cart
- Massholder with masses
- Friction box



Specifications

Height (fully open): approx. 40 cm

Weight: 2,9 kg

Max angle: 45°

Equipment suggested

Dual Range Force Sensor (code 2311.10)

LabPro (code 2300.10) or LabQuest (code

2300.30) or Go!Link (2320.30)

One of the classical simple machines.

This classical apparatus is devoted to the study of static friction and tangential/normal components of the weight force.

It consists of an aluminium folding track and a protractor scale to be used for angle measurements.

A set of accessories allows to perform several classical experiments on this subject.

▼ Students using the Inclined Plane



LAWS AND PRINCIPLES INVESTIGATED

- Balance of a heavy body on an inclined plane
- Weight: force
- Static and dynamic friction

Small Cubes with Equal Volume

4230.98

A simple way to study density



Specifications

Size: 2x2x2 cm - Weight: 0,3 kg

Set of four cubes of equal side (20 mm) and different mass in iron, brass, copper, aluminium for experiments on density measurements.



LAWS AND PRINCIPLES INVESTIGATED

- Density

Elastic and Inelastic Collision in 2D

4130.20

Discover energy and momentum conservation laws during collisions

Specifications

Track length: 29 cm - Weight: 0,3 kg



Using our simple apparatus you can demonstrate the conservation of momentum and conservation of energy by showing elastic and inelastic collision experiments.



LAWS AND PRINCIPLES INVESTIGATED

- Conservation of energy in elastic collisions
- Conservation of momentum in elastic collisions
- Conservation of momentum and loss of energy in inelastic and perfectly inelastic collisions



MAIN COMPONENTS

- Aluminium ramp
- Glass ball
- Wood ball
- Steel ball, 13 mm

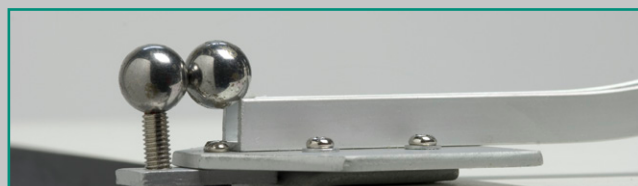


▶ EXAMPLE OF USE

Example of elastic collision

In order to investigate the elastic collision effect, choose two steel balls of equal mass; make one roll down the inclined ramp and collide with the second one at the rest on the support. The kinetic energy and momentum of the balls before collision can be easily determined as their masses and the height of the ramp are already known. What will happen to the balls after impact? What would happen if we changed the angle of impact?

Use carbon and tracing papers to estimate the final velocity of the balls.



▲ Just before collision of balls

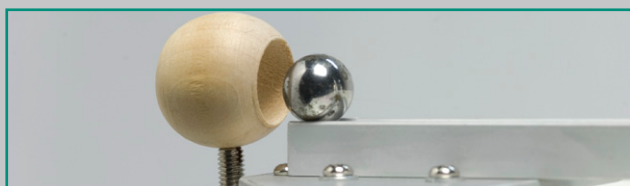
▶ EXAMPLE OF USE

Inelastic Collision

As you know, perfectly inelastic collisions do not conserve energy but only the total momentum of the system.

The drilled wooden ball placed at the end of the ramp with the hollow facing the track, will catch the rolling ball at the end of the fall. After the collision, they move on together as a one system.

Use carbon and tracing papers to empirically verify the conservation laws.



▲ Using the drilled wooden ball to perform perfectly inelastic collisions

SINGLE ITEMS

Mechanics • Dynamics

Maxwell Wheel

4150.00

Specifications

Approx. Size: diam. 30x20x40 cm

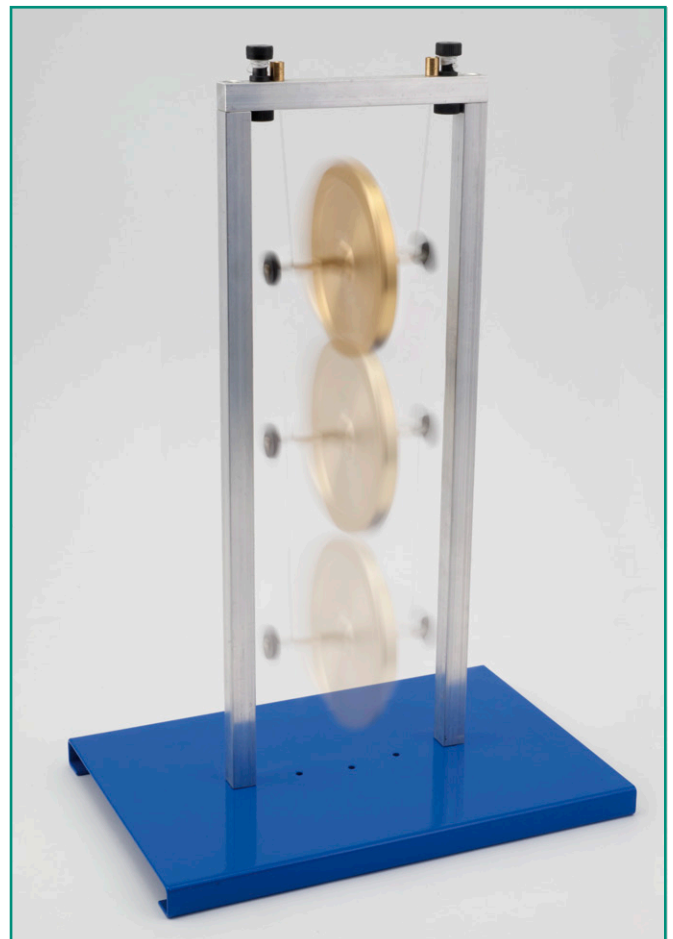
Weight: 2,5 Kg

Perform the most famous experiment on mechanical energy conservation



The Maxwell Wheel is the most famous apparatus used to perform experiments on Mechanical Energy conservation, explaining in an easy way how potential energy is transformed in and kinetic energy and vice-versa, without considering friction of the air and of the wires.

Maxwell Wheel is made by a big and heavy flywheel and a sturdy structure, allowing the demonstration for the whole class together.



LAWS AND PRINCIPLES INVESTIGATED

- Mechanical energy conservation
- Kinetic energy
- Potential energy
- Friction

▶ EXAMPLE OF USE

Mechanical Energy Conservation • Period of the Maxwell Wheel

Maxwell Wheel is, basically, a pendulum with its own period that can be determined using the mechanical energy conservation principle. While descending from the start position, the decrease in potential energy is compensated by the variations in kinetic energy (both rotational and translational): at the start point, there's only potential energy, while at the lowest point there's only kinetic energy.

Considering h the start point height, and c a constant coming from the moment of inertia of the flywheel, the pendulum period T is:

$$T = 2\sqrt{2h \frac{1+c}{-g}}$$

SINGLE ITEMS

Mechanics • Dynamics

Linear Air Track System

4132.10

A frictionless system to explore kinematics

Specifications

Size: 205x18x36 cm - Weight: 16 kg

Equipment Needed:

Air Blower Set (code 4132.60)

Timing Set (code 4922.10)



▲ The Air Track System

Used with the force sensor adapter (code 4132.90)

The most fundamental law of physics states that a moving object will continue forever at a constant velocity unless it is acted on by an external force. With our near frictionless linear motion track, this observation is made easy to understand. The Air Track can be used to obtain an accurate investigation of the laws of motion. Students can discover inelastic collisions, impulse and change in momentum, conservation of momentum, conservation of energy and more in our two meters long track. Because the frictional forces are negligible, the data derived will always be accurate.

▶ EXAMPLE OF USE

Newton's Laws

The best way to verify the Newton's Laws is to study an ideal rectilinear motion using the Altay's Linear Air Track System. Students can demonstrate precise accelerated motion in a frictionless system. For example, it is possible to attach a mass to one of the gliders via a pulley, and observe its accelerated motion, while a position sensor detects the characteristic parabolic trend in time.



MAIN COMPONENTS

- Track
- Long slider
- Short slider
- Electromagnet
- Magnetic Stands for photogates
- Low Friction Pulley
- Spring bumpers
- Pair of velcro attachments
- Slotted masses
- Springs
- Multiuse flag

Force sensor adapter for Air Track

4132.90*

Enhance the experiments with the Air Track using a Dual-Range Force Sensor

The Force Sensor Adapter allows the use of the Vernier Dual-Range Force Sensor (code 2311.10) on the Air Track Sliders (contained in code 4132.10); with it, it's possible to acquire data on frictionless dynamics experiments.

Specifications

Size: 4x1x5 cm - Weight: 0,1 kg

Equipment Needed:

Linear Air track (code 4132.10)

Dual Range Force Sensor (code 2311.10)



* Minimum Order Quantity 5 pcs



LAWS AND PRINCIPLES INVESTIGATED

- Conservation of momentum
- Conservation of momentum and energy
- Determination of the velocity of the constant linear motion
- Effect of a force on the motion of an object
- Elastic collisions
- Inelastic collisions
- Kinetic and potential energy
- Mixed motions: medium range speed, instantaneous speed, parabolic time chart
- Investigating Newton's 1st Law of Motion
- Investigating Newton's 2nd Law of Motion
- Looking at linear oscillating systems on a track
- Principle of Inertia
- Rectilinear uniform motion on a track
- Description of a trajectory
- Uniform accelerated rectilinear motion
- Uniformly mixed motion, speed and acceleration

SINGLE ITEMS

Mechanics • Dynamics

Collision Balls Apparatus

4130.50*

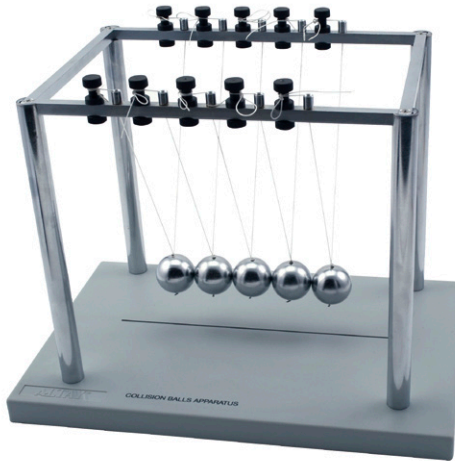
Altay's Collision Balls Apparatus provides an easy way to understand dynamics

Specifications

Size: 40x26x30 cm - Weight: 5,5 kg



The Collision Balls Apparatus



* Minimum Order Quantity 5 pcs

The 17th century physicist, Abbé Mariotte came up with the idea of the Collision Balls Apparatus.

It is an ideal apparatus to investigate several aspects of dynamics, such as conservation of momentum, conservation of energy and elastic collisions. It is constructed from five bobs hitting off one another. Each pendulum bob is restricted to move along the same plane, due to its attachment to the frame. Altay's Collision Balls Apparatus is made with sturdy materials, with steel balls to obtain the best results during impacts with every attachment is provided with an adjusting knob to increase accuracy.



LAWS AND PRINCIPLES INVESTIGATED

- Conservation of Momentum
- Conservation of Energy
- Elastic Collisions

EXAMPLE OF USE

Conservation of Momentum

Momentum (**p**) is the product of mass (**m**) and velocity (**v**) of an object (**p=mv**); it can be shown that the momentum of a closed system is conserved.

Considering a closed system of two objects, the change of momentum of the first object is equal and opposite to the change of momentum of the second:

$$\Delta p_1 = -\Delta p_2$$

In case of elastic collisions:

$$m_1 v_1 - m_1 u_1 = m_2 u_2 - m_2 v_2$$

With **u** velocity before the collision and **v** velocity after the collision.

Newton's Tube

4134.00

A falling body is independent of its mass and shape



LAWS AND PRINCIPLES INVESTIGATED

- Free fall motion in vacuum

Specifications

Size: DN5X105 cm - Weight: 0,7 kg

Weight: 1.0 kg

Equipment Needed

Vacuum pump (code 4184.21)

Using Newton's Tube we can demonstrate the independence of mass and shape of a falling body.

The apparatus consists of a vacuum tube containing a feather and a piece of metal. We can visually demonstrate both bodies falling together inside the evacuated tube.

EXAMPLE OF USE

Newton's 2nd Law of Motion • To verify that the falling velocity is independent of mass and shape

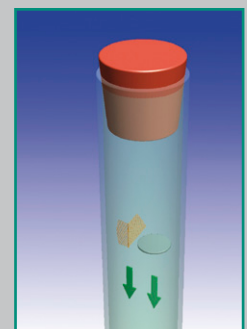
A force will produce an acceleration proportional to the mass of the body, as stated by 2nd Newton's Law of Motion. We can show that acceleration due to gravity (**g**) is independent of mass (**m**) as follows:

$$\begin{aligned} \text{Gravity force and Newton's 2nd Law of Motion} & \left\{ \begin{aligned} F_g &= mg \\ F &= ma \end{aligned} \right. \text{ which will make: } a = g \end{aligned}$$

Theory tells acceleration is independent of mass

The masses simplify, as we can observe thanks to Newton's Tube.

Detail of the falling bodies



Free Fall and Pendulum Apparatus

4134.70

A complete solution for the study of free fall and pendulum motion

Specifications

Vertical column height: 170 cm

Scaled surface length: 150 cm

Weight: 8,4 kg

The apparatus is designed specifically for the study of free fall due to gravity and the study of the Law of the Pendulum.

It consists of a vertical column with a graduated scale and an electromagnet, mounted on a triangular base with levelling screws and a basket for the falling spheres. The acceleration of free falling bodies, defined as "g", is studied by measuring the time necessary for a falling body to move a fixed distance on the graduated scale. The apparatus can be used with Electronic Timer. To use a large LED display for classroom use, the Altay Large Display (code 2236.50) is an ideal choice.



MAIN COMPONENTS

- Free Fall and Pendulum Apparatus
- Electronic Digital Timer
- Photogates
- Electronic Oscillation Counter
- Set of Three Spheres with Hook (PVC, Brass, Wood)
- Stainless Steel Spheres
- Free fall electromagnet cap



LAWS AND PRINCIPLES INVESTIGATED

- Investigating motion of different objects with free fall
- Experiment to demonstrate the Law of the Pendulum
- Acceleration of a free fall objects of different masses
- Determination of "g" and acceleration by means of the free fall
- Determination of "g" by means of the pendulum
- Drag or frictional force on a pendulum
- Study the oscillations or periods of a pendulum
- Determination of the drag force acting on a body in motion

▶ EXAMPLE OF USE

The Laws of the Pendulum • Study of the oscillations in a pendulum

The Law of the Pendulum ▼

The Electronic Digital Timer is an ideal tool to study of the Laws of the Pendulum. We can also use the Electronic Oscillation Counter to measure the period of the pendulum (T) to easily verify the following formula.

$$T = 2\pi \sqrt{\frac{l}{g}}$$

Pendulum accessories



Free Fall Apparatus components



Remote Control Upgrade

4134.75

Enhance the experiences with the Free Fall and Pendulum Apparatus



Specifications:

Weight: 0,6 kg

Equipment Needed:

Free Fall and Pendulum Apparatus (code 4134.70)



The Remote Control Upgrade is the perfect companion for the Free Fall and Pendulum Apparatus, allowing to use it from far away: just push a button and observe the phenomenon, while the Electronic Timer acquires the data.



MAIN COMPONENTS

- Receiving
- Stereo cable
- Remote control electromagnet cap

SINGLE ITEMS

Mechanics • Dynamics

Projectile Launcher

4135.10

The ideal tool to study projectile motion

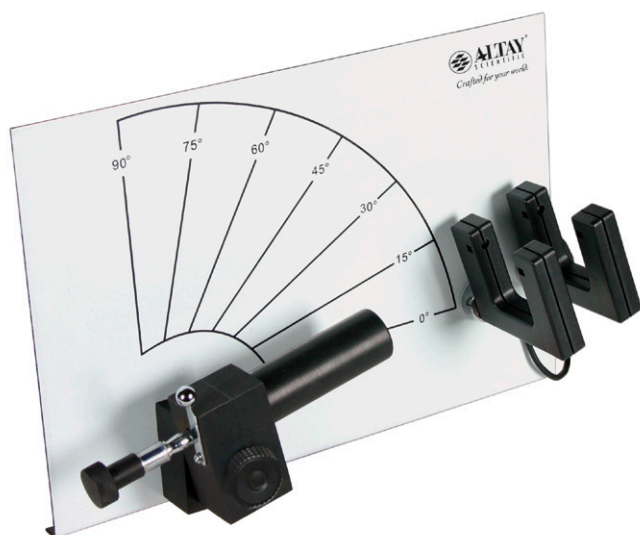
Specifications

Screen size: 30x20x10 cm cm - Weight: 2,3kg

Equipment Needed

Photogates (code 2232.52)

Electronic Digital Timer Set(code 2232.56)



▲ Projectile Launcher with photogates

The Altay Projectile Launcher is an ideal demonstrator showing that motion in different planes are independent of each other. The Altay Projectile Launcher not only illustrates this non-intuitive idea, but it can be used to describe the exact motion of the projectile as well.

Having seven different launch angles (in 15° increments) from 0° to 90°, it gives you the option of horizontal and variable angle launching positions. The Altay Projectile Launcher is designed with safety in mind, having our four setting spring mechanism fully enclosed. Each of the four launch positions are released by means of a simple arm release mechanism which ensures minimal contact and hence repeatable launches time and time again. Our unique piston design means that we have minimised projectile spin so that we can ensure the highest accuracy in hitting the exact stop each time. Also featured is a sturdy bench top clamp which can be rigidly secured to any table surface to ensure repeatable results each time the projectile is launched. Our launcher can also be fitted with photogates, which allows precise calculations of launch velocities, acceleration and for "monkey and hunter" experiments. With the help of a simple digital camera and a motion analysis software, it is also possible to study the motion in great detail.



MAIN COMPONENTS

- Projectile Launcher
- Stainless Steel Sphere
- Landing Base



LAWS AND PRINCIPLES INVESTIGATED

- Projectile motion
- Decomposition of motions
- Acceleration of gravity

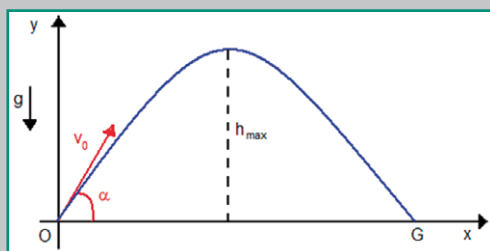
► Projectile Launcher components



EXAMPLE OF USE

Study of motion of a projectile • An experiment to analyse the motion of a projectile

The projectile fired by a gun is a good example of motion; there will always be constant acceleration (acceleration due to gravity, **(g)**) as described below:



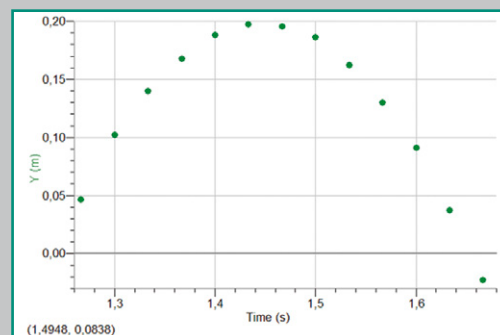
◀ Projectile motion showing constant acceleration

Using this graph, it is possible to draw the trajectory of motion and deduce the following equations:

$$\begin{cases} \frac{d^2x}{dt^2} = 0 \\ \frac{d^2y}{dt^2} = -g \end{cases} \Rightarrow \begin{cases} v_x = v_0 \cos \alpha \\ v_y = v_0 \sin \alpha - gt \end{cases} \Rightarrow \begin{cases} x(t) = (v_0 \cos \alpha)t \\ y(t) = (v_0 \sin \alpha)t - \frac{1}{2}gt^2 \end{cases}$$

◀ General equation of motion of the projectile

In the formula the motion along x axis is rectilinear uniform, along the y axis is determined by the acceleration of gravity (**g**) and is negative in the first half of motion and positive in the final trajectory. There are four spring launch positions and one arm for the release. By using one or two photogates it is possible to measure the launch velocity. With the help of a simple digital camera and motion analysis software it is possible to study the motion in great detail.



◀ Plot of trajectory of the projectile using datalogging

Simple Pendulum

4136.50

The simplest way to discover pendulum

Specifications

Size: 17x15x70 cm - Weight: 1,6 kg

Simple Pendulum is made of strong and lasting materials. Two different diameter balls show that the period of oscillation of pendulum depends only from the length of the cord. Altay Simple Pendulum is created to show to the whole class the fundamental experiments concerning pendulum and its laws.



LAWS AND PRINCIPLES INVESTIGATED

- The Law of the Pendulum
- Independency of the period from the mass

The Simple Pendulum



Multiple Pendulum Apparatus

4137.40

Specifications

Size: 104x30x35 cm - Weight: 2 kg

Understanding the Laws of the Pendulum



▲ The Multiple Pendulum Apparatus



MAIN COMPONENTS

- Multiple Pendulum Apparatus
- Set of four Wood Spheres
- Set of four Brass Spheres
- Set of four PVC Spheres



LAWS AND PRINCIPLES INVESTIGATED

- The Laws of the Pendulum
- Determination of the acceleration due to gravity



Multiple Pendulum Apparatus components

This apparatus has been developed for the specific purpose of studying the Laws of the Pendulum. Using a set of spheres of different masses we can demonstrate how influential mass can be on a pendulum system. The apparatus can also be used to measure gravity and acceleration.

EXAMPLE OF USE

The Law of the Pendulum

Sample experiments with the pendulum



▲ Pendulum detail with bifilar suspension

A simple pendulum can be thought as a point mass suspended on a wire of negligible weight. Two forces act on the mass: the centripetal force due to the wire and the force of gravity. In small oscillations the period (T) depends on the wire extension (l) and the gravity constant (g) defined as:

$$T = 2\pi \sqrt{\frac{l}{g}}$$

Simple pendulum formula

SINGLE ITEMS

Mechanics • Dynamics

Moment of Inertia Apparatus

4138.50

An experimental approach to the moment of inertia



Specifications

Disks diam. 60.0 cm and 20.0 cm
Rod length 50.0 cm
Weight: 6,4 kg

Equipment Needed

Digital Chronometer (code 2231.52)
Vernier Photogate (code 2312.10)
or Motion Detector (code 2310.10)
LabPro (code 2300.10)

The Moment of Inertia Apparatus allows students to verify the laws of the moment of inertia.

Disks of different masses and hollow cylinders, can be mounted on a low friction system in order to perform qualitative and quantitative observations. The apparatus can be used both with an electronic timer and photogates, or with a datalogger system and a computer interface.

◀ Moment of Inertia Apparatus



LAWS AND PRINCIPLES INVESTIGATED

- Disk's moment of inertia, experimental approach and theoretical approach
- Friction's moment
- Moment of inertia, experimental approach and theoretical approach
- Hollow cylinder's moment of inertia, experimental approach, theoretical approach
- Eddy currents and magnetic friction
- Parallel axis theorem



MAIN COMPONENTS

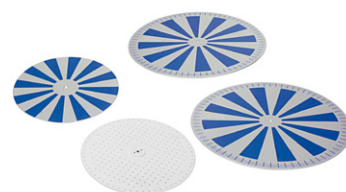
- Graduated Rod
- Aluminium Disks
- 50g with Pin
- Air Cushion
- Hollow Cylinders
- Air Blower
- Differential Pulley
- Cylindrical Masses
- Clamp



▲ Hardware components



▲ Air blower set



▲ Disks for moment of inertia experiments

EXAMPLE OF USE

Moment of Inertia • A nice demonstration of the important concept of Inertia

The moment of inertia of a solid body corresponds to its tendency to resist angular acceleration. It is specified with respect to a chosen axis of rotation and generally has an integral form. For a point mass, it simplifies to the product of the mass (**m**) times the square of the distance (**r**) from the rotation axis.

Sample assembly for the Moment of Inertia Apparatus

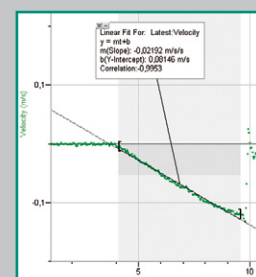


The point mass relationship is the basis for all other moments of inertia, since any object can be built from a collection of point masses.

$$I = mr^2$$

Moment of Inertia of a point mass

Data acquired to estimate the moment of inertia of a hollow cylinder



Centrifugal Force Apparatus

4142.70

An experimental insight into centrifugal forces and the flattening of the "Earth's poles"

Specifications

Size: 16x16x45 cm
Weight: approx. 3 kg
Mounted on base

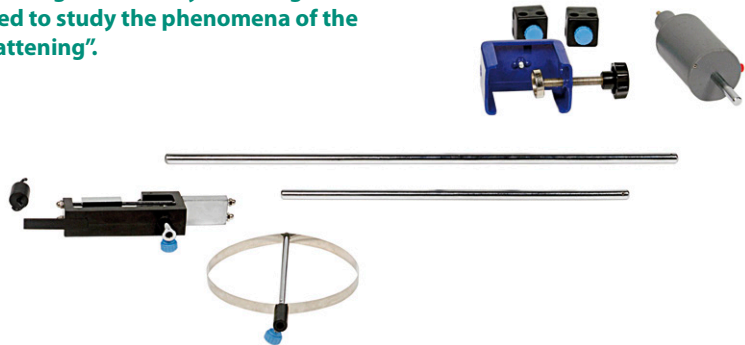
Equipment Needed

Vernier Photogate (code 2312.10)
Dual-Range Force Sensor (code 2311.10)
LabPro (code 2300.10)
Power Supply 1.5 A (code 2407.70)



Centrifugal Forces and "Earth's poles flattening" Apparatus

The apparatus is designed to study centrifugal forces. It can also be used to study the phenomena of the "Earth's poles flattening".



MAIN COMPONENTS

- Centrifugal Force Apparatus
- Bench Clamp
- Rolling wire suspension
- Centrifugal force rotator
- "Earth's poles flattening" demonstrator



LAWS AND PRINCIPLES INVESTIGATED

- Centrifugal and centripetal force
- Model of Earth's pole flattening

▶ EXAMPLE OF USE

Earth's poles flattening demonstrator

By using the Earth's poles flattening demonstrator mounted on the electric motor, it is possible to observe the effect of the centrifugal force on the shape of Earth.

We can readily see that the squeezing of the poles is a balance of the centrifugal force, due to the rotation of the Earth, and a centripetal force due to the elastic deformation of the Earth.

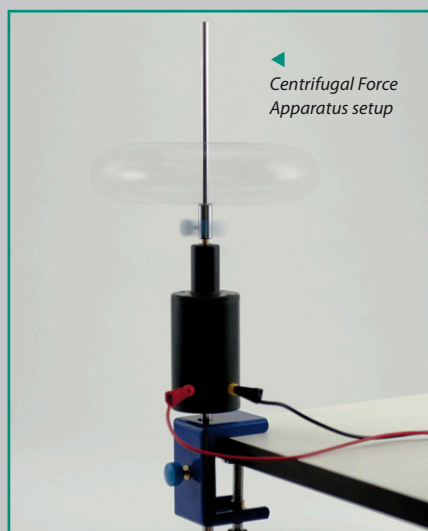
Centrifugal force • How to measure the intensity of the centrifugal force

According to Newton's 3rd Law of Motion, for every action there is an equal and opposite reaction.

In centripetal forces, the action is balanced by a reaction force and the centrifugal ("centre-fleeing") force. The two forces are equal in magnitude and opposite in direction.

The rotating mass is held in its path by a string which transmits the centrifugal force to the force sensor, meanwhile the photogate detects the passage of the mass at every revolution.

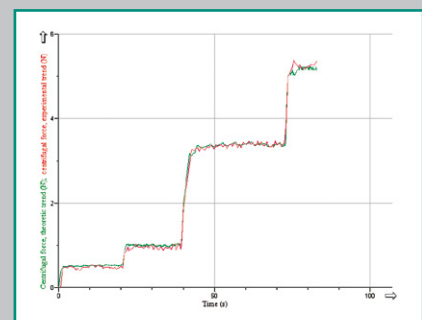
The measurements collected through the datalogger readily allow us to relate the centrifugal force to the angular velocity of the mass.



Centrifugal Force Apparatus setup

In the graph, experimental data is plotted in red and predicted data in green.

The dataplot shows different values of the intensity of the centrifugal force for various angular velocities.



▲ Data of the centrifugal force

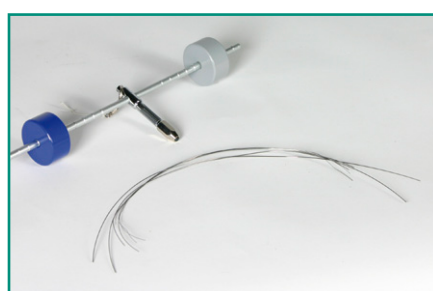
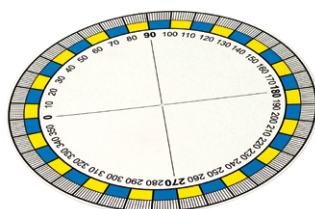
SINGLE ITEMS

Mechanics • Dynamics

Torsion Balance

4170.00

Static and dynamic measurement of the torsional modulus of a metal wire



Specifications

Size: 37x35x100 cm

Weight: approx. 5 kg

Equipment Needed

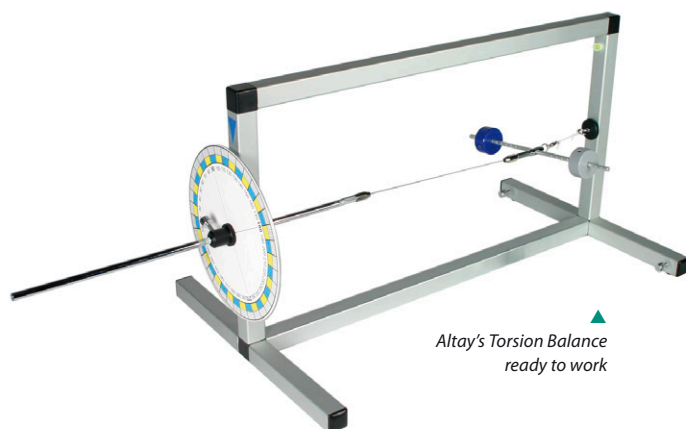
Digital Chronometer (code 2231.52)

or Vernier Photogate (code 2312.10)

or Motion Detector (code 2310.10)

LabPro (code 2300.10)

Precise and simple, the Altay's Torsion Balance is designed to study the torsional elasticity of a metal wire. Using pendulum's movement, the measurement of the balance oscillating period allows us to estimate the modulus of torsion.



MAIN COMPONENTS

- Torsion balance
- Pan for weights
- Reference index
- Mass
- Balance Arm with nylon string and weights
- Metal wire diam. 0,6mm
- Metal wire diam. 0,8 mm
- Metal wire diam. 0,4mm



LAWS AND PRINCIPLES INVESTIGATED

- Moment of inertia
- Oscillation's period
- Moment of a force
- Torsional modulus



EXAMPLE OF USE

Torsional modulus • The measurement of the torsional modulus of a metal wire

Place the torsional balance vertically to measure the torsion modulus. First, proceed to estimate the inertia momentum according to the weights' position on the balance arm. Then set on moving the balance and record the number of oscillations and the time period in your logbook. Apply the empirical formula relating the oscillation period, the momentum of inertia and the torsional modulus:

$$T = 2\pi \sqrt{\frac{I}{\tau}}$$

Set the apparatus horizontal and take a static measure of the torsional modulus, then compare the two.

SINGLE ITEMS

Mechanics • Mechanics of Fluids

Pellat Apparatus

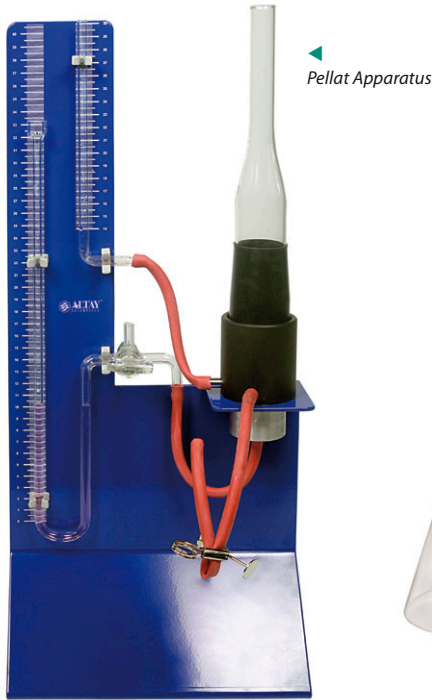
4180.20

Specifications

Size: 24x28x55 cm

Weight: 3.0 kg

A simple experiment to study hydrostatic pressure



The Pellat Apparatus is specifically designed to study the independence of hydrostatic pressure from the shape of the vessel.

The apparatus is provided with glass cones of different shapes in order to study this principle. A specifically designed pump system allows us to compare the pressures of different shapes. The apparatus is composed of a supporting panel on which a cylindrical support is used to hold the various shaped containers.



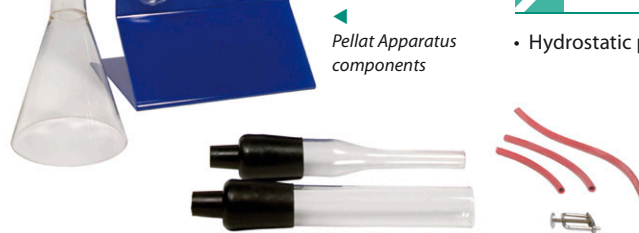
MAIN COMPONENTS

- Membranes
- Glassworks
- U-Tube Manometer



LAWS AND PRINCIPLES INVESTIGATED

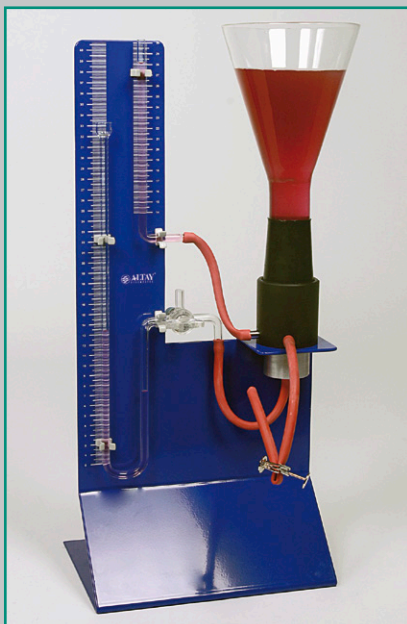
- Hydrostatic pressure
- Communicating vessels principle



The bottom of the support is made of an elastic membrane which is the moving part of a capsule connected with an air gauge. A small vertical tube is used for checking the level and the discharge of the vessels.

EXAMPLE OF USE

Hydrostatic pressure • Independence of the pressure on the shape of the vessel



With this easy to use apparatus, it is possible to demonstrate that the hydrostatic pressure on the bottom of a vessel does not depend on the shape of the vessel but only on the specific weight and on the level of the liquid. The effect can be shown through a vessel whose bottom is the membrane of a manometer capsule. If water is poured in the vessel it can be observed that as the level increases the pressure shown by the gauge increases. This is because the pressure on the flexible wall of the manometer capsule at the bottom increases.

Once a predetermined level (say 28 cm) has been reached, the level of the liquid contained in the left limb of the gauge is marked before turning the vessel over and substituting it with another of different shape. By filling a different vessel up to the same level as the first, it can be observed that the pressure at the bottom of the membrane will still remain the same. A similar result will be seen with a third different vessel.



Thin shape vessel with 28 cm water height shows the same 13 cm pressure column height



SINGLE ITEMS

Mechanics • Mechanics of Fluids

Pascal's Apparatus

Specifications

Size: 15x20x25 cm

Weight: 0,4 kg

4180.12

Verify the Pascal's Law in a simple way



Pascal's Apparatus

Our Pascal's Apparatus has been designed to easily demonstrate that the pressure in a vessel is the same in every direction.

The apparatus is mounted in a strong shock resistant plastic base.

EXAMPLE OF USE

Pascal's Law

Pascal's law or Pascal's principle states that for all points at the same absolute height in a connected body of an incompressible fluid at rest, the fluid pressure is the same, even if additional pressure is applied on the fluid at some place. The difference of pressure due to a difference in elevation within a fluid column is given by:

$$\Delta P = \rho g (\Delta h)$$

where, using SI units,

ΔP is the hydrostatic pressure (in pascals), or the difference in pressure at two points within a fluid column, due to the weight of the fluid;

ρ is the fluid density (in kilograms per cubic meter);

g is sea level acceleration due to Earth's gravity (in meters per second squared);

Δh is the height of fluid above (in meters), or the difference in elevation between the two points within the fluid column.

Pascal's law can be interpreted as saying that any change in pressure applied at any given point of the fluid is transmitted undiminished throughout the fluid.



LAWS AND PRINCIPLES INVESTIGATED

- Pascal's Law

Spouting Jar

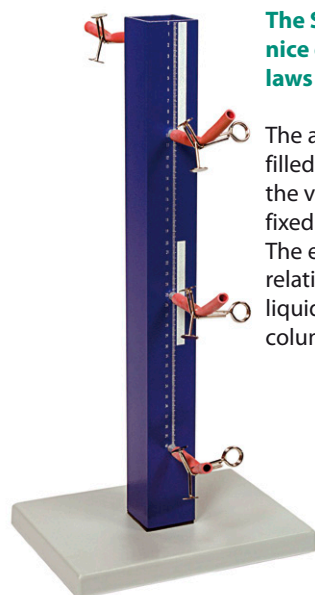
Specifications

Size: 25x28x52 cm

Weight: 1,2 kg

4180.42

Easily demonstrate the various pressures of liquids



The Spouting Jar Apparatus gives a very nice classroom demonstration of the laws governing pressure in fluids.

The apparatus consists of a metal column filled with water which spouts out along the vertical column through rubber tubes fixed along its length.

The experiment will clearly show the direct relationship between the pressure of the liquid and length of the ejected water column through each spout.

Altay's Spouting Jar

EXAMPLE OF USE

Mechanics of fluids • Verifying the Stevino's Law

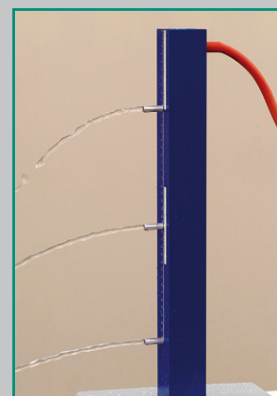
The most immediate application of this apparatus is the quantitative verification of the Stevino's Law. This law relates liquid pressure to the atmospheric pressure (P_{atm}), the density (ρ) of the fluid, the gravity acceleration (g) and the height (h) of the water column:

Right away students can notice a remarkable difference between the three spouts and applying the basic laws of kinematics,

$$P = P_{atm} + \rho gh$$

they can relate the velocity of the outgoing water with the pressure (P) of the liquid at that height. The linearity of Stevino's Law follows.

$$v = \sqrt{2gh} = \sqrt{\frac{2P}{\rho}} \rightarrow P = \frac{1}{2} \rho v^2$$



▲ Snapshot of the Spouting Jar at work



LAWS AND PRINCIPLES INVESTIGATED

- Stevino's Law

SINGLE ITEMS

Mechanics • Mechanics of Fluids

Communicating Vessels

4180.60*

An interesting experiments with connecting vessels

Specifications

Size: 20x18x20 cm
Weight: 0,2 kg
Mounted on base



Communicating Vessels with coloured water

* Minimum Order Quantity 5 pcs

The apparatus is an ideal experiment platform to study the principles of connecting fluid vessels.

It consists of a set of four inter-communicating glass tubes of different diameters and shapes. This is an ideal demonstration tool for the observation of fluid dynamics.



LAWS AND PRINCIPLES INVESTIGATED

- Communicating vessels principle



EXAMPLE OF USE

Fluid Dynamics • Take an insight of this interesting behaviour of liquids

The level reached by the liquid in each of the four glass tubes of the apparatus is the same and it remains so even if the apparatus is inclined! If you add a non-miscible fluid to one of the tubes by replacing the same amount of the fluid already there, the level containing the non-miscible fluid will be different from the other levels.



Students peering at the principle of communicating vessels

Capillary Tubes

4182.20*

Exploring capillarity of various fluids

Specifications

Size: 20x18x20 cm
Weight: 0,2kg
Mounted on base



The Capillary Tubes apparatus

* Minimum Order Quantity 5 pcs

An easy to use apparatus to investigate capillarity and surface tension in fluids.

The apparatus consists of a set of five interconnecting glass tubes of different diameters which give students a unique experimental insight to the phenomena of capillarity and surface tension.



EXAMPLE OF USE

Capillarity • Narrow tubes and fluid behaviour

Capillary action is a physical effect caused by the interactions of a liquid with the walls of a thin tube. The capillary effect is a function of the ability of the liquid to wet a particular material.

It is due to surface tension by which the portion of the surface of a liquid coming in contact with a solid is elevated or depressed, depending on the adhesive or cohesive properties of the liquid.

The liquid reaches different levels depending on the size of the capillary tube and the difference in height increases as the radius decreases according to Jurin's Law.

h is the height, **r** is the capillary radius, **t** is the surface tension of the liquid.

$$h \cong \frac{2\tau}{\rho g r}$$

Jurin's Law



LAWS AND PRINCIPLES INVESTIGATED

- Capillarity
- Jurin's Law

SINGLE ITEMS

Mechanics • Mechanics of Fluids

Lift Pump on Stand

4183.11

Discover how pumps work



The Lift Pump on Stand Apparatus

This striking demonstration glass apparatus, mounted on a strong iron base, allows students to understand the basic principles of mechanics of fluid.

The transparent design allows an in-depth comprehension of the mechanism, thanks to the view of valves.

Specifications

Size: 14x14x30 cm
Weight: 2,3 kg
Mounted on base



MAIN COMPONENTS

- Lift Pump
- Base
- Basket



LAWS AND PRINCIPLES INVESTIGATED

- Pump functioning
- Concept of Pressure

Vacuum Bell with Plate

4315.60

The classic vacuum bell for acoustic and mechanics of fluid Experiments

Specifications

Size: DN22x30 cm
Weight: 3,4 kg

This bell is the ideal solution for experiments involving propagation of sound in a vacuum.



The Vacuum Bell with Plate



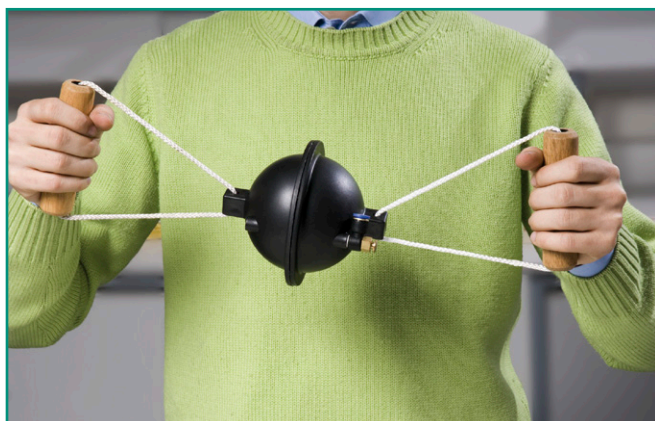
MAIN COMPONENTS

- Glass Bell
- Rubber cup
- Buzzer
- Plate

Magdeburg Hemispheres

4184.48

The clearest and funniest Experiment to explain the concept of pressure



Specifications

Size: diam. approx 13 cm
Weight: 0,4 kg

Equipment Needed

Vacuum Pump (code 4184.21)
or Manual Vacuum Pump (code 4184.13)

The Magdeburg hemispheres were designed by German scientist Otto von Guericke in 1650 to demonstrate the air pump he had invented and the concept of air pressure.

A pair of large PVC hemispheres with mating rims. When the the air is pumped out, the sphere contains a vacuum and could not be pulled apart by hands. To power the machine, connect it to the Altay Vacuum Pump (code 4184.21).

Try to open the hemispheres!



LAWS AND PRINCIPLES INVESTIGATED

- Concept of pressure
- Air pressure

SINGLE ITEMS

Mechanics • Mechanics of Fluids

Sphere with Two Stopcocks

4184.90*

A simple experiment to measure air density



▲ Sphere with Two Stopcocks



LAWS AND PRINCIPLES INVESTIGATED

- Air density
- Vacuum

Specifications

capacity 1 l

Weight: 0,4 kg

Equipment Needed

Vacuum Pump (code 4184.21)

Electronic Balance (code 2219.30)

or Ohaus Scout® Pro Balance 400 ± 0.01 g
(code 2219.61)

The purpose of this item is to measure air density making use of a vacuum pump and a sensitive balance.



* Minimum Order Quantity 5 pcs

▶ The Sphere with Two Stopcocks with the Vacuum Pump

Buoyancy Balance

4184.93

Simple and effective instrument to experience buoyancy of air



This apparatus consists of a polystyrene foam ball suspended on a balance arm and mounted on a PVC stand. When located in a vacuum jar and evacuated, the balance inclines as the buoyancy force diminishes.



LAWS AND PRINCIPLES INVESTIGATED

- Buoyancy of air
- Air Pressure and level of vacuum

Specifications

Size: 17x17x13 cm - Weight: 0,3 kg

Equipment Needed

Vacuum Pump (code 4184.21)

Vacuum Bell with Plate (code 4315.70)

Silicon Grease (code 5424.52)

▶ The Buoyancy Balance inside the Vacuum Bell, with the Vacuum Pump



Air Blower Set

4132.60

A powerful and adjustable air blower



Air Blower Set is designed to give the necessary of high-pressure air supply to our Linear Air Track System (code 4132.10), and to perform experiments on mechanics of fluids.

Air Blower Set is provided with a regulator, to fine tune the outflow of the blower itself, increasing the flexibility of the apparatus.

▶ The Air Blower Set

Also available for 110V mains (4132.60-110)

Specifications

Supply: 220V - 50Hz

Airflow max.: 20 l/sec

Total weight: 2 Kg

External outlet diam.: 35 mm



MAIN COMPONENTS

- Air Blower (220V)
- Voltage Regulator

SINGLE ITEMS

Mechanics • Mechanics of Fluids

Aluminium Cuboid for Buoyancy

4184.95

Ideal for demonstrating the principles of buoyancy



Aluminium parallelogram ideal for the study of the buoyancy.

Aluminium Cuboid

Specifications

Size: 15x3x8 cm

Weight: 0,2 kg

Equipment Needed

Buoyancy Balance (code 4184.93)

or Tubular Spring Balance (code 4110.03)



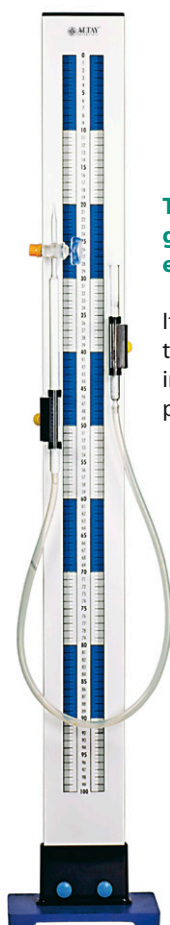
LAWS AND PRINCIPLES INVESTIGATED

- Hydrostatic pressure
- Buoyancy
- Weight: force

Boyle's Law Apparatus

4187.19

Get started with mechanics of fluids



The essential form of the apparatus gives a natural approach to the empirical basis of Boyle's Law.

It becomes a simple way to approach the experimental side of physics and to introduce at sight the concepts of vacuum, pressure, density, etc.

Boyle's Law Apparatus



MAIN COMPONENTS

- Graduated Burette
- Reservoir tube



LAWS AND PRINCIPLES INVESTIGATED

- Boyle's Law
- Atmospheric pressure

Specifications

Size: 20x14x125 cm

Weight: 4 kg

Equipment Needed

Mercury (code 4207.55)

EXAMPLE OF USE

Boyle-Mariotte Law • An experimental approach to this physical phenomena

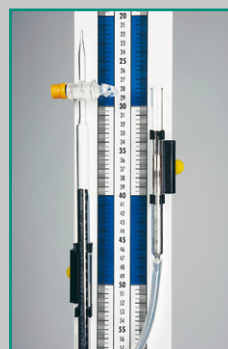
The tube filled with mercury and connected to a closed reservoir allows to study the aeriform substance in the expansion container. By raising or lowering the other end of the tube, compression or rarefaction of the gas is obtained.

$$PV = K$$

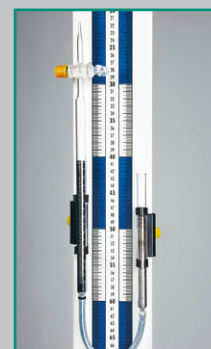
Boyle-Mariotte empirical law

The product of pressure and volume of a gas is constant when temperature is fixed.

The variation of the height of the mercury column implies a simultaneous change of the volume occupied by the substance.



Example showing the compression of gas



Particular showing the expansion of gas

This apparatus can also be used to estimate the atmospheric pressure. Thanks to the high density and the very low saturated vapour pressure of mercury at normal temperatures, it allows an immediate measure of the atmospheric pressure: the world famous Torricelli's barometer.

SINGLE ITEMS

Mechanics • Waves & Oscillations

Ripple Tank

4311.80

A very effective tool that helps students understand wave mechanics

The Ripple Tank is a very effective tool that helps students to understand waves refraction, diffraction and interference.

Our unique system uses a pulsed air supply so that standing waves are easy to reproduce. No more difficult phase change oscillators to worry about!



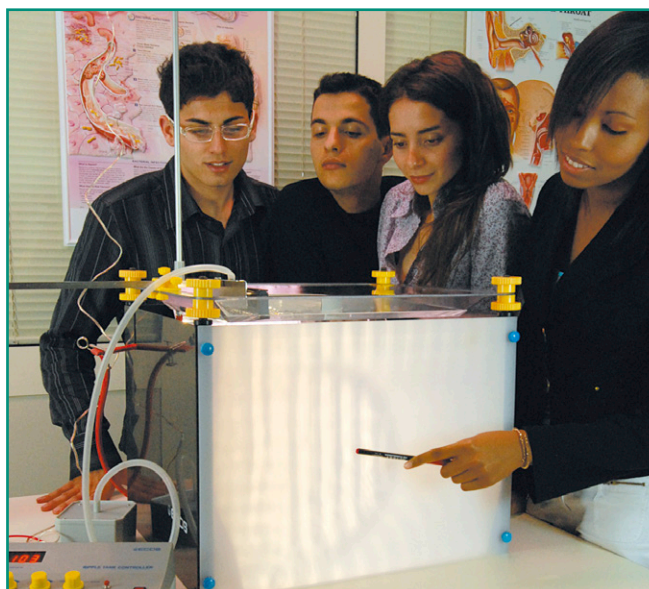
MAIN COMPONENTS

- Tank
- Controller
- Woofer
- Strobe lamp
- Figures
- Profiles
- Beater

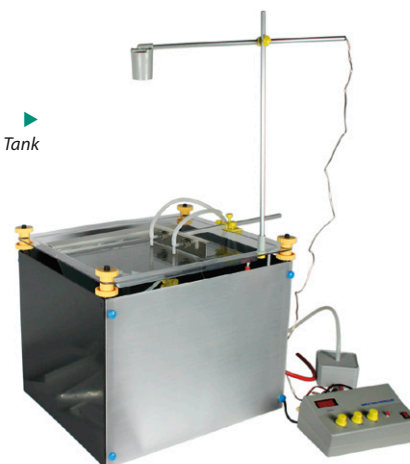


LAWS AND PRINCIPLES INVESTIGATED

- Diffraction of plane waves through a slit
- Dispersion
- Gravity waves
- Interference of waves
- Liquid depth and waves propagation speed
- Periodic waves
- Pulses diffraction
- Reflection of plane and circular waves on a curved obstacle
- Reflection of plane waves by angle shaped obstacle
- Reflection of plane waves on a flat obstacle
- Refraction of plane waves
- Refraction of plane waves through a plate with parallel faces
- Refraction of plane waves through lenses
- Stationary waves
- Superimposed pulses
- Total refraction



Ripple Tank



EXAMPLE OF USE

Reflected wave from a circular obstacle • With the Ripple Tank it is possible to study many types of interference between waves

By using the stroboscopic effect, it is quick and simple to have a fixed image of the interference of a plane wave on an obstacle and constructive and destructive interference phenomena between two circular waves. All this is due to the ripple tank controller that synchronises the stroboscopic flash and the air pulse with a selectable frequency and amplitude.

Seismic waves propagation Apparatus

4315.80

Investigate the propagation of seismic waves through the internal layers of the earth.

Using a laser and different chambers, the Seismic waves propagation apparatus explains how the seismic waves propagate while passing through the different layers of the Earth.



EXAMPLE OF USE

The Inside of the Earth • How seismic waves travel through different materials

The amount of time that it takes for a seismic wave to pass through the earth is dependent on the material that it encounters along its path. By monitoring arrival times of seismic waves throughout the earth we can make determinations about what types of materials are found in the earth. When traveling through the Earth, seismic waves frequently pass through materials of different densities, changing their direction and speed.

Specifications

Size: approx. 70 x 45 x 7 cm

Weight: 7 kg

Equipment suggested:

Food colouring (code 4207.60)



LAWS AND PRINCIPLES INVESTIGATED

- Seismic waves reflection and refraction

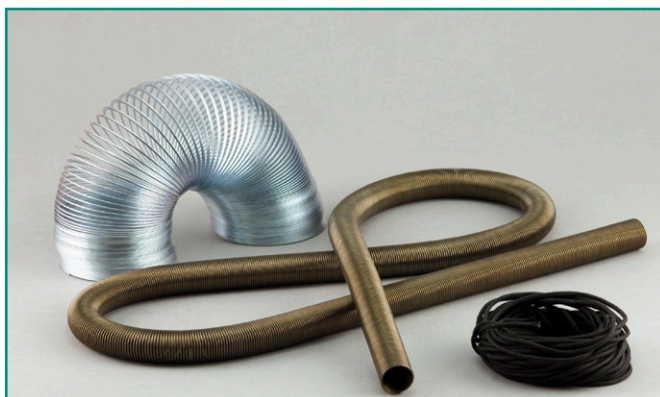
SINGLE ITEMS

Mechanics • Waves & Oscillations

Spring Set

4315.16

Longitudinal and transverse waves



▲ Altay's Spring Set includes Wave Form Helix and Helix Spring, that can be sold separately

Specifications

4315.00 Wave Form Helix (Slinky), diameter 8 cm, unstretched length 13 cm, may be stretched to approximately 5 m, Weight 0,6 kg

4315.02 Helix Spring, diameter 2 cm, unstretched length 1 m, Weight 0,5 kg

The springs can be sold separately

These springs are ideal for demonstrating longitudinal and transverse waves.



MAIN COMPONENTS

- Wave Form Helix (Slinky)
- Helix Spring



LAWS AND PRINCIPLES INVESTIGATED

- Logitudinal and transversal waves

▶ EXAMPLE OF USE

Waves • An introduction to a wide range of teaching involving longitudinal waves

Altay's Spring Set allows teachers to literally introduce a hands on approach to the teaching of waves. The motion of the coil compressions of the springs resemble sound waves.

You can observe reflection and interference on the slinky created by students themselves.



Kundt's Tube

4333.00

Study the speed of sound and stationary waves



▲ The Kundt's Tube

Specifications

Size: 10x77x10 cm

Weight: 4 kg

Equipment suggested

Function Generator (code 2290.10)

Oscilloscope (code 2280.70)



LAWS AND PRINCIPLES INVESTIGATED

- Speed of sound
- Stationary waves

▶ EXAMPLE OF USE

Speed of Sound

The approximate speed of sound in dry (0% humidity) air, in meters per second ($\text{m} \cdot \text{s}^{-1}$), at temperatures near 0°C , can be calculated from:

$$c_{\text{air}} = 331.3 + (0.606 \cdot \theta) \text{ m} \cdot \text{s}^{-1} \quad c_{\text{air}} = 331.3 \sqrt{1 + \frac{\theta}{273.15}} \text{ m} \cdot \text{s}^{-1}$$

where θ is the temperature in degrees Celsius ($^\circ\text{C}$).

Kundt's tube, invented by August Kundt, is used to measure the speed of sound.

Altay offers a revised and modern version of the classical tube experiment to study propagation of sound waves in air.

This equation is derived from the first two terms of the Taylor expansion of the following much more accurate equation. The value of 331.3 m/s , which represents the 0°C speed, is based on theoretical (and some measured) values of the heat capacity ratio, γ , as well as on the fact that at 1 atm real air is very well described by the ideal gas approximation. Commonly found values for the speed of sound at 0°C may vary from 331.2 to 331.6 due to the assumptions made when it is calculated. If ideal gas γ is assumed to be $7/5 = 1.4$ exactly, the 0°C speed is calculated to be 331.3 m/s , the coefficient used above.

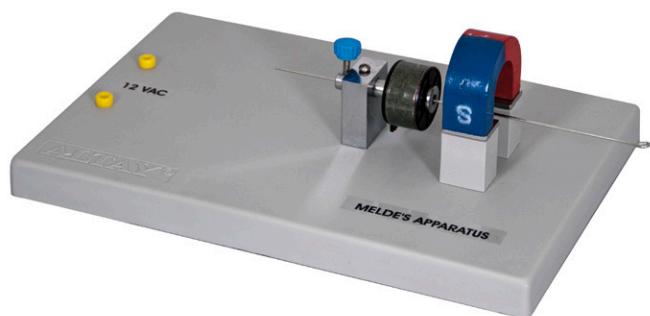
SINGLE ITEMS

Mechanics • Waves & Oscillations • Acoustics

Melde's Apparatus

4315.35

A simple experiment to study standing waves on a string



Specifications

Size: 25x18x7cm - Weight: 1,4 kg

Equipment Needed

Multitap Transformer (code 2403.70)

Equipment Suggested

Stroboscope (code 2238.10)

The Melde's Apparatus is a simple way to introduce students to the concept of standing waves.

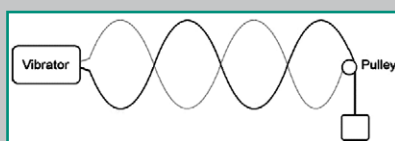
The apparatus consists of a string and an oscillator to generate different frequencies. Melde's experiment is ideal to study the behaviour of standing waves. You can even visually determine wavelength, period and amplitude of waves.

▶ EXAMPLE OF USE

Standing waves

Easy determination of amplitude and wavelength in a standing wave

Simply connect a string with a hanging mass attached to the wave generator and turn on the apparatus. You can start observing the standing waves, in particular, the distance between two nodes corresponds to half the wavelength. Using a simple tape meter, it is possible to measure the wavelength and the amplitude. With some basic calculations, you will verify the relation between the frequency of the vibrating string, its wavelength, the tension applied and the density of the string.



▲ Standing waves schema



LAWS AND PRINCIPLES INVESTIGATED

- Standing waves on a string



▲ Melde's Apparatus components

Three-Wire Sonometer

4316.05

Investigating the vibrating string

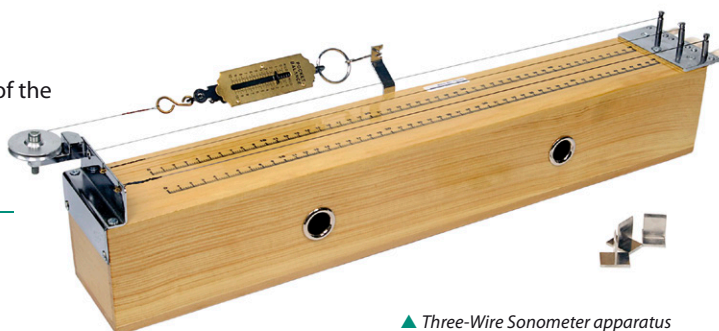
Appealing and elegant, the Sonometer is a classical device developed in order to study vibrating strings.

With this apparatus it is possible to investigate the dependence of the pitch on the length, tension and thickness of a vibrating string.



LAWS AND PRINCIPLES INVESTIGATED

- | | | |
|--|--|---------|
| • Vibration frequency of a stretched string as a function of the length, tension and | density of the string | tension |
| • Frequency versus length | • Frequency versus mass per unit of length | |
| • Frequency versus | | |

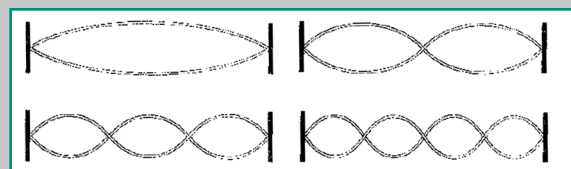


▲ Three-Wire Sonometer apparatus

▶ EXAMPLE OF USE

Vibrating strings • How to visualize the normal modes of a string

Students can readily verify the dependence of the pitch on the length of the string, by just inserting a bridge under the string so to choose such length. Moreover, two strings of different diameters are put under tension with an endless screw device; weights or a dynamometer can be attached to the other string. The excitation of the strings is obtained with a bass bow or by simply plucking them.



▲ Examples of normal modes of a vibrating string

SINGLE ITEMS

Mechanics • Acoustics

Pair of LA₃ Tuning Forks

4317.40

A pair of mounted tuning forks for interference and resonance experiments

Specifications

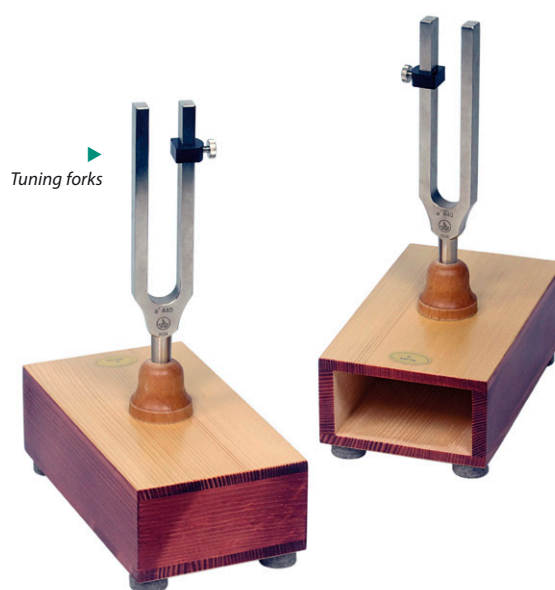
Size: 14x7x20 cm

Weight: 1 Kg



Tuning forks are a standard tool in school laboratories helping students to understand the relationship between wave frequency and pitch.

The Altay tuning forks can be used to perform several experiments. Ideal for determining the wave frequency (can be used with a data logger and sound sensor) and the pitch. These high quality aluminium forks are mounted on a base to enhance the resonant sounds. Complete with rubber mallet.



LAWS AND PRINCIPLES INVESTIGATED

- Use of the tuning forks
- Resonance
- Interference
- Beats

The tuning fork is a sound generator. It was invented by John Shore in 1711, and it is used for determining musical pitch and also in sound experiments.

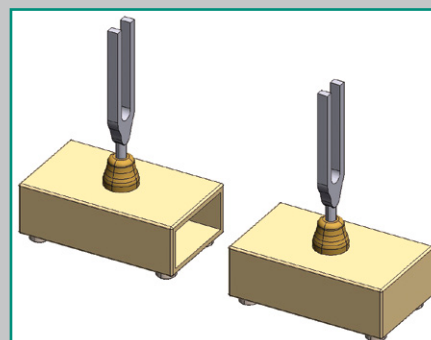
The tuning fork generates a pure sound of a determined frequency. Each fork is a metallic elastic body which vibrates and then generates longitudinal elastic waves of acoustic frequencies.

▶ EXAMPLE OF USE

Pure tone • LA₃ sound and resonance

When the tuning fork is mounted on the resonance box and is hit with the mallet, it will transmit a vibrational energy to the walls of the resonance box and then to the air inside the box. The box is also an oscillating system and therefore can resonate both on the fundamental frequency as well as on higher harmonics. The tuning forks will produce a note at a frequency of 440 Hz. Two adjustable masses can be fitted to the tuning fork and can modify the frequency of each one by moving the arm up and down.

Setup for resonance experiment



SINGLE ITEMS

Mechanics • Acoustics

Set of Tuning Forks

4317.90

Set of Tuning Forks for a wide range of experiments

Specifications

Size: 25x21x7 cm

Weight: 0,9 kg

Packing: ABS carry case with foam inserts



▲ Set of Tuning Forks in its ABS case with foam inserts

The Altay Set of Tuning Forks contains eight tuning forks representing a full octave of frequencies, a soft protective case and a rubber mallet. You can also study resonance, interference, beats and the relationship among them.

The set also contains tuning forks of exact multiple frequencies of each other (for example 256 Hz and 512 Hz), allowing you to perform interesting experiments in harmonics. Ideal for use with the LabPro software and data logging sound sensor to demonstrate beats.



MAIN COMPONENTS

- Tuning fork c^1 , 256 Hz
- Tuning fork d^1 , 288 Hz
- Tuning fork e^1 , 320 Hz
- Tuning fork f^1 , 341.3 Hz
- Tuning fork g^1 , 384 Hz
- Tuning fork a^1 , 426.6 Hz
- Tuning fork h^1 , 480 Hz
- Tuning fork c^2 , 512 Hz
- Rubber mallet



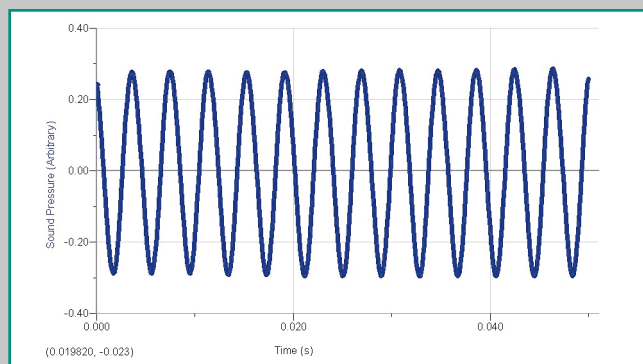
LAWS AND PRINCIPLES INVESTIGATED

- Measure the frequency and period of sound waves from tuning forks
- Measure the amplitude of sound waves from tuning forks
- Investigating resonance, interference and beats

EXAMPLE OF USE

Resonance frequencies • Determine the sound frequency of the tuning forks

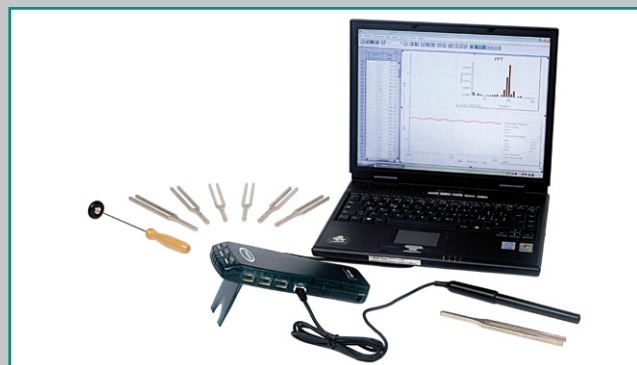
When tuning forks are vibrated, the forks create a compression and a rarefaction of the surrounding air. Periodically vibrating the tuning fork alternatively compresses and rarefies the surrounding air that transmits this in the form of longitudinal waves that move away from the source.



▲ Sound pressure data acquisition

The diaphragm of a microphone sensor records these variations by moving in response to the pressure changes. The diaphragm motion is then converted to an electrical signal. Using a microphone and a computer interface, you can explore the properties of common sounds such as period, frequency and amplitude. When two sound waves overlap, their air pressure variations will combine.

When these waves reach the ear, they cause us to hear a sound. This set of tuning forks is ideal in all the experiments useful to illustrate acoustic phenomenon, particularly with the Three-Wire Sonometer (code 4316.05), and the Resonance Apparatus (code 4331.27).



▲ Sample use of a datalogger to determine the frequency of tuning forks

For sound waves, this combination is additive. We say that sound follows the principle of linear superposition.

Beats are an example of superposition.

Two sounds of nearly the same frequency will create a distinctive variation of sound amplitude, which we call beats. You can study this phenomenon with a microphone, lab interface, and computer.

SINGLE ITEMS

Mechanics • Acoustics

Resonance Apparatus

4331.27

Demonstrating standing waves

Specifications

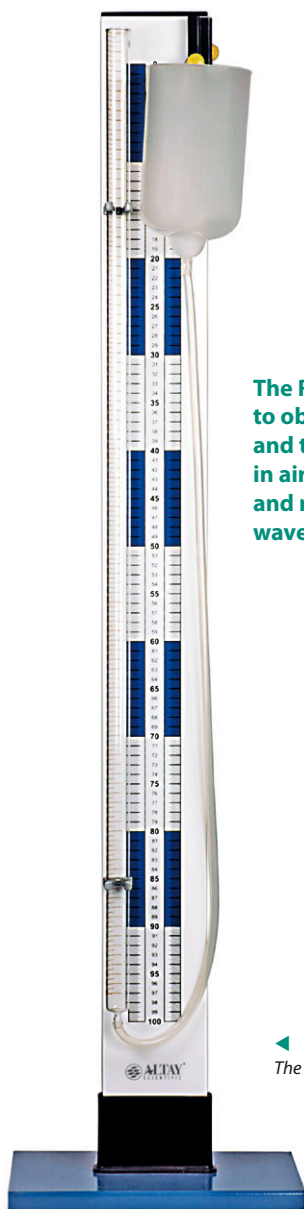
Size: 30x20x104 cm

Weight: 5 kg

Mounted on base

Equipment Needed

Set of Tuning forks (code 4317.90)



The Resonance Apparatus allows you to observe the resonance phenomena and to measure the speed of sound in air by exploiting standing wave and resonance effects in longitudinal waves.

The Resonance Apparatus



MAIN COMPONENTS

- Resonance Apparatus
- Levelling Bulb
- Resonance tube



LAWS AND PRINCIPLES INVESTIGATED

- Resonance
- Resonance points for a certain frequency and their relation with the standing wavelength
- Measurement of the speed of sound in air
- Measurement of the wavelength of the incoming wave

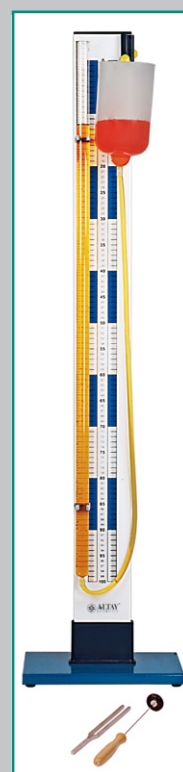
EXAMPLE OF USE

Resonance phenomena

How to visually determine the wavelength of a standing wave

This apparatus allows us to introduce the concepts and the main features of resonance. By raising or lowering the water-filled bulb, the length of the air column in the tube can be adjusted to correspond to the wavelength of the sound source placed near the mouth of the tube.

Air in a tube can be regarded as an oscillating system with its own vibration frequencies. When an exciting frequency is equal to one of the apparatus, stationary waves can be observed in the oscillating air cylinder. An audible sound is detected because the vibrating air volume is now larger than the volume excited by the tuning fork. For a sound of given frequency, the tube length has to be a multiple of a quarter of the wavelength of the incoming wave, which is the shortest measure a standing wave can form.



The Resonance Apparatus ready to use



The resonance tube matching the wavelength of the incoming sound wave

SINGLE ITEMS

Thermodynamics

Gravesande Ball and Ring

4200.10*

Simple and effective piece of equipment for qualitative experiments



* Minimum Order Quantity 5 pcs

▲ Altay's Ball and Ring

A concrete demonstration of the cubic thermal expansion of a solid. Ring and ball on chain with 2 wooden handles.

The ball passes through the ring when cold but will not pass through after being heated.

Specifications

Length of the bar 130 mm
Length of the chain 100 mm
Weight 0,6 kg

Equipment Needed

Bunsen Burner (code 5511.00)



LAWS AND PRINCIPLES INVESTIGATED

- Cubic thermal expansion of solids

Bar and Gauge

4200.15*

Simple instrument to show thermal expansion of solids



* Minimum Order Quantity 5 pcs

For demonstration of solids expansion.

Steel bar on rod with wooden handle. U-shaped gauge, sliding fit over ends of bar, with holes 12 mm bore.



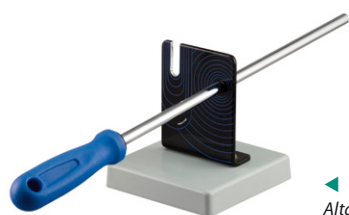
LAWS AND PRINCIPLES INVESTIGATED

- Solid expansion

Thermal Expansion Bar

4200.18*

Simple and effective piece of equipment to show thermal expansion



* Minimum Order Quantity 5 pcs

◀ Altay's Thermal Expansion Bar

A model to demonstrate the change of diameter of a metal rod when heated including brass rod with insulated handle. Mounted on sturdy shock resistant plastic base.

Specifications

Plastic base: dimensions approx. 12x12 cm
Weight: 0,5 kg

Equipment Needed

Bunsen Burner (code 5511.00)



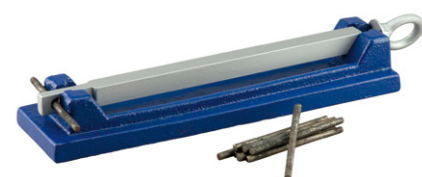
LAWS AND PRINCIPLES INVESTIGATED

- Thermal expansion

Pin Shearing Apparatus

4200.30

Simple instrument to show forces of thermal contraction



◀ Altay's Pin Shearing Apparatus with cast iron bars

This effective piece of equipment shows dramatically the forces of thermal contraction.

Constituted of a metal bar mounted on a sturdy metal base; the bar extends when heated and offers room to place the cast iron pin; the pin will break during cooling (i.e. contraction). Equipped with a set of cast iron pins.



MAIN COMPONENTS

- Metal Base
- Cast iron pins set



LAWS AND PRINCIPLES INVESTIGATED

- Thermal expansion
- Tensions due to expansion and contraction

SINGLE ITEMS

Thermodynamics

Gunther Expansion Apparatus

4200.22

With Altay's Gunther Expansion Apparatus, students can accurately and easily investigate the expansion of metals with increasing temperature

Gunther Expansion Apparatus



Specifications

Size: 62x8x12 cm
Weight: approx. 2 kg

Equipment Needed

Filtering Flask (code 1331.05)
Bunsen Burner with Accessories (code 5511.00)
Digital Multimeter (code 2275.10)

This is an ideal apparatus for determining the coefficient of linear expansion of a solid.

The apparatus comprises of a double metal plastic jacket containing the rods which will be raised to a temperature of 100°C. A micrometer screw gauge is mounted at one end and will show any expansion of the rods. We make temperature measurement simple, yet accurate. We directly measure the temperature of each tube with a mercury thermometer. A digital multimeter can be used together with the micrometer screw gauge. Comes complete with one brass, one aluminium and one iron rod of length 50 cm approx, mounted in the double jacket.



MAIN COMPONENTS

- Gunther Apparatus
- Metal Rods Set (Brass, Aluminium, Iron)
- Thermometer (-10 to 110°C)



LAWS AND PRINCIPLES INVESTIGATED

- Linear thermal expansion

EXAMPLE OF USE

Linear thermal expansion • How to measure the expansion of solids due to heat

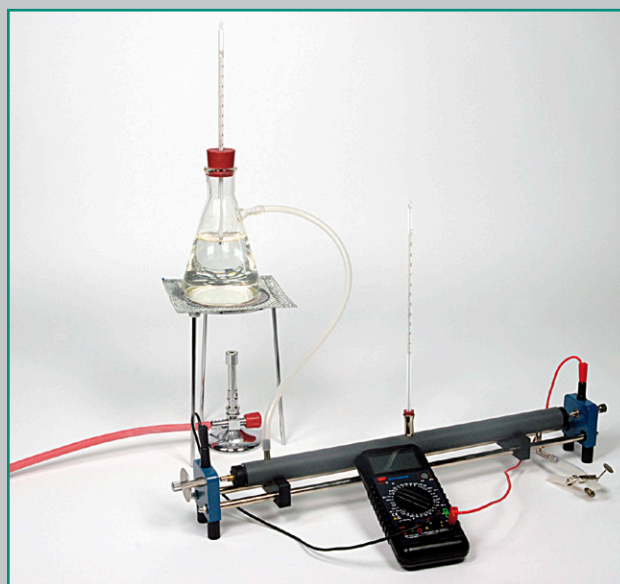
All bodies undergo variations in volume when their temperature increases or decreases.

For a body with length much greater than its width, the expansion and contraction are very evident and dependent on the material of the body. The forces associated with the thermal expansion and contraction are very powerful and are used widely in engineering and other applications. Suppose an object of length (L) undergoes a temperature change of magnitude (ΔT). If ΔT is reasonably small the change in length, (ΔL), is generally proportional to L and to ΔT . Therefore we can say:

$$\Delta L = \alpha L \Delta T$$

Linear Thermal Expansion Law

Where α is called the coefficient of linear expansion for the material. For an isotropic material, α will be the same in all directions, so we can measure a simply by measuring the change in length of the material. The values obtained for the coefficient of linear expansion will be compared with accepted values to determine the composition of each rod.



▲ Apparatus ready to use

SINGLE ITEMS

Thermodynamics

Compound Bar

4200.60

Simple instrument to study thermal expansion



▲ Altay Compound Bar

Specifications

Length 300 mm
Weight: 0,1 kg

Equipment Needed

Bunsen Burner (code 5511.00)

Demonstrates how the unequal expansion of different metals may be used for practical applications (principle of bimetallic thermostats, switches, etc.). With wooden handle.



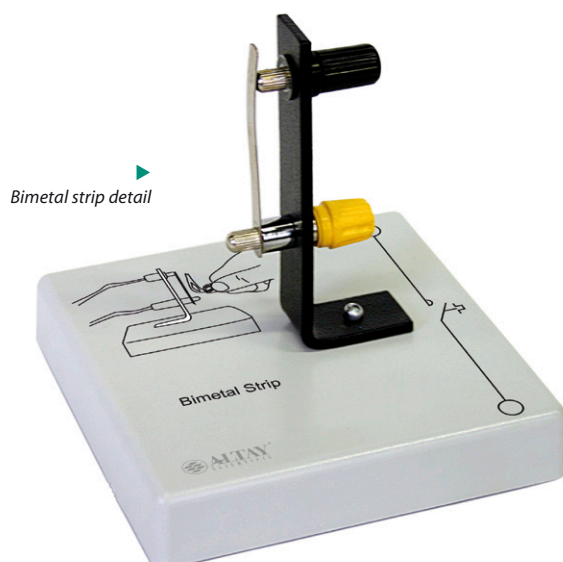
LAWS AND PRINCIPLES INVESTIGATED

- Expansion of solids
- Functioning of thermostats

Bimetal Strip with Electric Contact

4200.80

Simple demonstrator for thermal expansion



LAWS AND PRINCIPLES INVESTIGATED

- Thermal expansion
- Demonstration model of thermostat

Specifications

Size: 10x10x12 cm
Weight: 0,2 kg

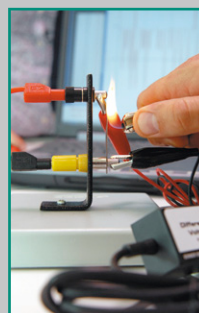
Mounted on base, with electrical plugs for electric contacts

The apparatus consists of a bimetal strip that expands differently on both sides due to two different materials. Once heated, it will bend to one side as one of the metals will expand faster than the other.



EXAMPLE OF USE

Thermal expansion • Demonstration of a Bimetal Strip in action



▲ Bimetal strip in use

Many of today's thermostats are based on the differential expansion of two different metals. Differential expansion causes the metals to change shape when heated. This metal bending can then be used to turn off a switch. With our Bimetal Strip it is possible to demonstrate this behaviour by just connecting a multimeter to the electric contacts. Before it is heated, you will see that the Bimetal Strip will make a closed circuit. When it starts to heat up, the circuit will open as the Bimetal Strip will visibly bend away. Once cooled, it will revert back to its original position, closing the circuit once more.

Thermal Conductivity Apparatus

4210.73

Simple apparatus to show thermal expansions in introductory physics courses



▲ Altay Thermal Conductivity Apparatus

Specifications

Total length: approx. 35 cm
Weight: 0,1 kg

Equipment Needed

Bunsen Burner (code 5511.00)

Demonstrates the different thermal conductivity of four different metal rods (brass, copper, aluminium, iron). With wooden handle.



LAWS AND PRINCIPLES INVESTIGATED

- Conductivity of different materials

SINGLE ITEMS

Thermodynamics

Convection Apparatus

4210.91

Tubular chamber to demonstrate convection



Gentle heating one of the lower corners of the tube creates convection currents in the liquid.

The currents are demonstrated by the addition of a small amount of potassium permanganate crystals or food colorant.



LAWS AND PRINCIPLES INVESTIGATED

- Convection

Specifications

Size: 30x20x1,5cm

Weight: 0,2 kg

Heat resistant borosilicate glass

Equipment Needed

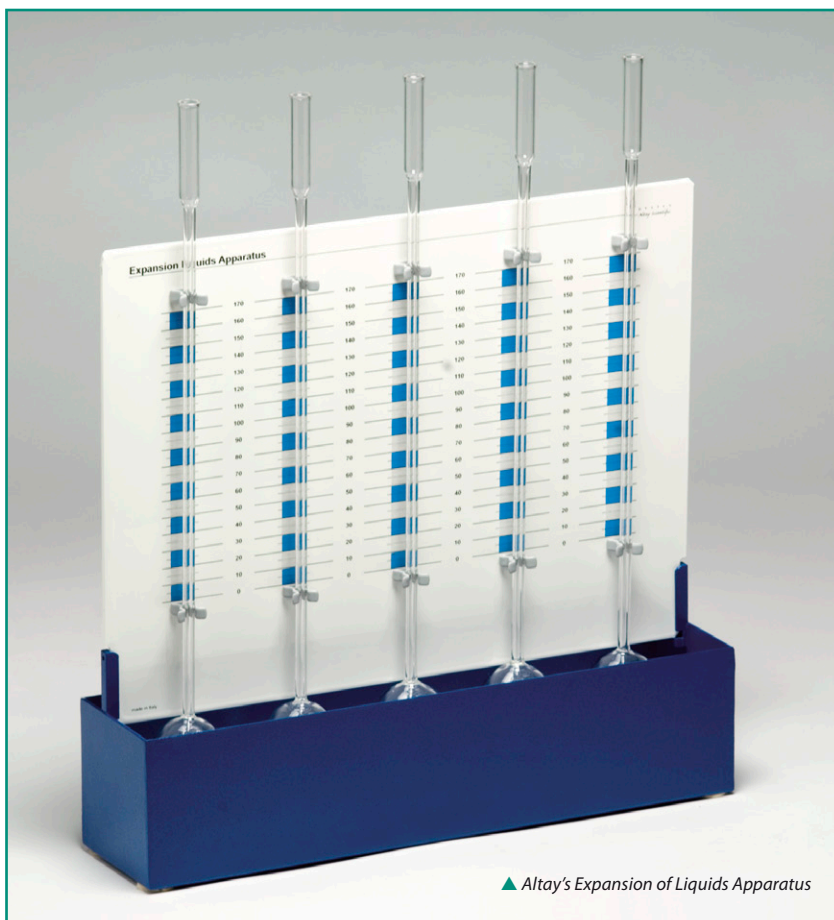
Bunsen Burner (code 5511.00)

Food colorant or potassium permanganate crystals

Expansion of Liquids Apparatus

4210.32

Discover the relative coefficient of expansion of different liquids



▲ Altay's Expansion of Liquids Apparatus

Specifications

Overall Size: 38x10x6cm

Weight: 2,9 kg

Equipment Needed

Alcohol Thermometer $-10^{\circ}\text{C} \div 110^{\circ}\text{C}$
(code 2245.15)

Equipment suggested

Stainless Steel Temperature Probe
(code 2314.20)

LabPro (code 2300.10)

or LabQuest (code 2300.30)

or Go!Link (code 2320.30)

Illustrates the different expansion of liquids and allows for the determination of the relative coefficient of expansion.

Consisting of five glass bulbs with stem, total height 400 mm; mounted against a plastic stand, with 5 scales graduated in mm. Complete with metal trough for the uniform and simultaneous heating of the 5 glass bulbs.



LAWS AND PRINCIPLES INVESTIGATED

- Expansion of liquids (relative expansion)
- Coefficient of expansion

SINGLE ITEMS

Thermodynamics

Hope's Apparatus

4210.10

Hope's Apparatus is the simplest way to verify maximum water density at 4°C.



◀ Altay Hope's Apparatus to study anomaly of water density

The solid form of most substances is denser than the liquid phase. Water is an exception and with this apparatus you can determine the temperature at which water attains its maximum density.



LAWS AND PRINCIPLES INVESTIGATED

- Determination of water maximum density at 4°C
- Determination of sea water density maximum at 2°C

Specifications

Size: DN 14x30 cm - Weight: 2,5 kg

Equipment Needed

Alcohol Thermometer -10°C ÷ 110°C (code 2245.15)

Equipment suggested

Stainless Steel Temperature Probe (code 2314.20) (2x or 3x)
LabPro (code 2300.10)
or LabQuest (code 2300.30)
or Go!Link (code 2320.30)

Mixing Calorimeter

4230.60

Ideal apparatus for simple example of uses in thermodynamics



◀ Mixing Calorimeter

The Mixing Calorimeter is used for the study of heat characteristics of masses. The apparatus has been insulated from the surrounding environment with a felt cover in order to perform experiments in a state of thermal equilibrium.



LAWS AND PRINCIPLES INVESTIGATED

- Determination of the water equivalent of a mixing calorimeter
- Specific heat of bodies
- Time constant of a thermometer

▶ EXAMPLE OF USE

Thermodynamics of equilibrium

How to determine the specific heat of a body



A heat quantity is lost or gained by a material when in contact with another body of a different temperature. Specific heat in general depends on temperature.

◀ Estimating the specific heat of aluminium



MAIN COMPONENTS

- Copper Calorimeter
- Lid with Stirrer
- Thermometer (-10 ÷ 110°C)

SINGLE ITEMS

Thermodynamics

Joule's Law Unit for Calorimeter

4230.65

Joule's Law: electricity and thermodynamics



Joule's Law Unit for Calorimeter

The Joule's Law Unit for Calorimeter is used to demonstrate the thermal effect of currents and the specific heat of a fluid. Add this attachment to the Altay Calorimeter to perform experiments involving electricity and thermal energy.

Specifications

Size: DN 12x10 cm - Weight: 0,1 kg
Specifically developed for our Mixing Calorimeter
Resistances: 1, 2, 3 Ω
4 mm jacks for power supply

Equipment Needed

Mixing Calorimeter (code 4230.60)
Power Supply 1.5 A (code 2407.70)



LAWS AND PRINCIPLES INVESTIGATED

- Joule's Law
- Time dependence of the heat quantity generated in the spiral
- Resistance's value dependence of the heat quantity generated in the spiral
- Current intensity value dependence of the heat quantity generated in the spiral

EXAMPLE OF USE

Joule's Law • How to convert electrical energy to heat

Joule's Law describes how the amount of heat per second (Q) that develops in a wire carrying a current (I) is proportional to the electrical resistance of the wire (R) and the square of the current. The heat evolved per second is equivalent to the electric power absorbed, or the power loss. With this apparatus you can determine the relationship between calories and joules.

$$Q = I^2 R t$$

Joule's Law

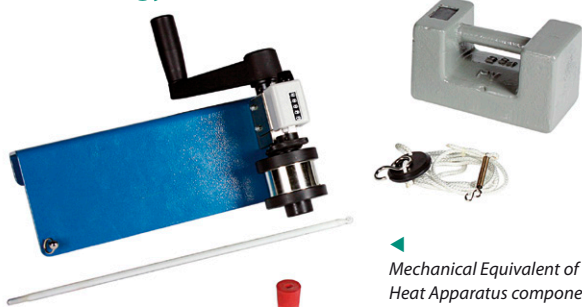


Joule's Law Unit setup with the Calorimeter

Mechanical Equivalent of Heat Apparatus

4235.10

Joule's most important experiment, converting mechanical work to thermal energy



Mechanical Equivalent of Heat Apparatus components



MAIN COMPONENTS

- Mechanical Equipment of heat apparatus
- Weight: (5 Kg)
- Thermometer (-10 ÷ 110°C)
- Silicone Grease



LAWS AND PRINCIPLES INVESTIGATED

- Conversion factor between joules and calories

Specifications

Size: 26x22x20 cm - Weight: 8,5 kg
Inclusive of clamp for table mounting

The apparatus is a simple and accurate demonstration of how to turn mechanical energy into heat.

Using the rotation-counter and a falling mass it is possible to calculate the mechanical effect of friction and the increase in temperature of the calorimeter.



EXAMPLE OF USE

Converting joules into calories • Experimental determination of the conversion factor between joules and calories



The apparatus is quick and easy to set up and will give an excellent approximation of the work done by a falling mass and the produced energy. We can compare the difference in temperature and the mass of water with the number of turns of the counter and the mass of the hanging weight. The ratio term between the work performed and the thermal energy produced and transmitted to the cylinder determines the mechanical equivalent of heat.

Mechanical Equivalent of Heat Apparatus in use

SINGLE ITEMS

Thermodynamics

Thermal Leakage System

4200.35

A simple apparatus to perform a complete study of heat losses



MAIN COMPONENTS

- Aluminium cylinders
- Aluminium dissipator
- Brass cylinder
- Insulator

LAWS AND PRINCIPLES INVESTIGATED

- Heat Transfer
- Gradient of temperature
- Heat capacity
- Heat coefficient

Specifications

Size: 25x18x14 cm - Weight: 1,9 kg

Equipment Needed

Bunsen Burner with Accessories (code 5511.00)
Beaker 500 ml (code 1118.50)
Go!Temp (code 2320.20)

Heat losses strictly depend on the material, the mass and the shape of an object. With this apparatus students can understand the basic concepts of thermodynamics.

Sturdy and easy to use, this kit provides repeatable and accurate results every time. Ideal for use with our Temperature Probes (such as Go!Temp, code 2320.20)

EXAMPLE OF USE

Heat transfer vs surface area

Two aluminium samples are heated up to the same temperature and let cool in air. The bodies are equal in mass and therefore in heat capacity, but they offer different surfaces to air. One sample is a cylinder and the other one is a so-called dissipator with many surfaces thus having a larger surface. This quantitative experiment allows the measurement of heat transfer coefficient for each of the two samples.



Thermal Conductivity Apparatus

4200.36

A simple apparatus to study heat conductivity



MAIN COMPONENTS

- Glass jar with rods
- Alcohol Thermometer (-10 to +110 °C)

LAWS AND PRINCIPLES INVESTIGATED

- Heat Transfer
- Gradient of temperature
- Heat capacity
- Heat coefficient

Specifications

Size: DN13x20 cm

Weight: 1,20 kg

Equipment Needed

Caliper (code 2213.10)
Go!Temp (code 2320.20)

With this apparatus it is possible to study heat conductivity of different materials. Constructed of a glass jar with three different rods (aluminium, brass and PVC) of equal shape, it can contain cold or hot liquids, therefore demonstrating heat transmission through different materials.

EXAMPLE OF USE

Thermal conductivity

It is common experience that certain materials conduct heat faster than others, for example, take a steel spoon and immerse part of it in boiling water. After a short time it is you will observe the flow of heat from the water through the metal. You can do the same with a wooden spoon and observe that heat transfer is much slower. Wood is an example of insulator while the steel is an example of conductor. In this way, it is possible to verify that each material has a different thermal coefficient and transmits heat in different times.



SINGLE ITEMS

Thermodynamics • Optics

Stirling Engine

4250.00

Discover one of the most important developments in motoring history

Specifications

Size: 30x22x16 cm

Weight: 1,7 kg



▲ The Stirling Engine

A Stirling engine is a closed-cycle regenerative heat engine with a gaseous working fluid which is permanently contained within the engine's system.

The Stirling engine uses the temperature difference between its hot end and cold end to establish a cycle of a fixed mass of gas, heated and expanded, and cooled and compressed, thus converting thermal energy into mechanical energy. The greater the temperature difference between the hot and cold sources, the greater the thermal efficiency. The maximum theoretical efficiency is equivalent to the Carnot cycle, however the efficiency of real engines is only a fraction of this value, even in highly optimized engines.

This piece of apparatus, with his innovative transparent design, aids in the understanding of the mechanism of the external-heat engine, encouraging students to discover thermodynamics and its applications and also of the great discoveries of motoring history.



LAWS AND PRINCIPLES INVESTIGATED

- Stirling cycle
- External heat engines
- Efficiency

▶ EXAMPLE OF USE

The idealized Stirling Cycle

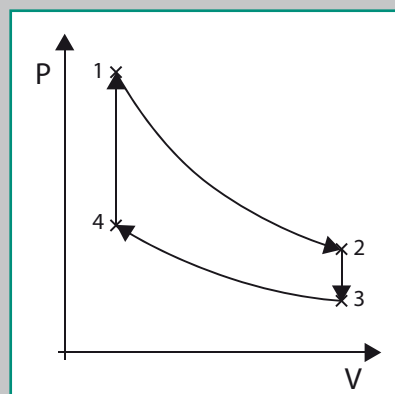
The idealized Stirling cycle consists of four thermodynamic processes acting on the working fluid:

Isothermal Expansion (Points 1 to 2). The expansion-space is heated externally, and the gas undergoes near-isothermal expansion.

Constant-Volume heat-removal (Points 2 to 3). The gas is passed through the regenerator, thus cooling the gas, and transferring heat to the regenerator for use in the next cycle.

Isothermal Compression (Points 3 to 4). The compression space is intercooled, so the gas undergoes near-isothermal compression.

Constant-Volume heat-addition (Points 4 to 1). The compressed air flows back through the regenerator and picks-up heat on the way to the heated expansion space.



◀ The idealized Stirling cycle

He-Ne Laser

4506.00

A useful instrument for optics experiments of interference and diffraction

Specifications

Size: 35x10x14 cm

Weight: 1,5 kg

Light: Coherent Red

Wave Length: 633 nm



LAWS AND PRINCIPLES INVESTIGATED

- Interference
- Diffraction

The He-Ne Laser represents an important laboratory device for optics experiments especially the study of interference and diffraction.

This piece of equipment is made of a glass envelope filled with a low pressure mixture of Helium and Neon gases. A cathode and anode placed at each end of the glass tube provides the energy for electrons to reach excited states and thereby discharge electrical energy. To have a laser effect we need an optical cavity consisting of a plane, high-reflecting mirror at one end of the laser tube and a partially reflecting mirror at approximately 1% transmission at the other end. He-Ne lasers emit monochromatic, coherent red light at 633nm.

SINGLE ITEMS

Optics

Stroboscope

2238.10

Light from a timing source



▲ Stroboscope



◀ Stroboscope with frequency selector



LAWS AND PRINCIPLES INVESTIGATED

- Frequency determination in various contexts

Specifications

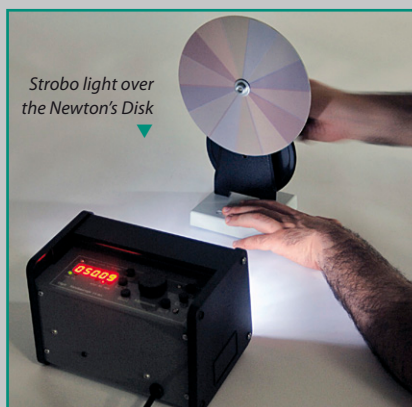
Size: 20x12x14 cm - Weight: 1,8 kg
Frequency range: 1 ÷ 300 Hz
External input for trigger

A Stroboscope is a pulsed lamp which is used to observe rapidly moving phenomena, such as a vibrating string or waves in a Ripple Tank.

If the frequency of "flashes" from the Stroboscope matches the frequency of the object being observed, it causes the eye to see the image as having been frozen at that matched frequency. Hence, useful measurements can be made and observations made easy.

▶ EXAMPLE OF USE

Slow down motion • Decomposition of colours



Strobo light over the Newton's Disk

Make the Newton's Disk rotate and note that the colours merge and fuse to white. Now direct the strobo light towards the Newton's Disk and observe that at a certain frequency of flashing, the Newton's Disk appears still and the colours do not change.

Crooke's Radiometer

4215.20

Investigating the energy and impulse of an electromagnetic wave



▲ Crooke's Radiometer

Invented by Sir William Crooke, the vanes in the highly effective radiometer rotate when exposed to solar radiation.

The cause for this rotation can open up much debate for which students should be encouraged to develop their own explanations. Some will state that the device relies upon the difference in absorption of impulse between the black and metal vanes. Others may think there is a difference in temperature of the vanes. This device has been designed with black vanes that absorb electromagnetic radiation and reflective metal vanes. Students need also remember that black painted sides get warmer than metallic ones.



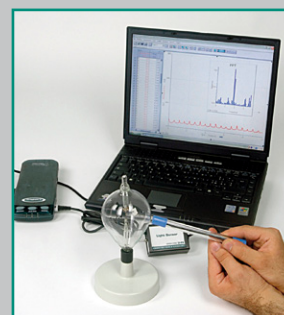
LAWS AND PRINCIPLES INVESTIGATED

- Energy conversion

▶ EXAMPLE OF USE

Black body • Heating up the vanes

The correct solution concerns heat considerations. We know that the black surface is warmer than the shiny one and that gas molecules will recoil faster from a hot surface. The slight difference in molecular recoil causes the device to spin. The other proposal involving photon absorption by the black vane and reflection by the metal side is physically correct, but negligible with respect to the main effect described above. With a light sensor, it is also possible to measure the frequency of rotation and calculate the angular speed of the radiometer.



▲ Investigate light reflection using a light sensor

SINGLE ITEMS

Optics

Optical Bench Deluxe Edition

4417.50

A complete set for exploring geometrical optics



▲ Optical Bench with Accessories Deluxe Edition



LAWS AND PRINCIPLES INVESTIGATED

- Concave and convex mirror
- Convergent and divergent lens
- Focal length
- Gauss approximation
- The eye, hyperopic and myopic eye
- Inverse square law
- Lens power
- Luminous intensity
- Magnifier and magnifying power
- Photometry
- Prism
- Ray tracing
- Refraction index
- System of lenses
- The compound microscope
- The telescope
- Thin lens equation
- Principles of biconcave, biconvex lenses and mirrors
- Determine the focal length of a lens
- Inverse square law of light
- Rotation of light
- Grease spot photometer
- Polarization



◀ Iris diaphragm, adjustable slit diaphragm and mirror

Specifications

Optical Bench: length 116 cm

The Altay's Optical Bench Deluxe Edition allows the student to investigate a wide variety of optical phenomena. These include: reflection, lens theory, polarization, interference, diffraction and optical instruments.



MAIN COMPONENTS

- Optical bench
- Set of 7 diaphragms
- Iris diaphragm
- Adjustable slit diaphragm
- Projector
- Lamp Holder Single
- Lamp Holder Quadruple
- Equilateral Prism
- Right-angle prism (90°, 45°, 45°)
- Right angle prism (90°, 60°, 30°)
- Prism table
- Translucent screen
- Two colour metal screen
- Plane mirror on mount
- Double-sided concave-convex mirror
- Polaroid filters
- Biconvex lenses set
- Biconcave lenses set
- Bunsen Photometer

▼ Optical Bench with supports and holders



▶ EXAMPLE OF USE

Polarization of light • Discover the principle of sunglasses

In electrodynamics, polarization is the property of electromagnetic waves such as light, which describes the direction of their transverse electric field. More generally, the polarization of a transverse wave describes the direction of oscillation in the plane perpendicular to the direction of travel.

A polarizing filter, such as a pair of polarizing sunglasses, can be used to observe this by rotating the filter while looking through. At certain angles, the reflected light will be reduced or eliminated. Polarizing filters remove light polarized at 90° to the filter's polarization axis. If two polarizers are placed atop one another at 90° angles to one another, no light passes through.



▲ Polarization experiment setup

SINGLE ITEMS

Optics

Optical Bench Standard Edition

4417.60

Specifications

Optical Bench: length 116 cm

A simple and affordable way to begin exploring optics

The Optical Bench Standard Edition is the most easy and complete way to begin the exploration of the optics. Simple, complete and affordable.



MAIN COMPONENTS

- Optical bench
- Slider for holders
- Slider for projector
- Slides and
- diaphragm holders
- Set of 7 diaphragms
- Projector
- Lamp Holder Single
- Lamp Holder
- Quadruple
- Equilateral Prism
- Prism table
- Two colour metal screen
- Set of colour Filters
- Joly Photometer
- Set of 4 biconvex Spherical Lenses
- Set of 4 biconcave Spherical Lenses
- Set of 4 Convex Spherical Mirrors
- Set of 4 Convex Spherical Mirrors



LAWS AND PRINCIPLES INVESTIGATED

- Concave and convex mirror
- Convergent and divergent lens
- Focal length
- Gauss approximation
- The eye, hyperopic and myopic eye
- Inverse square law
- Joly photometer
- Lens power
- Luminous intensity
- Magnifier and magnifying power
- Photometry
- Prism
- Refraction index
- System of lenses
- The compound microscope
- The telescope
- Thin lens equation
- Principles of biconcave, biconvex lenses and mirrors
- Determine the focal length of a lens

Swivel Joint Bench

4412.00

Improve the experiences on diffraction

Specifications

Size: approx. 56x12x15 cm

Weight: 0,8 kg

Equipment Needed:

Optical Bench Deluxe Edition (code 4417.50) or Optical Bench Standard Edition (code 4417.60)



Using the Swivel Joint Bench as an upgrade for the Altay Optical Benches, it's possible to measure in an accurate way the diffraction of a light passing through a prism. The Swivel Joint Bench is provided with a fully rotating support, to perform experiments on a range of 180°.



Slits, coloured screens, holders, prism table



EXAMPLE OF USE

Prism • Separate white light into its different components

A prism is a wedge-shaped transparent body which causes incident light to be separated into its constituent colours when it exits the prism. The separation by colour occurs because different colours (corresponding to different wavelengths) of light travel at different speeds in the prism (although they travel at the same speed, namely the speed of light, in a vacuum). As a result, refraction causes the wavefronts of different wavelengths to be deflected by different angular amounts. Since "white" light is really a superposition of many different wavelengths, the prism therefore has the effect of angularly separating the incident light by colour.

SINGLE ITEMS

Optics

Newton's Disk

4453.22

The human perception of colours



Newton's Disk



LAWS AND PRINCIPLES INVESTIGATED

- Colour mixing
- Human perception of colours

Specifications

Size: 18x25x12 cm
Weight: 0,7 kg
Mounted on base

The Newton's Disk consists of an aluminium platform with coloured segments printed on it.

The colours represent the primary colours of the spectrum (red, orange, yellow, green, blue, indigo and violet). When the disk is rotated, the colours blur together and the eye, unable to respond rapidly enough, sees the colours mixed together to form white. Since the eye is more sensitive to colours in the middle of the visible spectrum, the wedges with yellow and green often become narrower, while those for red and violet become wider. When the disk is rotated, the colours fuse together resulting in the effect of "white light".

▶ EXAMPLE OF USE

Colour mixing • By rotating the disk all colours mix together becoming white

Using the handle on the back of the apparatus, the disk is soon set in motion. Observe how the eye, from a certain speed, can no longer follow the rotation of a particular coloured section but rather it sees a fusion of the various colours on the disk. As the rotation frequency increases, the edges of the sections begin to blur and the colours start to mix.



▶ Rotating disk at low speed



◀ Newton's Disk turns white at a higher rotation

Spectrometer

4455.02

Studying the spectral lines of a light source



▲ Altay's Spectrometer with accessories

The Spectrometer is used to study the spectral lines of a light source.

Altay's Spectrometer allows you to detect the spectral lines with precision and to measure the corresponding wavelength.

Easy to use and robust, this instrument is particularly suitable for classrooms.

Specifications

Size: 40x30x30 cm in wooden box
Weight: 11 kg

Equipment Needed

Spectrum Tubes Holder (code 4470.50)
5 kV Power Supply Unit (code 2407.05)
Prism (code 4450.14)
Diffraction Grating 600 Lines

Gas tubes

Helium (code 4470.10)
Neon (code 4470.11)
Argon (code 4470.12)
Mercury (code 4470.13)
Hydrogen (code 4470.14)
Oxygen (code 4470.15)
Nitrogen (code 4470.16)
Carbon Dioxide (code 4470.17)



LAWS AND PRINCIPLES INVESTIGATED

- Dispersion of light from a prism
- Diffraction of light from a diffraction grating
- Measurement of a dispersion power of a prism
- Refraction index of a prism
- Measurement of the diffraction power of a grating
- Visualizing atomic spectra for different kind of lamps
- Light emission by excitation of electrons
- Measurement of the wavelength of the spectral lines
- Quantum energy levels
- Intensity of a spectral line

SINGLE ITEMS

Optics

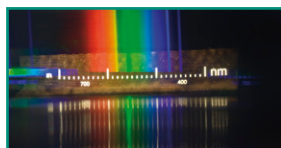
Handheld Spectrometer

4455.30

A simple and affordable way to begin studying the spectral lines



Altay's Handheld Spectrometer



Handheld Spectrometer at work

Altay Handheld Spectrometer is the best solution to begin studying the spectral lines of a light source.

With this instrument every single student could explore spectrometry by his own. Altay's Handheld Spectrometer allows to detect the spectral lines with precision.

Specifications

Size: 28x22x3 cm
Weight: 0,4 kg

Equipment Needed

Spectrum Tubes Holder (code 4470.50)
with one or more Gas Tubes
5 kV Power Supply (code 2407.05)



LAWS AND PRINCIPLES INVESTIGATED

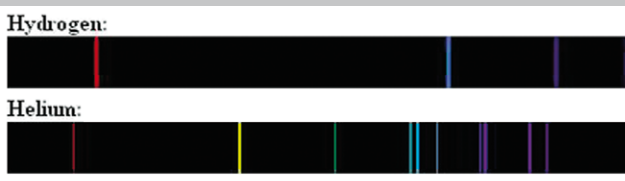
- Visualizing atomic spectra for different kind of lamps
- Light emission by excitation of electrons

EXAMPLE OF USE

Spectral Lines • Measuring the wavelength of the hydrogen spectra

The spectrometer is an ideal instrument for analysing the spectral lines of a light source. In order to perform the experiment, set the position of the sodium lamp so that the collimator is properly aligned.

The diffraction grating is then placed in its holder, allowing you to observe the spectral lines of sodium. The full spectra can be seen by rotating the telescope. By knowing the diffraction angle, we can then work out the wavelength of the light.



▲ Hydrogen and Helium emission spectra

Spectrum Tubes

4470.10-50*

Excitation of the gas in the tube produces light

Spectrum Tubes are an effective tool to teach the effect of gas excitation and visible light emission.

Our Spectrum Tubes can also be used together with the Spectrometer (code 4455.02) to analyse the spectra of gases in the different tubes. Spectrum Tubes can easily be mounted on our Tube Holder that protect them against accidental shocks. Tubes of different gas types are available. Altay designed to be capillary thin at their centre point to produce a sharp and bright spectra.



LAWS AND PRINCIPLES INVESTIGATED

- Light from excited energy levels
- Monochromatic light



Hydrogen Spectrum Tube on Spectrum Tubes Holder

Specifications

All items are sold separately
Spectrum Tubes Holder with Ballast Resistance (code 4470.50)
Size: 12x12x36 cm
Weight: 0,1 kg

Equipment Needed

5 kV Power Supply (code 2407.05)

Gas tubes

Size: 1x10x23 cm
Weight: approx. 20 g
Helium (code 4470.10)
Neon (code 4470.11)
Argon (code 4470.12)
Mercury (code 4470.13)
Hydrogen (code 4470.14)
Oxygen (code 4470.15)
Nitrogen (code 4470.16)
Carbon Dioxide (code 4470.17)

EXAMPLE OF USE

Monochromatic light emission • The principle behind neon lamps

A Hydrogen vapour lamp is a gas discharge lamp which uses the excitation of the atoms to produce light. Very high voltage between the anode and cathode plates causes the hydrogen atoms to move to an excited state. When the atom reverts to its stable condition, a definite quanta of light is emitted. This observed spectral line is the energy associated with the first energy level state of the atom and its normal fundamental state.



▶ Hydrogen light emission detail

* Minimum Order Quantity 5 pcs

SINGLE ITEMS

Electrostatics

Wimshurst Machine

4622.20

One of the classic electrostatic generator experiment

Specifications

Size: 40x24x43cm

Weight: 3,8 kg



▲ The Wimshurst Machine ready to run



LAWS AND PRINCIPLES INVESTIGATED

- Electrostatic charge
- Electrical sparks

The Wimshurst Machine is an electrical generator with a distinctive appearance. With its two large contra-rotating disks mounted in a vertical plane and a spark gap within two metal spheres, the Wimshurst Machine is a historical electrostatic machine used for generating high voltages.

Constructed according to the classical model, this generator is safe to use and robustly built. Structural elements are in cast metal, with all insulating components constructed from high dielectric strength plastic. Particular attention has been paid to the collection combs and supports so as to prevent damage to the radial aluminium strips.

▶ EXAMPLE OF USE

Electrical sparks • How to generate high potential differences between conductors

High voltages break down air and produce a spark. The dielectric strength of air is 10.000 volts/cm; when this is exceeded we can create sparks of lightning.

The generator simply requires mechanical power to run the disks. The output is a constant current and the spark energy can be increased by adding a Leyden jar.

▶ Wimshurst Machine at work



Pith Ball Electroscope

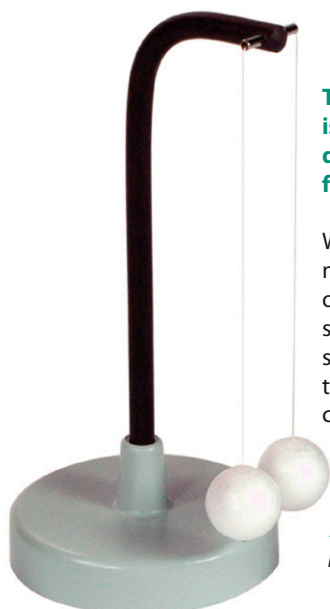
4625.00

High impact electrostatic force experiment

Specifications

Size: DN13x26 cm

Weight: 0,2 kg



The Pith Ball Electroscope is a simple instrument for demonstrating electrostatic force.

With some simple rods of different materials such as perspex, PVC or glass and a piece wool or silk surface, you can charge one of the spheres in the electroscope. After, the spheres will have different charges and will repel each other.

◀ Pith Ball Electroscope in detail



LAWS AND PRINCIPLES INVESTIGATED

- Electrostatic charge
- Electrical sparks

▶ EXAMPLE OF USE

Electrostatic force of repulsion • Charging the spheres

By rubbing a PVC rod on a wool surface it is possible to charge the rod by friction. If you place the rod near one of the spheres it will be electrified by induction; touching it with the rod you will charge the sphere by conduction. It is therefore possible to charge the electroscope positively or negatively depending on the electrifying properties of the rod.

▶ Charging the electroscope by conduction



SINGLE ITEMS

Electrostatics

Van de Graaff Generator

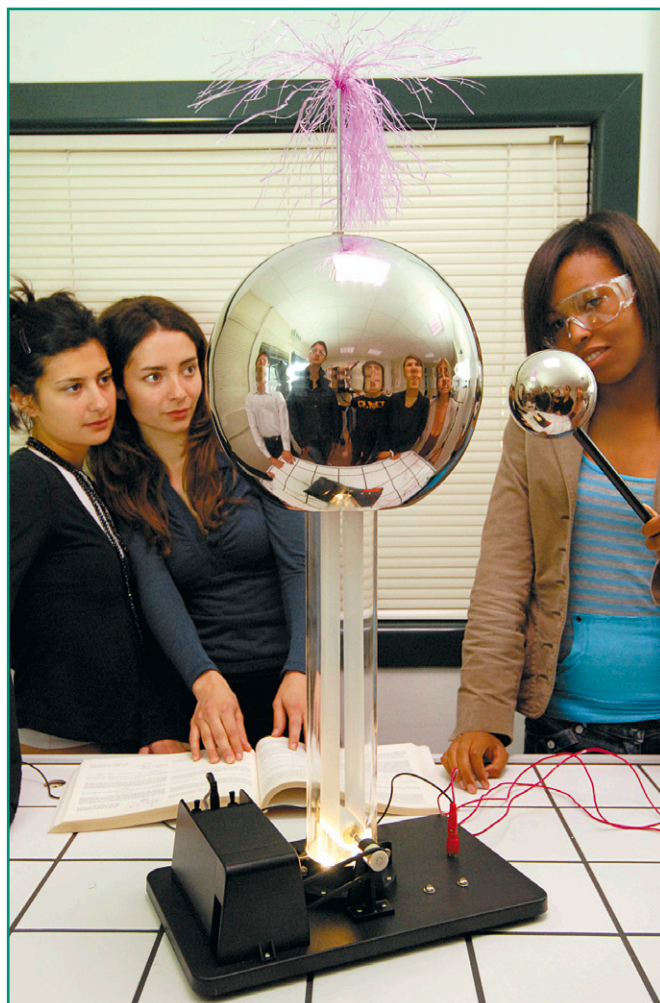
4623.20

High Energy Physics with the Van de Graaff Generator

Specifications

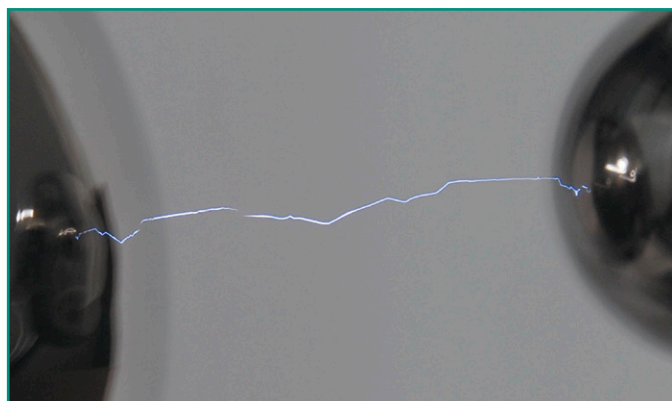
Size: 20x20x77 cm

Weight: 6,1 kg



▲ Students having fun learning electricity with the Van de Graaff device

▼ Detail of the spark of several thousands volts



The Van de Graaff Generator is considered an important and powerful apparatus to perform electricity experiments. Its great appeal attracts students into the amazing world of physics.

Historically developed to accelerate particles in high energy physics experiments, our Van de Graaff Generator has been redesigned to perform demonstrations and experiments in schools.



LAWS AND PRINCIPLES INVESTIGATED

- Potential difference
- Electrostatic repulsion and attraction
- Dielectric strength
- Point effect



Van de Graaff components ▼

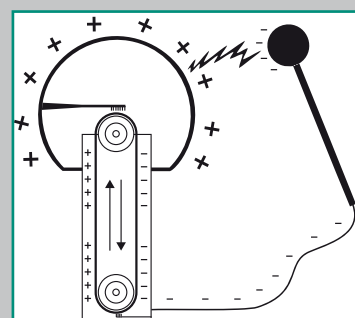
▶ EXAMPLE OF USE

Breakdown field strength • Visualise the electric spark when the electric current flows through a dielectric

The Van de Graaff Generator uses a belt to strip electrons from the base to the metal head of the system. This transfer of charges creates a potential difference between the base and the head.

The static electricity produced with Van de Graaff Generator is used to empirically study the effects of charges on metals and dielectrics.

The finite dielectric strength of air allows the production of an electric spark through the gas, showing the outstanding phenomena resembling a thunderbolt. The dielectric strength air is roughly 10,000 volts/cm, which means that the spark shown in the picture reveals a potential difference of at least 50,000 volts.



SINGLE ITEMS

Electrostatics

Leaf Electroscope

4625.50

A classical instrument measure static charges



LAWS AND PRINCIPLES INVESTIGATED

- Electrostatic charge measure

Specifications

Size: 20x15x20 cm
Weight: 0,6 kg
Mounted on base

Simple and functional, Altay's Leaf Electroscope allows us to measure the amount of excessive electric charges of one sign over the other.

Place a dielectric material to induce or bank charges on top of the electroscope box and observe a permanent or temporary displacement of the thin metallic leaf from the vertical metal rod. If you introduce a charge on the metal cap of the electroscope, you will see the displacement of the leaf.

◀ Altay's Leaf Electroscope

▶ EXAMPLE OF USE

Electrostatics • Detect the excess of charges of one sign

When electrons are removed or added on the metal top, the excess of charges spread over the whole metal surface, producing an electrostatic repulsion between the leaf and the vertical rod.

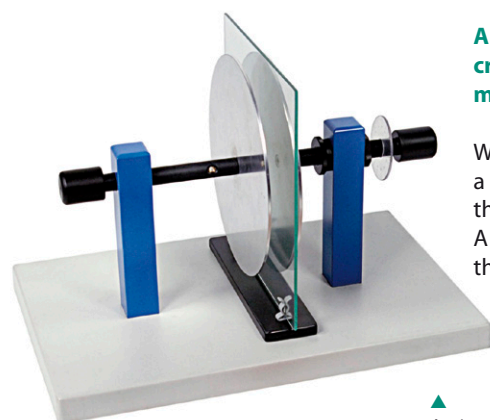


▶ Leaf detail with back lighting

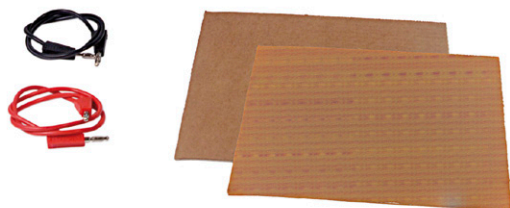
Aepinus Air Condenser

4628.32

A demonstration model of a condenser



▲ Aepinus Air Condenser



A condenser is a device that allows the storage of energy in the electric field created between a pair of conductors on which electric charges of equal magnitude, but opposite sign, have been placed.

With our Aepinus Air Condenser, it is possible to show the dependence on capacity of a parallel plate condenser and the distance between the plates and the nature of the medium between them.

A set of three dielectric plates of bakelite, glass and wood is supplied in order to verify the dependence of capacity on the medium between the two disks.

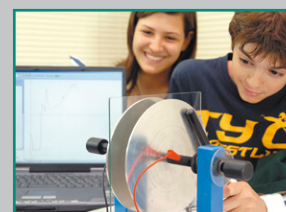
Specifications

Size: 34x20x25 cm
Weight: 3,3 kg

▶ EXAMPLE OF USE

Condenser principles • Verify the law of capacitors

In order to verify the laws governing charge and potential in the two condensers, the first step is to charge one of the discs. With a differential voltage sensor, it is possible to acquire data on the computer and verify the dependence of the potential difference on the distance between the two disks. The plates can be manually adjusted by means of a micrometer screw gauge.



▲ Students charging the condenser



LAWS AND PRINCIPLES INVESTIGATED

- Plane face condenser
- Dielectric effect

Various Magnets

Different shape magnets for a wide number of magnetism experiments



LAWS AND PRINCIPLES INVESTIGATED

- Magnetic poles
- Magnetic field
- Lines of force

Cylindrical Magnets

4611.18

Cylindrical magnets, supplied in pairs.

Specifications

Material: ALNICO
Size: DN 0,8x2,5 cm
Weight: 0,10 kg

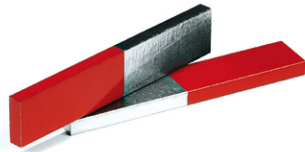
Chrome Steel Bar Magnets

4611.50

Painted in two colours for North and South, with keeper. Supplied by pair, in plastic case.

Specifications

Size: 5x1x0,5 cm
Weight: 0,1 kg



U-Shaped Magnet

4611.71

Strongly magnetized, with keeper.

Specifications

Size: 6x5x2,4 cm
Weight: 0,2 kg



Horseshoe Magnet

4611.81

With keeper, painted red.

Specifications

Material: ALNICO
Size: 3x3x1 cm
Weight: 0,1 kg



Neodymium-Iron-Boron Magnet

4611.86

Face-polarised disc shaped magnets.

May be used for many magnetic demonstrations where intense field strength is an important criterion. Protected against corrosion and can be used up to 80 °C; are not suitable in situations involving impact or significant vibration.



Specifications

Material: NdFeB - Size: DN 2,5x0,5 cm - Weight: 0,1 kg

Specifications

All items can be bought separately

In physics, magnetism is one of the phenomena by which materials exert an attractive or repulsive force on other materials.

Some well known materials that easily exhibit detectable magnetic properties are iron, some steels and the mineral lodestone; however, all materials are influenced to a greater or lesser degree by the presence of a magnetic field. Altay offers a wide variety of permanent magnets.

Plastic Cased Bar Magnets

4611.40

Ideal for demonstrating attraction and repulsion. Supplied in pairs, with different colours for North and South.

Specifications

Size: 8x2,x2x1 cm
Weight: 0,4 kg



Bar Magnets

4611.65

Red in colour, with north pole
Boxed in pairs with keepers.

Specifications

Material: ALNICO
Size: 5x1,5x1 cm
Weight: 0,1 kg



Horseshoe Flat Magnet

4611.72

Painted, with keeper, in plastic case.

Specifications

Material: chrome steel
Size: 10x5x0,5cm
Weight: 0,1 kg



Ring Magnet

4612.03

Anular magnets with face poles.

Specifications

Size: DN 2,4x0,7 - Weight: 01 kg



Ferrite Magnet

4612.09

Magnetised through thickness.

Specifications

Size: 5x2x0,6 cm - Weight: 0,1 kg



SINGLE ITEMS

Magnetism & Electromagnetism

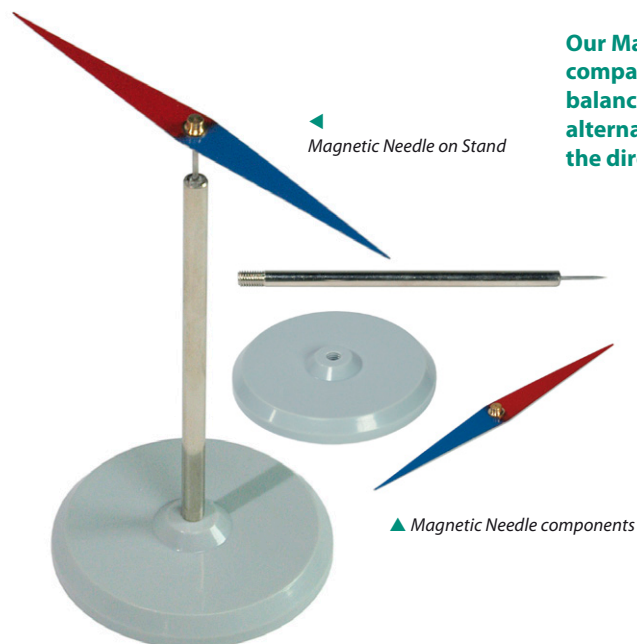
Magnetic Needle on Stand

4613.80

A simple magnetic needle compass

Specifications

Needle: 10 cm length
Support rod: 11 cm length
Mounted on base: 6 cm dia.
Weight: 0,1 kg



Our Magnetic Needle provides a simple demonstration model of how a compass works. It is simply constructed with a magnetic needle finely balanced on a needle on top of a supporting stand. The pointer is alternately coloured in red and blue, allowing the user to easily identify the direction of North and South Poles.

EXAMPLE OF USE

The North • To determine the position of cardinal points

The compass was developed in China in the 4th century and it was mainly used as a navigational instrument to find a travellers' direction on the Earth: "The navigator knows the geography, he watches the stars at night, watches the sun at day; when it is dark and cloudy, he watches the compass." (Pingzhou Ke Tan, Zhu Yu).

The simplest compass consists of a magnetised pointer that aligns itself accurately with Earth's magnetic field.

In our Magnetic Needle, you will find a simple compass useful to determine the position of the cardinal points of every location.

The red side points to North (0°), the blue to South (180°). Earth's rotation defines the orientation of East (90°) and West (270°).



World map in: "Tabulae Rudolphinae: quibus astronomicae..." by Johannes Kepler



LAWS AND PRINCIPLES INVESTIGATED

- Earth magnetic field
- North and cardinal points

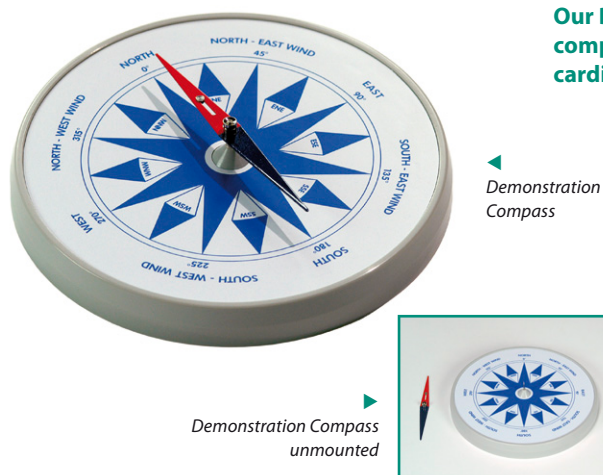
Demonstration Compass

4614.50

Study the cardinal points with a compass

Specifications

Size: DN16x5 - Weight: 0,1 kg
Magnetic needle: 10 cm length



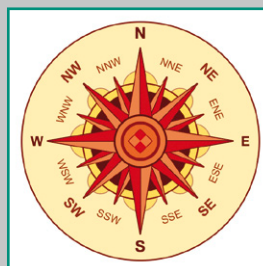
Our Demonstration Compass consists of a simple magnetic needle on a compass map. Our compass makes it extremely easy to demonstrate the cardinal points of a compass and determine all their directions.

EXAMPLE OF USE

The cardinal points • How to read the compass

A compass or "wind rose" is a figure that displays the orientation of the cardinal directions: North, South, East and West on a map or nautical chart. Today the use of a compass rose is used in almost all navigational systems, including nautical charts, NDB and VOR systems and in some GPS systems.

Placing our Demonstration Compass on a table the magnetic needle orientates itself with Earth's magnetic field. The red part of the needle points to North; this way all other cardinal points are immediately defined.



Compass rose example



LAWS AND PRINCIPLES INVESTIGATED

- Investigating Earth's magnetic field
- What are the cardinal points?
- The compass point and winds direction experiments

SINGLE ITEMS

Magnetism & Electromagnetism

Circular Coil

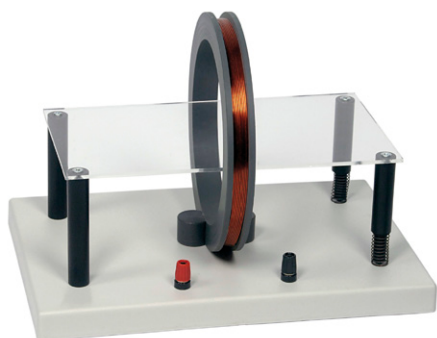
4640.50

The easiest way to observe static magnetic fields

Specifications

Size: 30x20x20 cm

Weight: 1,2 kg



This equipment has been developed for students' demonstrations on static magnetic fields generated by a constant flowing current.

The evident results can be visualised by the more classical iron filings' disposition along the magnetic lines of a force or with a magnetic field sensor and a datalogger.



LAWS AND PRINCIPLES INVESTIGATED

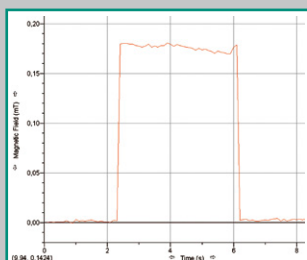
- Magnetic field by electric current

▶ EXAMPLE OF USE

Magnetic fields generated by currents • A Circular Coil with a constant current passing through it generates a static magnetic field

Connecting the Circular Coil to a power supply and allowing current to flow, a low magnetic field starts to appear in the vicinity of the coil. With a datalogger and a magnetic field sensor it is possible to measure even a slight magnetic force.

If the power supply is able to produce more current (up to 10 A), the iron filings will start to align on the magnetic field lines.



◀ Magnetic field data acquisition

▶ Teacher demonstrating how the Circular Coil works



U-Shaped Electromagnet

4652.10

Magnetic and electric fields



◀ Altay's U-Shaped Electromagnet

Specifically designed to perform experiments of electromagnetism, Altay's U-Shaped Electromagnet encourages students to learn the relationship between electricity and magnetism.

Specifications

Size: 10x12x4 cm

Weight: 0,3 kg

Resistance: approx. 30 W

Impedance at 50 Hz: approx. 50 W without keeper

Equipment Needed

Power Supply 1.5 A (code 2407.70)

Iron Filings (code 4612.12)



LAWS AND PRINCIPLES INVESTIGATED

- Magnetic effect of a flowing current
- Magnetic strength and its dependence on the intensity of the electric current
- Magnetic lines of force

Gimbals Magnetic Field Sensor

4640.70*

The simplest way to explore magnetic fields

▶ Altay's Gimbals Magnetic Field Sensor



* Minimum Order Quantity 5 pcs

Altay Gimbals Magnetic Field Sensor is an effective equipment for pupils' first approach to magnetism.

The gimbals magnetic field sensor is useful to demonstrate the 3-D nature of magnetic fields.



LAWS AND PRINCIPLES INVESTIGATED

- Detection of lines of magnetic field like earth magnetic field, permanent magnets magnetic fields etc.

SINGLE ITEMS

Magnetism & Electromagnetism

Induction Coils

4640.75*

Induction coils are essential laboratory equipment for a wide range of electromagnetism experiments



Altay Induction Coils are a simple and versatile piece of equipment for the study of electromagnetism, magnetic induction and generation of static and dynamic magnetic fields.

Suggested for all physics introductory laboratory courses.



MAIN COMPONENTS

- Coil 250 Turns
- Coil 2000 Turns
- Iron Core



LAWS AND PRINCIPLES INVESTIGATED

- Magnetic induction
- Inductance

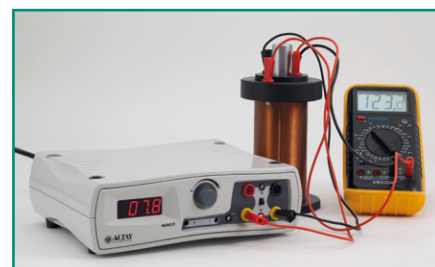
* Minimum Order Quantity 5 pcs

Specifications

Size: DN 10x17 cm - Weight: 4 kg

Equipment suggested

Current probe (code 2313.20)
LabPro (code 2300.10)
or LabQuest (code 2300.30)
or Go!Link (code 2320.30)
Chrome Steel Bar Magnets (code 4611.50)
Power Supply 10 A (code 2407.75)



Waltenhofen's Pendulum

4640.80

Altay Waltenhofen's Pendulum emulates the historic experiments to study Foucault's currents.



Specifications

Size: 30x15x10 cm

Weight: 9 kg

Equipment suggested

Rotary motion sensor (code 2310.20)
LabPro (code 2300.10)
or LabQuest (code 2300.30)
or Go!Link (code 2320.30)

It is composed of a plate of a diamagnetic material free to oscillate between the polar expansions of an electromagnet.

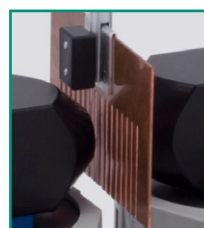
Damping is due to currents induced in the plate (Foucault currents or Eddy currents) and to their verse which opposes to the change of magnetic flux through the plate. Substituting the solid disc with a brush disc, we see that the damping decreases because the eddy currents can no longer flow.



LAWS AND PRINCIPLES INVESTIGATED

- Foucault's (or Eddy) currents
- Faraday-Neumann-Lenz's law

Polar expansions detail



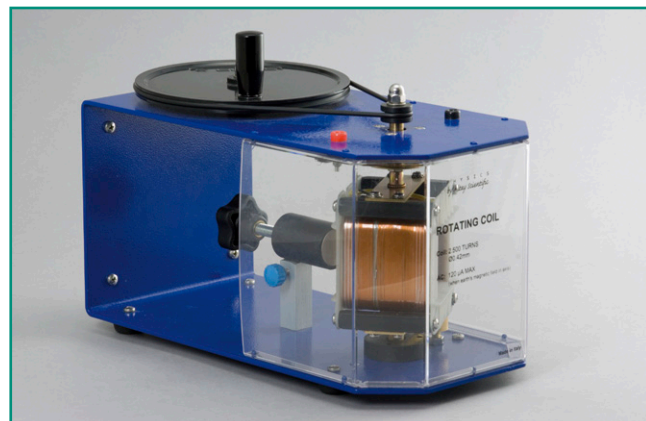
SINGLE ITEMS

Magnetism & Electromagnetism

Rotating Coil

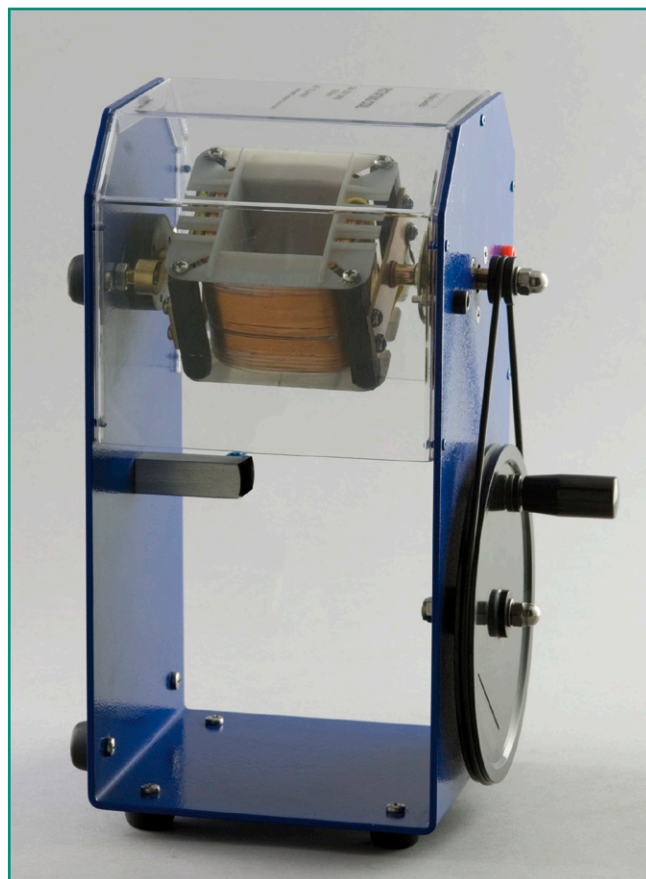
4640.60

Rotating Coil is an interesting device to study Faraday-Neumann-Lenz's law.



Generation of currents when a coil rotates in a magnetic field is a basic concept of hundreds of crucial applications in physics, engineering and everyday life (e.g. this is the principle of the dynamo).

This apparatus is comprised of a suspended coil free to rotate and magnets beneath; a crank will help to rotate the coil; two 4 mm sockets allow to measure the differential voltage generated by the coil or to mount a circuit. The Rotating Coil has a sturdy base with rubber feet and a security shield for safe usage.



▲ The Rotating Coil in standing position

Specifications

Size: 20x20x25 cm

Weight: 2,7 kg

Equipment Needed

Vernier Differential Voltage Sensor (code 2313.40)

LabPro (code 2300.10)

or LabQuest (code 2300.30)

or Go!Link (code 2320.30)



LAWS AND PRINCIPLES INVESTIGATED

- Faraday-Neumann-Lenz's law
- Earth magnetic field



EXAMPLE OF USE

Faraday-Newmann-Lenz Law • Generate electric current

It is possible to generate electric currents in a circuit, without generators. Those currents are called "induced currents" and the phenomenon is called "magnetic induction". The Faraday-Newmann Law describes this phenomenon, asserting that when a magnetic field varies in a certain point of a conductor, there an electric field is created. Lenz showed that the electromotive force generated in this way, produces a current generating a magnetic field opposite to the one which generated the current.

So the Faraday-Newmann Law can be written as:

$$C(E) = f.e.m. = - \frac{d\Phi(B)}{dt}$$

The negative sign shows that the f.e.m. oppose itself to the variations of the flux.



◀ Using the Rotating Coil with LabQuest



Using the coil in vertical position and taking away the magnet, it is possible to find the North-South direction of the Earth's magnetic field.

◀ Using the Rotating Coil with LabQuest

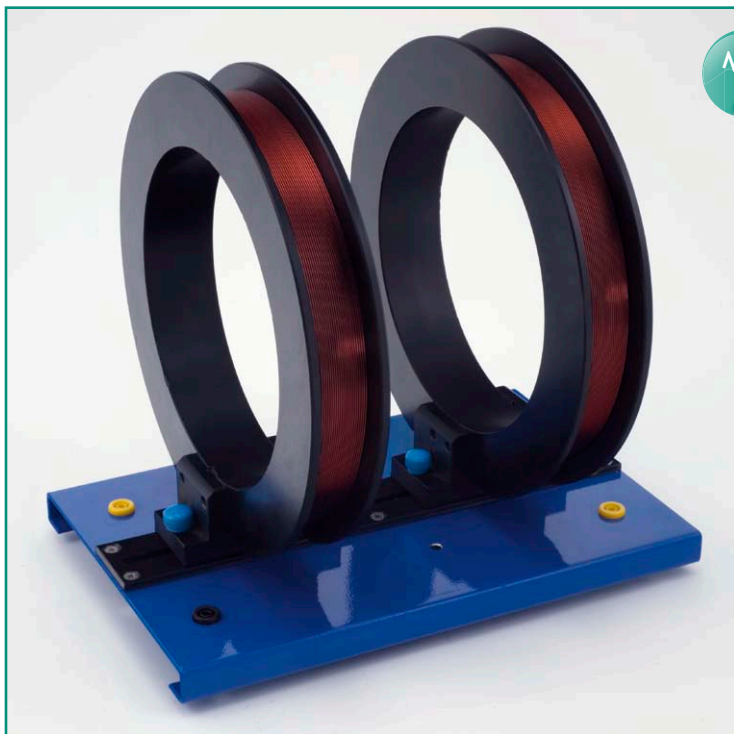
SINGLE ITEMS

Magnetism & Electromagnetism

Helmholtz Coils

4851.04*

Generate a nearly uniform magnetic field using Helmholtz Coils



Specifications

Approx. Size: 30 x 20 x 28 cm

Weight: 5 Kg

1100 Turns

Equipment suggested:

Power Supply 10A (code 2407.75)

Magnetic field sensor (code 2313.50)

LabPro (code 2300.10) or LabQuest (code 2300.30)

The Helmholtz Coils consist of a pair of coil placed on a base, along the same axis and at a distance equal to the coil radius; they provide an almost uniform magnetic field between them, usable in different experiments on magnetism.

Altay Helmholtz Coils can be moved along the axis direction, to discover how magnetic field changes moving them from their standard position.



LAWS AND PRINCIPLES INVESTIGATED

- Uniform magnetic field

* Minimum Order Quantity 5 pcs

Induction Coil 600 turns

4640.76*

A powerful and sturdy coil for electromagnetism experiments



This coil provides the easiest way to generate a strong magnetic field (up to 80 mH).

Used with a Magnetic Field Sensor (code 2313.50), it provides accurate and repeatable results.

Specifications

Size: approx. diam. 19 cm

Weight: 2 Kg

600 Turns

Max inductance: 80 mH approx

Wire diam.: 1 mm

Two function modes: 300 - 600 turns

Maximum current: 3A

Equipment Needed:

2x Connecting Lead (code 2522.14)

Equipment suggested:

Power Supply 10A (code 2407.75)

Magnetic field sensor (code 2313.50)

LabPro (code 2300.10) or LabQuest (code 2300.30)

Laboratory jack (code 5406.30 - 34)

Tape measure (code 2211.10)



LAWS AND PRINCIPLES INVESTIGATED

- Multilayer solenoid
- Ampere's equivalence theorem
- Biot-Savart law

* Minimum Order Quantity 5 pcs

SINGLE ITEMS

Magnetism & Electromagnetism

Induction Coil 1100 turns

4640.77*

Explore magnetic fields easily



Specifications

Approx. Size:
diam. 12 cm, length 31 cm
Weight: 2 Kg
1100 Turns
Max inductance: 20 mH approx
Wire diam.: 1 mm
Two function modes: 550 - 1100 turns
Maximum current: 5A

Equipment Needed:

2x Connecting Lead (code 2522.14)

Equipment suggested:

Power Supply 10A (code 2407.75)
Magnetic field sensor (code 2313.50)
LabPro (code 2300.10) or LabQuest
(code 2300.30)
Laboratory jack (code 5406.30 – 34)
Tape measure (code 2211.10)

Using this apparatus and with a simple set-up, it's possible to explore and to understand in depth basic laws of electromagnetism such as Biot-Savart Law and Ampere Equivalence Theorem.

* Minimum Order Quantity 5 pcs



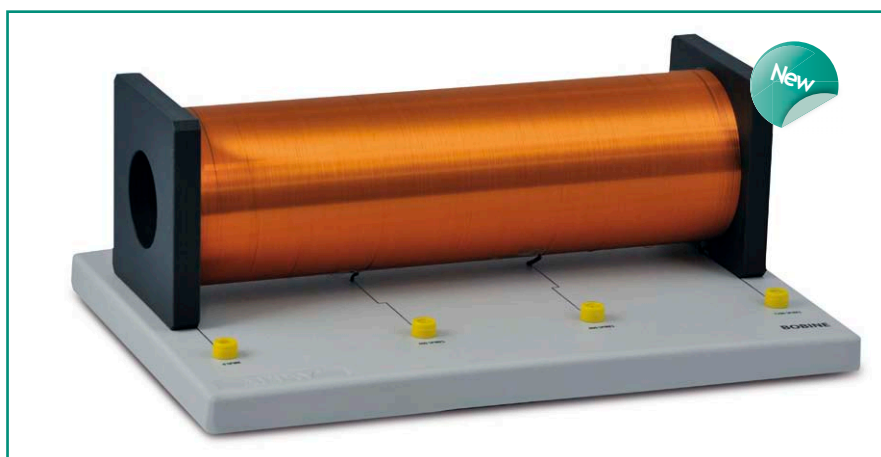
LAWS AND PRINCIPLES INVESTIGATED

- Multilayer solenoid
- Ampere's equivalence theorem
- Biot-Savart law

Coil 1200 turns

4640.79*

An easy way to study the magnetic field generated by a coil when current flows through it.



* Minimum Order Quantity 5 pcs

Specifications

Size: 42x30x16 cm - Weight: 4,2 kg
Single layer solenoid
Three safety sockets (400 – 800 - 1200 turns)
Copper wire diam. of 0.25 mm.
maximum allowed current of 0.3 A

Equipment Needed

Connecting leads (code 2522.02 - 14)
Digital teslameter (code 2280.50)
Low Voltage Power Supply (code 2407.80 -70)

Equipment Suggested

Magnetic field sensor (code 2313.50)

This item is a single layer solenoid that enables to study the fundamental laws of electromagnetism.



EXAMPLE OF USE

Axial magnetic field of a single layer solenoid

By using this single layer solenoid, a DC power supply and a magnetic field sensor it's possible to measure the magnetic field along the axis of the coil itself when current flows through it.



LAWS AND PRINCIPLES INVESTIGATED

- Single layer solenoid
- Ampere's equivalence theorem
- Biot and Savart law
- RL, RLC circuits

SINGLE ITEMS

Magnetism & Electromagnetism • Electricity & Electronics

Double Winding Coil

4640.90

A unique solution to investigate the inductance and the magnetic field generated by a single layer coil.



This item is a single layer solenoid characterized by an inductance ranging from a maximum of about 1.28 mH up to few units of μHs equipped with fourteen safety sockets and a copper wire diam. of 1.03 mm. It actually consists of two copper wires, one is coated by an isolating glaze (yellow wire) and the other is not isolated (white wire); they alternate while the white one comes out through the red safety sockets. By a connecting cable we can obtain combinations with different number of turns.

Specifications

Size: 70x18x12 cm
Weight: 2,8 kg

Equipment Needed

DC power supply (code 2407.70)
Connecting leads (code 2522.02 - 14)

Equipment suggested

Digital Multimeter (code 2275.10)
Inductance meter



MAIN COMPONENTS

- Coil, Digital
- Teslameter



LAWS AND PRINCIPLES INVESTIGATED

- Magnetic field generated by currents flowing through a coil
- Inductance of a single layer coil
- Study of RL, RLC circuits

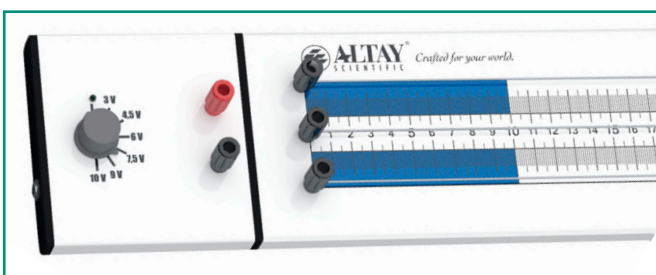
Ohm Apparatus

4697.30

Verify the Ohm's Law easily



▲ The Ohm Apparatus



Altay's Ohm Apparatus is a simple and economical solution to perform experiments to investigate Ohm's Law.

We can discover how resistance, current and voltage are linked together and how material and thickness affect resistance. This apparatus has a unique feature in that it can operate by fixing current or voltage independently verifying Ohm's Law in two different ways. The Apparatus is provided with a set of wires of different materials and thickness's.

EXAMPLE OF USE

The Ohm's Law

Ohm's Law states that the current through a conductor between two points is directly proportional to the potential difference (i.e. voltage drop or voltage) across the two points, and inversely proportional to the resistance between them: $I = V/R$, with I current (Amperes), V difference of potential (Volts) and R the resistance of the circuit (Ohms). Resistance is a characteristic of the circuit, dependent by various factors, such as material.



MAIN COMPONENTS

- | | | |
|----------------|-------------------|-------------------|
| • Ohm's Law | Apparatus Voltage | Apparatus Current |
| Apparatus Base | Generator | Generator |
| • Ohm's Law | • Ohm's Law | • Set of wires |



LAWS AND PRINCIPLES INVESTIGATED

Ohm's Law

SINGLE ITEMS

Electricity & Electronics

Barlow's Wheel

4645.02

Discover Lorentz force without using mercury

Specifications

Size: 25x18x20 cm

Weight: 2,7 kg

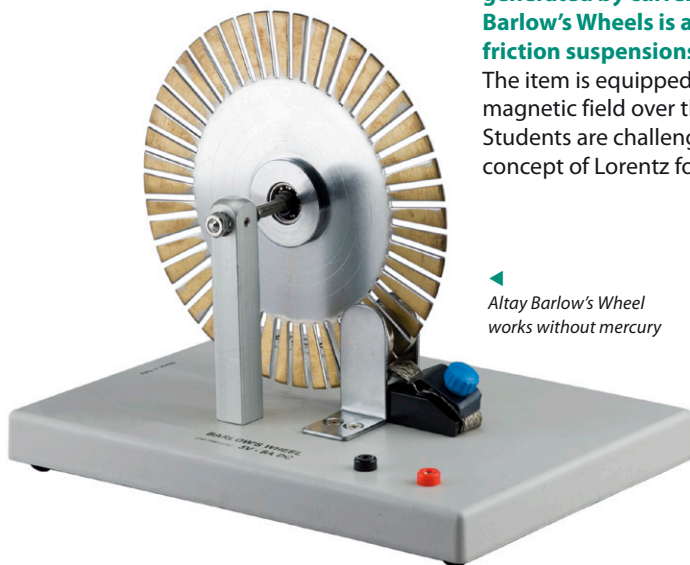
Equipment Needed

Power Supply 30 A (code 2407.65)

Connecting leads (code 2522.00) (2x)

Barlow's Wheel is an historical demonstration experiment of Lorentz force generated by currents flowing between the polar expansions of a magnet. Barlow's Wheel is an impressive piece of apparatus constituted by a wheel on low friction suspensions.

The item is equipped with neodymium-iron-boron magnets that generate a strong magnetic field over the wheel that is therefore set on motion when crossed by currents. Students are challenged to find an explanation to the phenomenon making use of the concept of Lorentz force.



Altay Barlow's Wheel works without mercury



LAWS AND PRINCIPLES INVESTIGATED

- Lorentz force
- Interaction of currents with magnetic field



EXAMPLE OF USE

Lorentz force • How force acts on a single particle

Lorentz force is the force exerted on a charged particle in an electromagnetic field.

The particle will experience a force due to electric field of $q\mathbf{E}$, and due to the magnetic field $q\mathbf{v} \times \mathbf{B}$. Combined they give the Lorentz force equation (or law):

$$\mathbf{F} = q \cdot (\mathbf{E} + \mathbf{v} \times \mathbf{B})$$

where

\mathbf{F} is the force (in newtons)

\mathbf{E} is the electric field (in volts per meter)

\mathbf{B} is the magnetic field (in teslas)

q is the electric charge of the particle (in coulombs)

\mathbf{v} is the instantaneous velocity of the particle (in meters per second), and \times is the cross product.

Thus a positively charged particle will be accelerated in the same linear orientation as the \mathbf{E} field, but will curve perpendicularly to both the instantaneous velocity vector \mathbf{v} and the \mathbf{B} field according to the right-hand rule (i.e., if the thumb of the right hand points along \mathbf{v} and the index finger along \mathbf{B} , then the middle finger points along \mathbf{F}).



Laplace Apparatus

4646.10*

Laplace Apparatus works without mercury



The study of Lorentz's force is a crucial topic of introductory physics courses and interaction between electric currents and magnetic fields is a major issue of electromagnetism.

* Minimum Order Quantity 5 pcs



Altay's Laplace Apparatus works without mercury

Specifications

Size: 25x18x45 cm

Weight: 1,7 kg

Equipment Needed

Power Supply 10 A (code 2407.75)

Connecting leads 50 cm (code 2522.00) (3x)



LAWS AND PRINCIPLES INVESTIGATED

- Laplace's Law
- Lorentz's Force

SINGLE ITEMS

Electricity & Electronics

Laplace Rail

4646.15*

Discover the concepts of electromagnetism



▲ Students enjoying with the Laplace Rail.

The links between electrical and magnetic fields will be easily explained by this apparatus



LAWS AND PRINCIPLES INVESTIGATED

- Laplace's Law
- Lorentz's Force



MAIN COMPONENTS

- Laplace Rail
- C shape magnet
- Rod

* Minimum Order Quantity 5 pcs

Specifications

Size: 25x18x8 cm

Weight: 1 kg

Equipment Needed

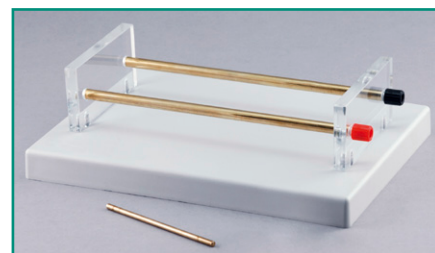
Power Supply 10 A (code 2407.75)

Connecting leads (code 2522.00) (2x)

Electromagnetism is one of the most abstract theories of physics.

This apparatus helps students to approach with fun the concepts of interaction between electric charges and magnetic fields.

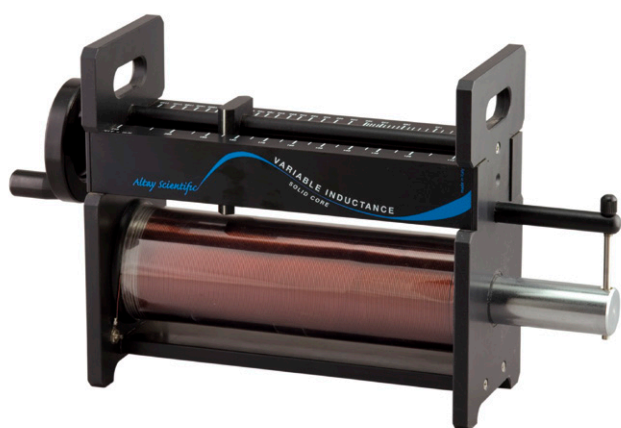
The sliding bar that closes the circuit can be set on motion moving a few permanent magnets (or other sources of magnetic field) in the surroundings of the rail; students will see the sliding bar moving and electric currents flowing if the apparatus is connected to a current probe.



Variable Inductance

4731.00

A unique apparatus to discover inductance



LAWS AND PRINCIPLES INVESTIGATED

- Generation of magnetic fields by flowing currents
- Study of a variable inductance
- Role of iron cores
- Study of RL, RLC circuits



MAIN COMPONENTS

- Variable Inductance
- Solid Iron Core
- Laminated Iron Core

Specifications

Size: 25x11x22 cm

Weight: 8 kg

Equipment Needed

Power Supply 10 A (code 2407.75)

Connecting leads (code 2522.00) (2x)

Equipment suggested

Magnetic Field Sensor (code 2313.50)

Digital Multimeter (code 2275.10)

Learning of magnetism and especially the topic of electric generation of magnetic fields, necessarily passes through the experimental study of tensioned coils whose inductance can be measured and related to theory when Altay's Variable Inductance is used.

Two iron cores are also supplied; solid iron core when using DC and laminated core when using AC.



Bridge Rectifier

2404.13

The Altay Bridge Rectifier transforms alternate current (AC) in direct current (DC)



◀ The Altay Bridge Rectifier

Specifications

Size: 3,5x9x5,5 cm
Weight: 0,17 kg

The Altay Bridge Rectifier consists of four diodes connected in a bridge circuit.

The most common application of this circuit is the conversion of alternating current (AC) input into direct current (DC) output. The unit has a circuit diagram printed so that student may gain an appreciation of the importance of diodes and how they can rectify alternating current to direct current.



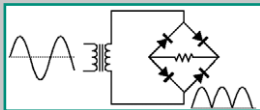
LAWS AND PRINCIPLES INVESTIGATED

- AC-DC Conversion
- Diode principle

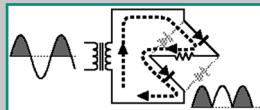
▶ EXAMPLE OF USE

AC – DC Converter • How to transform an alternate current in direct current

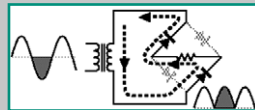
A bridge rectifier makes use of four diodes in a bridge arrangement to achieve full-wave rectification. For both positive and negative swings of the transformer, there is a forward path through the diode bridge. Both conduction paths cause current to flow in the same direction through the load resistor, achieving full-wave rectification. By simply placing a capacitor in parallel to the output of the bridge rectifier, it is possible to stabilize the tension of the DC current. While one set of diodes is forward biased, the other set is reverse biased and effectively eliminated from the circuit.



▲ Full wave rectification schema

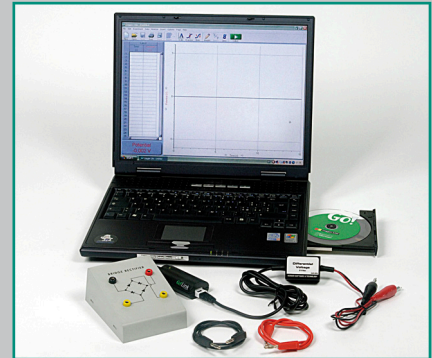


▲ Positive current flow



▲ Negative current flow

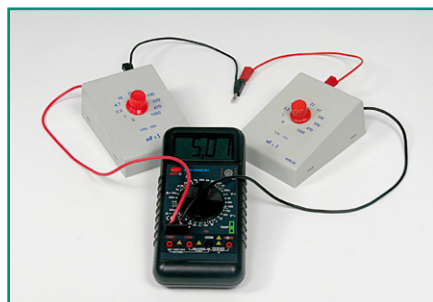
▼ Bridge Rectifier with Go!Link and a Differential Voltage Probe



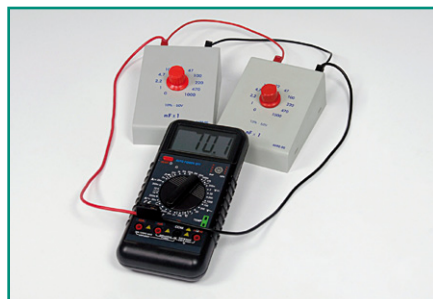
Capacitance Box

4690.00*

A didactic solution for students to study capacitances



▲ Capacitances in series



▲ Capacitances in parallel

The Altay capacitance box allows you to perform experiments on series and parallel using ten different values.

▶ EXAMPLE OF USE

Capacitances in series and in parallel Verify the laws of capacitances in circuits

Capacitors are different from resistors connected in series.

Two or more capacitors are rarely deliberately connected in series in real circuits, but it can be useful to connect capacitors in parallel to obtain a very large capacitance, for example, to smooth a power supply.

Capacitances connected in parallel offer an equivalent resistance equal to the sum of the two. In this case, is also easy to setup the experiment.

Specifications

Size: 13,5x9x5,5 cm
Weight: 0,2 kg
11-position switch
4 mm sockets
Max. voltage: 50 V
Accuracy 10%
Capacitance: 1 - 2.2 - 4.7 - 10 - 22 - 47 - 100 - 220 - 470 - 1000 nF.

Also Available

Capacitance: 1 - 2.2 - 4.7 - 10 - 22 - 47 - 100 - 220 - 470 - 1000 μ F (code 4690.02*) Capacitance: 100 pF - 470 pF - 1 nF - 4.7 nF - 10 nF - 47 nF - 100 nF - 1 μ F - 4.7 μ F - 10 μ F (code 4690.04*)



LAWS AND PRINCIPLES INVESTIGATED

- Capacitances in series
- Capacitances in parallel

* Minimum Order Quantity 5 pcs

SINGLE ITEMS

Electricity & Electronics

Decade Resistance Box

4693.00-50*

An easy to use, multiple value resistances with 4 mm jacks

* Minimum Order Quantity 5 pcs



▲ Resistance Boxes

Specifications

Size: 13,5x9x5,5 cm
Weight: 0,2 kg
11 position switch 4 mm sockets
Max voltage: 50 V
Power permitted: 1 W
Decade Resistance Box: $0.1 \Omega \div 1$, accuracy 2% (code 4693.00*)
Decade Resistance Box: $1 \Omega \div 10 \Omega$, accuracy 2% (code 4693.10*)
Decade Resistance Box: $10 \Omega \div 100 \Omega$, accuracy 2% (code 4693.20*)
Decade Resistance Box: $100 \Omega \div 1 \text{ k}\Omega$, accuracy 2% (code 4693.30*)
Decade Resistance Box: $1 \text{ k}\Omega \div 10 \text{ k}\Omega$, accuracy 2% (code 4693.40*)
Decade Resistance Box: $10 \text{ k}\Omega \div 100 \text{ k}\Omega$, accuracy 2% (code 4693.50*)



LAWS AND PRINCIPLES INVESTIGATED

- Resistance in series
- Resistance in parallel

The Altay Decade Resistance Boxes are a flexible solution for any electronics laboratory and ideal for testing circuits with different resistances.

EXAMPLE OF USE

Resistance in series and in parallel - Ohm's Law and its consequences

The most fundamental law of electrical circuits is known as Ohm's Law: "To make a current flow through a resistance there must be a voltage across that resistance."

Ohm's Law shows the relationship between the voltage (V), current (I) and resistance (R)"

$$V = IR$$

◀ Ohm's Law

Resistors connected in series

When resistors are connected in series, their combined resistance is equal to the individual resistances added together.

$$R_{eq} = R_1 + R_2$$

◀ R_{eq} in series

When resistors are connected in parallel, their combined resistance is less than any of the individual resistances. There is a special equation for the combined resistance of two resistors R_1 and R_2 .

$$R_{eq} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$$

◀ R_{eq} in parallel



▲ Resistance boxes in series



▲ Resistance boxes in parallel

Sliding Contact Rheostat

4694.11-61

Changing the resistance value with a Sliding Contact Rheostat



◀ Altay's Sliding Contact Rheostats

Specifications

Size: 35x10x15 cm
Weight: 2,5 kg
Sliding Contact Rheostat, 2,9 Ω , max 9 A (code 4694.11)
Sliding Contact Rheostat, 10 Ω , max 5 A (code 4694.21)
Sliding Contact Rheostat, 50 Ω , max 2.2 A (code 4694.31)
Sliding Contact Rheostat, 120 Ω , max 1.4 A (code 4694.41)
Sliding Contact Rheostat, 300 Ω , max 0.9 A (code 4694.51)
Sliding Contact Rheostat, 1400 Ω , max 0.4 A (code 4694.61)



LAWS AND PRINCIPLES INVESTIGATED

- Variable resistance

A rheostat is similar to a potentiometer as they both control the input voltage by varying the level of resistance. Available in different resistance values.

SINGLE ITEMS

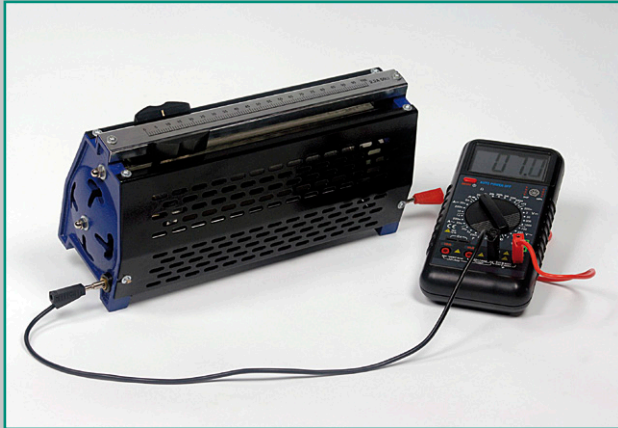
Electricity & Electronics

▶ EXAMPLE OF USE

Variable resistance • Suitable for use in many electricity experiments

Each rheostat is fitted with three terminals that allow it to be used as a fixed or a variable resistance or a potentiometer.

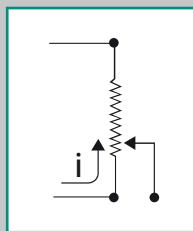
▼ Resistance measurement



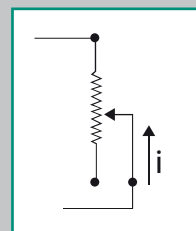
Connecting the two black plugs to the circuit, the rheostat works as a fixed resistance.

Connecting the black and red plugs to the circuit, the rheostat works as a variable resistance.

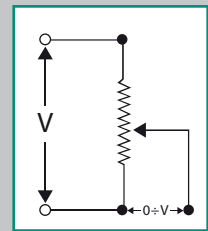
With a more complex circuit schema is possible to realise a potentiometer.



▲ Rheostat used as a fixed resistance



▲ Rheostat used as a variable resistance



▲ Rheostat used as a potentiometer

Potentiometer Bridge

4697.00

Specifications

Size: 110x12x3 cm

Weight: 2,7 kg

The most effective way to introduce the concept of resistance



◀ Altay's Potentiometer Bridge

We have developed our Potentiometer Bridge specifically for the teaching laboratory. This apparatus allows to study the resistance easily and quickly and determine the value of an unknown resistance.



MAIN COMPONENTS

- Graduated metal scale
- Metal wire with jockey



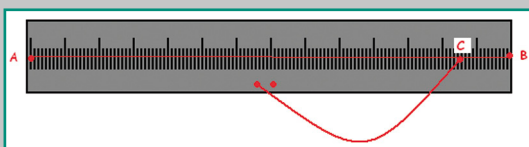
LAWS AND PRINCIPLES INVESTIGATED

- Resistance dependence from geometrical quantities

▶ EXAMPLE OF USE

Investigating the principles of variable resistance • How to build a potentiometer

A metal wire of known linear resistance is connected between the two extremes of the scaled surface

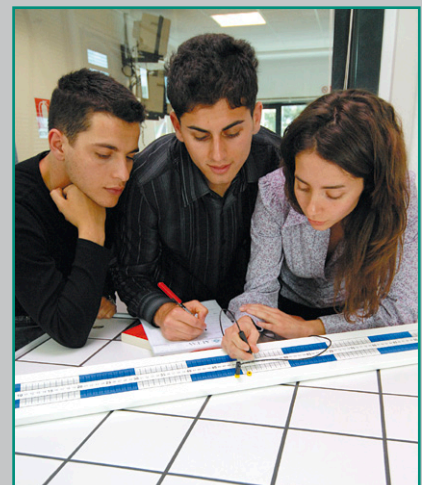


◀ Potentiometer Bridge schema

If tension is applied between A and B, the current flowing on the wire will depend on the resistance of the whole wire. If we now connect our circuit at point C, the resistance of the circuit will be less, and can be shown that it is directly proportional to the wire length.

By simply using a voltmeter and applying Ohm's Law, is possible to verify the linear increasing of the resistance with length.

▶ Students using the Potentiometer Bridge



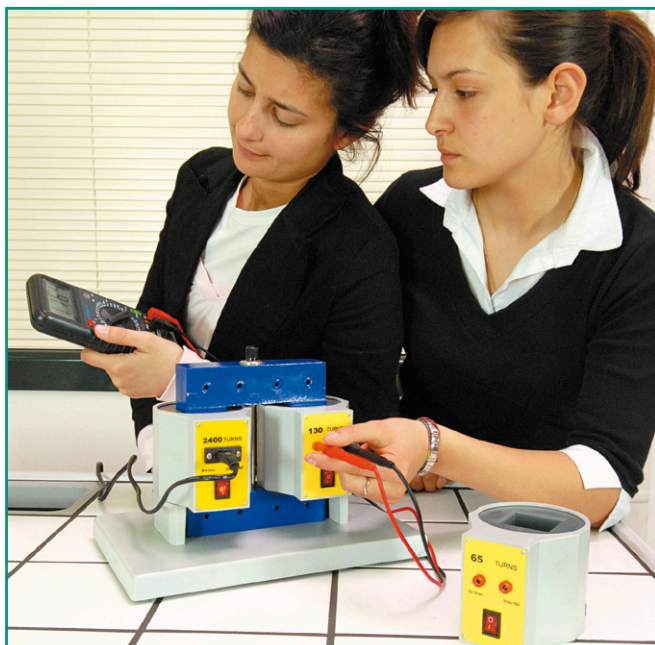
SINGLE ITEMS

Electricity & Electronics

Demonstration Transformer

4729.00

Demonstration of the voltage transformation in an alternate current



Specifications

Size: 20x15x20 cm
Weight: 6,2 kg
Power output: 2 A max.

Equipment Needed

Digital Multimeter (code 2275.10)

With our Demonstration Transformer, students will learn how to change the voltage of an alternate current at a certain frequency to a different value.

Ideal for use in many experiments such as plotting a hysteresis of a ferro-magnet.

Students realizing a voltage transformation

Demonstration Transformer components



MAIN COMPONENTS

- Main coil, 2400 turns
- Interchangeable secondary coil, 65 turns
- Interchangeable secondary coil, 130 turns



LAWS AND PRINCIPLES INVESTIGATED

- Voltage transformation
- Current transformation
- Resistance in an ideal transformer
- Magnetic hysteresis



EXAMPLE OF USE

Voltage transformation • How to obtain 12 V power supply from 220 V line power

A transformer is an electrical device that is used to convert AC power at a certain voltage to a different voltage at the same frequency. The Demonstration Transformer had been specifically developed to aid the understanding of AC power and frequency relationships. The apparatus is easy to setup whilst still safe and secure to use.

Generator Model

4739.20

Demonstration model of dynamo for easy understanding of the functioning

Specifications

Base dimensions 12x12x12 cm
Weight: 0,4 kg

Bicycle dynamo on plastic base dimensions 12x12 cm, complete with a E10 (MES) bulb on bulb holder, and two 4 mm sockets for the dynamo output.

The dynamo is driven by a crank, transmission ratio 1:4. Complete with spare bulb.



LAWS AND PRINCIPLES INVESTIGATED

- Motor spinning
- Dynamo
- Current generation



SINGLE ITEMS

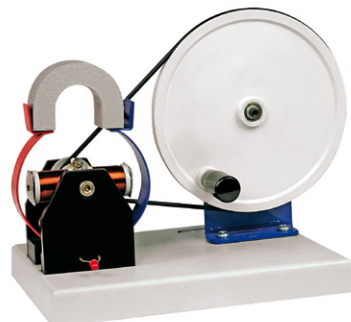
Electricity & Electronics

Demonstration Dynamo

4739.40

Open demonstration model of dynamo for easy understanding of the functioning

Specifications
Base dimensions
15x20x20 cm
Weight: 0,8 kg



Altay's
Demonstration
Dynamo side view.

An armature comprising two coils of copper wire is mounted to rotate about a horizontal axis. Transmission ratio 1:4.



LAWS AND PRINCIPLES INVESTIGATED

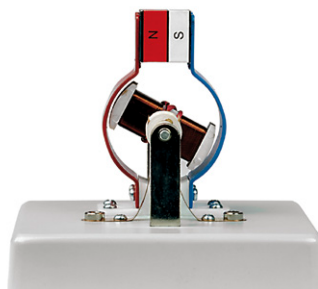
- Motor spinning
- Current generation
- Interaction between currents and magnetic fields
- Dynamo

Motor Unit

4743.05

Open demonstration model of motor for easy understanding of the functioning

Specifications
Size: 12x12x10 cm
Weight: 0,7 kg
Electrical supply:
4-6 V DC or AC



The magnetic field is generated by means of the permanent magnet supplied with the unit. Mounted on a sturdy shock resistant plastic base with 4mm sockets for connection to power source.



LAWS AND PRINCIPLES INVESTIGATED

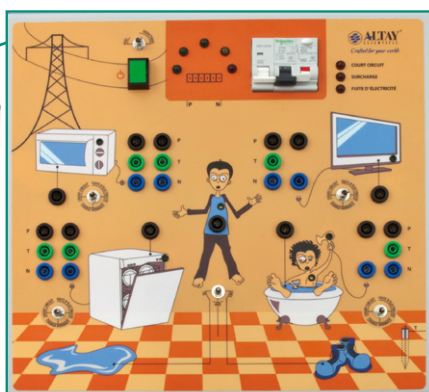
- Motor spinning
- Dynamo
- Interaction between currents and magnetic fields

Electrical safety simulator

4715.00

Simulate easily the typical technical problems of an electrical system: short circuit, current leakage, overload.

The Simulator enables students to understand how dealing with electrical systems in a safe way. The system gives the opportunity to feed different electrical devices, commonly present in our houses and buildings. A couple of safety socket located on the left side of the electrical Simulator give the chance to separate the circuit breaker from the whole device by connecting it to an external circuit to study its specific behavior



Specifications

Approx. Size: 50x45x15 cm
Weight: 5,5 kg

Equipment suggested

Digital Multimeter (code 2275.10)
Sliding Contact Rheostat 2.9 KOhm (code 4694.11)
Decade Resistance Box 10 Ohm - 100 Ohm (code 4693.20)
Decade Resistance Box 100 Ohm - 1 kOhm (code 4693.30)



LAWS AND PRINCIPLES INVESTIGATED

- Short circuit
- Overload
- Current leakage
- Circuit breaker

▶ EXAMPLE OF USE

Electrical overload

Purpose of this experiment is to simulate a typical occurrence characterizing the electrical systems when a excessive number of electrical devices is connected to the power supply.

DATALOGGER & SENSORS

Interfaces

LabPro

2300.10

Get Started with Datalogging: Data Collection Technology



Compatibility

- Windows or Macintosh OS, serial or USB port, with Logger Pro software (sold separately)
- TI handhelds: TI-73, TI-82, TI-83, TI-83 Plus, TI-83 Plus Silver Edition, TI-84 Plus, TI-84 Plus Silver Edition, TI-86, TI-89, TI-92, TI-92 Plus, Voyage 200
- Palm® Handhelds: Palm T|X, Tungsten E2, T5, T3, C, W, T2, T, Zire 71, m515, m130, m125, m500, i705, and many legacy, Palm, and Visor handhelds
- Sony Handhelds: PEG-TJ25, TJ35, TJ27, TJ37
- Garmin® iQue™ 3600, 3200

The Vernier LabPro offers data logging in a new level of affordability and flexibility. The LabPro is very versatile as it can be used directly with a USB or Serial Port on your computer and has four digital and two analogue inputs. LabPro can be used directly with a computer (using the award winning LoggerPro software) or with a Texas Instruments graphing calculator, Palm OS® PDA*, or as a stand-alone data collector.

MAIN COMPONENTS

- LabPro Interface
- Voltage Probe
- Computer cables (USB & serial)
- Calculator cradles
- DataMate calculator program
- Calculator link cable
- User's manual
- AC power supply

To collect data, simply connect the LabPro to your computer or hand-held device, plug in one of our sensors, and start the data-collection program. The program automatically detects which sensors are connected.

This datalogger has been classroom tested by hundreds of thousands of students around the world.



▲ Easily and immediate field data acquisition to the computer

Six data collection channels

- Four analogue channels for over 40 different sensors, for physics, chemistry, environmental science, mathematics, biology and physiology
- Two digital channels (DIG/SONIC 1, DIG/SONIC 2) for motion detectors, photogates, radiation monitors and rotary motion sensors
- Samples up to 50,000 readings per second
- 12-bit A/D conversion
- Internally stores 12,000 data points
- Four analogue input channels (CH1÷CH4)
- Analogue Output, 1 channel (CH4), ± 3 volts, 100 mA (with function generator)



▲ Datalogger with motion detector used to acquire collision data with the Altay Mechanics Upgrade 1

DATALOGGER & SENSORS

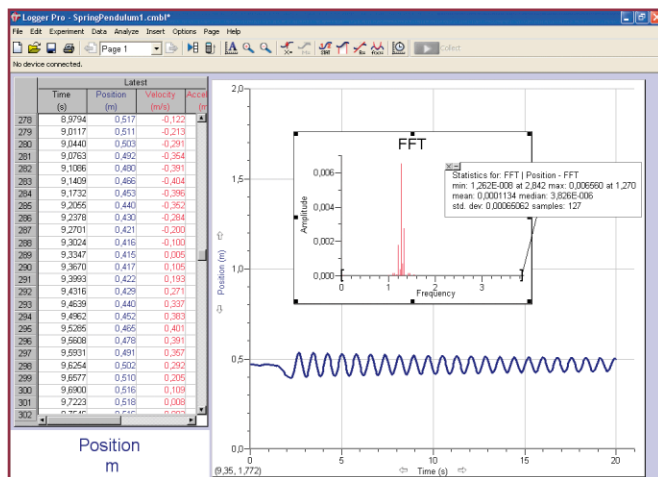
Interfaces

The datalogger can be easily connected to:

- Computers: Windows or Macintosh computers (serial or USB). Using the LabPro3 software (sold separately)
- Texas Instruments Handhelds: the datalogger can be directly connected to many TI graphic calculators for field data acquisition
- Palm® Handhelds: with the Palm data collection kit (sold separately) and a Palm Powered™ handheld, you get the same portability as a calculator on the highly popular Palm OS. For further analysis, it is always possible to uploading data to a computer
- As a Stand-Alone Data Logger: in remote mode, you can take LabPro to an amusement park or a local stream and collect data without a computer or handheld attached.

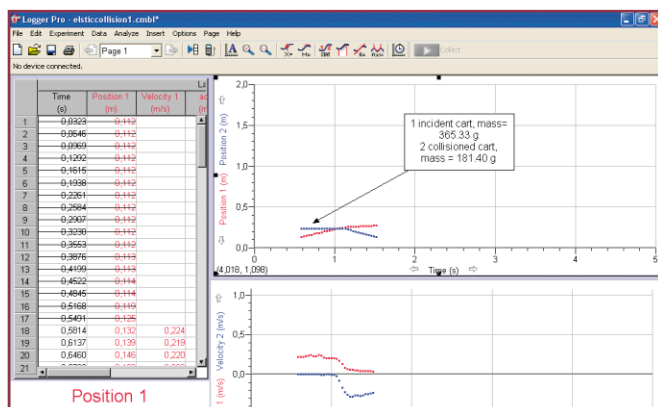
The Motion Sensor is ideal for most Kinematics Experiments. Using LoggerPro software and the Altay Mechanics System 1, we can use the powerful LoggerPro software to easily determine the elastic constant of a spring.

This is done by using the FFT (Fast Fourier Transform function in real time).



▲ Spring pendulum experiment using LoggerPro data logging software

With the datalogger and software it is easy to study collision between carts. It is very easy to set up an experiment by combining two motion sensors to acquire position, velocity and acceleration data for two carts in real time. Using LoggerPro, it is possible to graph simultaneously the positions of the two carts and see what happens during the collision in real time.



▲ Collision graphs with the datalogger and motion sensors

A Differential Voltage Sensor can be used together with the Bimetal Strip and a Stainless Steel Temperature Probe to determine the instantaneous temperature of the circuit when it opens.

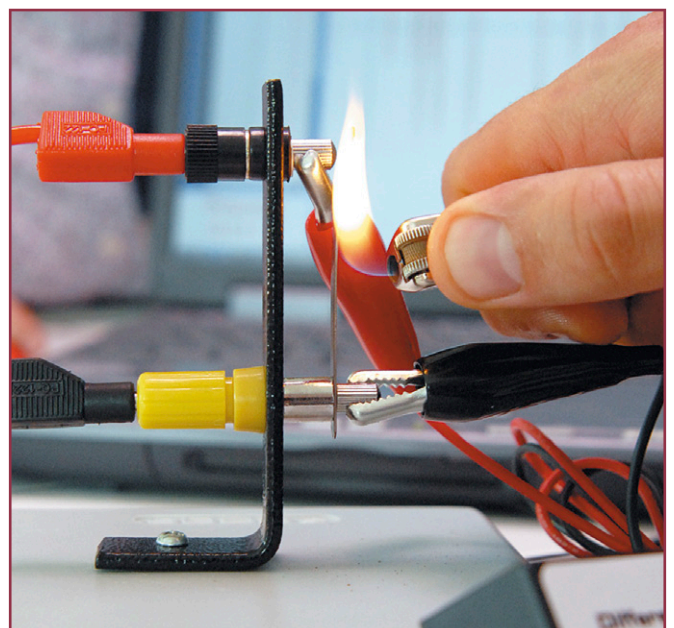


▲ Mechanics experiments with datalogger

The Motion Sensor can be also used in collision experiments to acquire data of elastic and inelastic collisions in real time with incredible accuracy.



▲ Investigating collisions using a datalogger



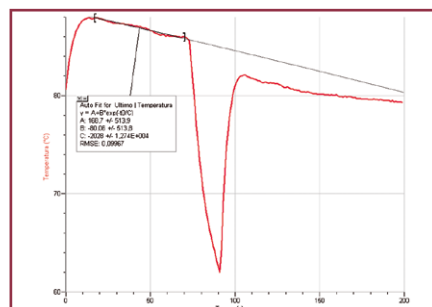
▲ Using the Bimetal Strip and the Differential Voltage Probe

DATALOGGER & SENSORS

Interfaces



With a calorimeter and a temperature probe is easy to acquire data and determine the specific heat of materials.



Calorimeter and Stainless Steel Temperature Probe

The Light Sensor is ideal for use with the Altay Optics Systems 1 and 2 for accurate data on a very wide range of experiments. Using a Light Sensor we can acquire extremely accurate interference fringes and other diffraction patterns.



The Light Sensor and the Altay Optics System 2

Wireless Dynamics Sensor System

2300.20

Force, acceleration, altitude. All in one, all wireless

Equipment needed

- LoggerPro 3.4.5 software
- Windows XP SP2 (or newer) or Macintosh OS X 10.3 (or newer)
- Bluetooth® wireless technology enabled computer



Wireless Dynamics Sensor System, the wireless solution for datalogging

A complete system

The Wireless Dynamics Sensor System includes a high capacity lithium-ion rechargeable battery and charger, AAA alkaline battery holder (allows you to use AAA batteries instead of the rechargeable battery), bumpers for collisions, hooks for mounting the unit in different positions, mounting hardware for Vernier and other dynamics carts and user manual.

Specifications

- Internal data storage capacity: 50,000 points
- Maximum sampling rate: 1,000 samples/sec
- Force Sensor: Range ± 50 N – Resolution 0.006 N (< 10 N), 0.03 N (> 10 N)
- Accelerometer: Range (for each axis) ± 50 m/s² (± 5 g) Resolution 0.04 m/s²
- Altimeter: Altitude Change Range ± 200 m – Resolution 1 m
- Force Sensor, custom load cell provides accurate, repeatable results
- Altimeter, record changes in altitude for roller-coaster physics
- 3-Axis Accelerometer, three orthogonally mounted sensors let you

All in one, all wireless. Ideal for use with the Altay Multiuse Systems, this new sensor offers true portability. Using Bluetooth® technology it is useful for both experiments inside the physics lab as well as on amusement park rides!

The new Wireless Dynamics Sensor System combines a 3-axis accelerometer, force sensor and altimeter into one unit that communicates wirelessly with your computer via Bluetooth®. You can also use it as a stand-alone data logger. It is more than just a wireless sensor; it is a complete data-collection system completely free of friction due to cables.

- measure acceleration in all directions
- Wireless Communication, Bluetooth® wireless technology transmits data to a supported device
- Start/Stop Button, one-button operation allows you to start and stop data collection when away from the computer
- Multiple Mounting Options, mount the device in almost any orientation using standard hardware
- On-Board Memory, retains data even after the unit is turned off
- Additional Hook, allows the device to be mounted in-line for tension and pendulum experiments

DATALOGGER & SENSORS

Interfaces

LabQuest

2300.30

The freedom to inquire. The technology to excel



One-touch simplicity for real-time data analysis at your fingertips, the Vernier LabQuest is as easy to use as point and touch. Vernier LabQuest offers a durable, color, touch-screen interface with powerful built-in software. It provides intuitive data collection in the field, as well as in the classroom.

The new LabQuest can be used with your existing Vernier sensors. Also for good measure, a handy touch screen display was added, so the students do not have to work with messy and hard to use menus or a complicated array of buttons.

◀ *LabQuest, the most powerful and intuitive interface for science education*

Features of LabQuest

- High-speed data collection with color graphs and powerful analysis
- Linear and curve fits
- Draw a prediction before taking data
- Display a tangent line on the graph
- Color-coded periodic table, on-screen keyboard, scientific calculator, and stopwatch
- Export data to Logger Pro software

LabQuest is the most powerful and intuitive interface designed specifically for science education. Combined with Vernier sensors, LabQuest will engage your students in hands-on science and provide real-time graphing and analysis. Use it stand-alone or with a PC!



◀ *Use your LabQuest stand-alone*



▶ *Use your LabQuest with a PC*



◀ *LabQuest works with over 50 Vernier sensors*



▶ *Use your LabQuest in any condition*

The Vernier LabQuest interface is built with rugged reliability in mind. The Vernier LabQuest is designed to withstand a fall from a lab bench. It is water resistant, and holds a battery charge for your entire school day.

The LabQuest Graphing and Analysis Application gives your students real-time graphing capabilities in a handheld device. It's powerful-yet beautifully simple.

Built-in Applications

- Stopwatch

Specifications

- Size: 20.0x20.0x10.0 cm
- Weight: 0.8 kg
- CPU: 416 MHz Processor
- Display: 320x240 pixel color touch screen 7x5.3 cm
- Input Method: Touch Screen, On-Screen Display, Buttons
- Battery: Lithium Ion, rechargeable
- Sensors: 6 Channels (4 Analogue – 2 Digital)
- Resolution: 12 bit
- Sampling Rate: 100,000 samples per second
- Other Ports: USB Standard-A, USB Mini-AB, DC Power Jack, Audio In – Speaker Out
- Memory: 40 MB built-in storage – SD/MMC card slot for expandability
- Built-in temperature sensor and microphone
- Splash proof
- Rugged enclosure with rubber molding for shock absorption

- Periodic table
- On-screen keyboard
- Scientific calculator

Built-In Curriculum

Vernier has embedded over 50 science labs into LabQuest. These well-designed labs have been tested by science educators and make it easy for your students to follow along.

Lab Books

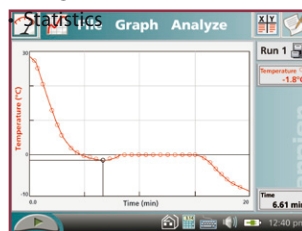
Written by science teachers, each lab book guides you through core science labs.

Our popular lab books have been updated with instructions for LabQuest:

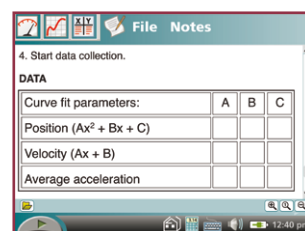
- Biology with Vernier
- Middle School Science with Vernier
- Physics with Vernier
- Water Quality with Vernier
- Chemistry with Vernier
- Advanced Chemistry with Vernier
- Earth Science with Vernier
- Physical Science with Vernier
- Investigating Environmental Science through Inquiry

Analysis Features

- Perform linear and curve fits
- Draw a prediction before taking data
- Display two graphs at once
- Display a tangent line on the graph
- Autoscale
- Integral function



▲ *Discover the LabQuest graphic features*



▲ *LabQuest data collection capabilities are the state of the art in datalogging*

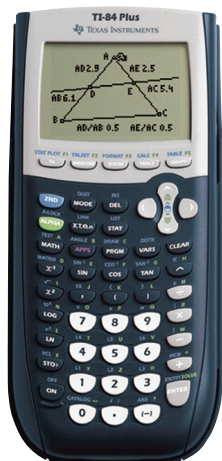
DATALOGGER & SENSORS

Handheld Interfaces

TI-84 Plus Calculator

2300.40

The ideal instrument for High School calculus and data collection



TI-84 Plus calculator is learning tool designed to help students visualize concepts and make connections in math and science, offering advanced data collection features.

Use easily the TI-84 Plus calculator with the Vernier sensors



Features of TI-84 Plus

- Three times the memory of the TI-83 Plus model
- More than twice the speed of the TI-83 Plus model
- USB cable included with purchase (built-in USB port)
- Preloaded Apps: Cabri® Jr., Vernier EasyData™, StudyCards™ and more
- Compatible with TI presentation
- One-year limited manufacturer's warranty

The TI-84 Plus, with Easy Link (code 2300.41), provides an easy to use and versatile system to acquire data from any type of Vernier Sensor, offering, at the same time, all the powerful capabilities in calculus of the TI calculators. Simply connect the EasyLink to your TI-84 Plus, plug the sensor you need to use in the EasyLink and start acquiring!

Specifications

- Electronically upgradeable graphing calculator allows you to have the most up-to-date functionality and software applications (Apps)
- 480 KB Flash ROM memory for data archive and storage of Apps
- 24 KB of available RAM memory
- USB port for computer connectivity, unit-to-unit communication with TI-84 Plus and TI-84 Plus Silver Edition graphing calculators, and more
- I/O port for communication with other TI products
- Internal Clock with date and time display
- 8-line by 16-character display
- Real and complex numbers calculated to 14- digit accuracy and displayed with 10 digits plus a 2-digit exponent
- Compatible with Vernier EasyLink™, and Vernier EasyTemp™ systems to allow collection and analysis of real-world data

EasyLink

2300.41

Easy Data Collection for Math and Science



Connect one of 42 compatible sensors to your TI-84 Plus calculator using an EasyLink interface. Use EasyLink to explore math and science concepts found in real-world phenomena such as light, pressure, force, and more. EasyLink simplifies data-collection because it plugs directly into the USB port of a TI-84 Plus calculator. This action launches the preloaded Vernier EasyData Application on your calculator. Simply press "Start" and you are collecting data.

Features of EasyLink

- Easy to use USB connection
- Compatible with 42 Vernier sensors, as Dual Range Force Sensor, 25-g Accelerometer, Barometer, Gas Pressure Sensor, etc.

Equipment needed

TI-84 Plus – Calculator Operating System 2.30 or higher
EasyData (1.0 or higher)

The Vernier EasyLink is the least expensive way to collect data using a single sensor and a TI-84 Plus graphing calculator.

TI USB Graph Link Connectivity Kit

2300.42

Easy connection between TI-84 Plus and Windows and Macintosh Computers



The TI USB Graph Link Connectivity Kit allows easy connections between your TI-84 Plus and your PC, to download and share your data.

Easy to use as the others Texas Instruments products, includes a USB TI-Graph Link cable that works on Windows or Macintosh computers to be immediately ready to work.

Features of TI USB GRAPH LINK Connectivity Kit

- Capture multiple screen images and use them in tests, presentations and quizzes
- Drag and drop all data types in one consistent manner
- Download calculator Software Applications to use your TI calculator in more classes
- Back up the data from your TI calculator to your computer

DATALOGGER & SENSORS

Software

LoggerPro 3

2300.50

Real-time graphing and powerful analytical tools



▲ LoggerPro 3 Software

The award winning LoggerPro software is used by many schools worldwide and has become the basic programme for data logging experiments. It is both powerful and extremely intuitive.

Its ease of use has made it the standard across the world and is used in more schools than any other programme of its type.

Specifications

- Designed for Windows XP
- Mac OS X Native
- Software of choice for Apple® Mobile Science Labs
- Available in multiple languages

Analysis tools

- Draw predictions on graphs prior to collecting data
- Determine statistical information about data
- Perform a linear regression
- Fit a curve to data
- Model data with an equation

Compatibility

- LabPro
- Go!Temp
- Go!Link
- Go!Motion
- Vernier Spectrometer
- Garmin GPS
- Wireless Dynamics Sensor System
- Ohaus Balances

Features

- Video capture
- GPS data collection
- Vernier Spectrometer and Ocean Optics support
- Date and time stamps for long-term collection
- User-adjustable parameters for total control over calculations
- Double y-axis graphs for plotting unlike units on the same graph
- Collect data from multiple LabPros, Go! devices, or Ohaus balances
- Synchronize videos to sensor data
- Easy unit switching
- Log graphs
- Auto-save feature to protect data during long collections

Features of LoggerPro

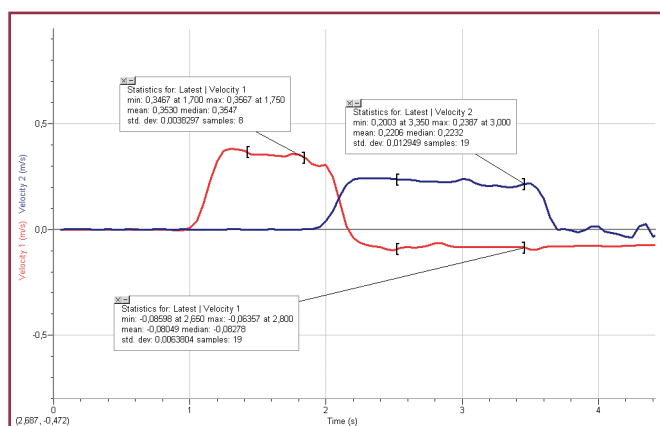
- One program does it all for your computers and your students' personal computers
- Think of LoggerPro as the digital data hub of your classroom and lab. It can gather data from a variety of sources: Vernier LabPro, Go! devices, Ohaus balances, TI graphing calculators, Palm Powered™ handhelds, manual entry, movies and more
- Easily export data and graphs from LoggerPro to Microsoft® Word documents or Excel spreadsheets. Students can even use the multiple page feature to write lab reports in LoggerPro
- LoggerPro will be your students' favourite graphing program. Our generous LoggerPro site license allows your students to continue working with lab data on their home computers
- LoggerPro includes over 1,000 experiment files

LoggerPro can also be used as a basis for student's lab books, being able to create multiple pages to their lab reports.

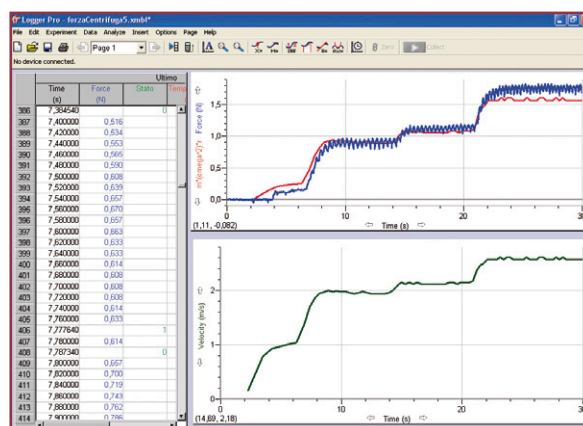
They can incorporate data from other students, enter text for their report, and show step-by-step analysis. It is also free for their home computers!

With LoggerPro, it is possible to compare experimental data with theoretical predictions.

In the above plot the theoretical centrifugal force (red line) is compared with the actual experimental data (blue line).



▲ Elastic collision between two carts plotted in LoggerPro software



▲ Centrifugal forces apparatus data plotted in multiple graphs

DATALOGGER & SENSORS

Packages • Sensors

Physics Data Logging Packages

2300.61-63

Three levels of data logging for different levels of study



We offer three levels of data logging bundles for physics.

All bundles are ideal for use with Altay apparatus. We offer Starter, Standard and Deluxe Bundles aimed at different levels of study. Combine the award winning Vernier software and the largest range of sensors in the world with our high quality and affordable physics apparatus.

Starter Bundle • 2300.61

The ideal starter package for data logging in physics. The bundle consists of a LabPro Interface with a voltage sensor, motion detector, dual-range force sensor and microphone.

COMPONENTS

• LabPro Interface	2300.10	• Dual-Range	
• Motion Detector	2310.10	• Force Sensor	2311.10
		• Microphone	2313.60

The bundles include all you need to perform a wide variety of experiments. Concepts such as velocity, acceleration, Newton's Laws, and momentum will be more clearly understood by your students using both data logging and physics apparatus.

Deluxe Bundle • 2300.63

Our advanced bundle allows for over fifty different experiments in kinematics, optics, electricity, magnetism, thermodynamics and much more.

COMPONENTS

• LabPro Interface	2300.10	• Ultra Pulley	
• Motion Detector	2310.10	• Attachment	2312.12
• Dual-Range		• Magnetic Field Sensor	2313.50
• Force Sensor	2311.10	• Differential Voltage	
• Microphone	2313.60	• Probe	2313.40
• Picket Fence	2312.11	• Current Probe (2x)	2313.20
• Light Sensor	2315.10	• Stainless Steel	
• Low-g Accelerometer	2311.21	• Temperature Probe	2314.20
• Vernier Photogate (2x)	2312.10		

Motion Detector

2310.10

The most versatile instrument for dynamics experiments

Our Motion Detector can measure objects as close as 15 cm to the detector and as far away as 6 m. The short minimum target distance allows objects to get closer to the detector, which reduces stray reflections.

A special track mode switch controls the sensitivity for dynamics carts on tracks for lower noise and higher quality data. The Motion Detector easily attaches to the Altay dynamics systems and has a pivoting head and rubber feet for ease of use when not attached to a dynamics track. The cable is removable, so you can use the Motion Detector with other interfaces with an alternate cable.



Specifications

- Range: 0.15 ÷ 6.0 m
- Resolution: 1 mm
- Sensitivity: 2 settings

The Motion Detector uses the Doppler Effect to take accurate and real time measurements. The Motion Detector uses ultrasound to measure distance. Ultrasonic pulses are emitted by the Motion Detector, reflected from a target and then detected by the device.

The time it takes for the reflected pulses to return is used to calculate position, velocity, and acceleration. This allows you to study the motion of objects such as a person walking, a ball in free fall or a cart on a ramp. These three measurements are calculated in real time by the data logger and shown simultaneously on the computer.

DATALOGGER & SENSORS

Sensors

Rotary Motion Sensor

2310.20

Ideal for linear and rotary motion measurements

Using the Rotary Motion Sensor you can monitor directional angular motion with ease and accuracy to graph angular displacement, angular velocity and angular acceleration.

Typical experiments include measuring moments of inertia, torque, transmission of light through polarizing materials (as a function of angle), pendulum and Atwood's machine.

The Rotary Motion Sensor can also be used to measure precise linear position by rolling the pulley of the sensor along a table.

Specifications

- Standard Resolution:
1.0° (angular velocity up to 13 rev/sec)
- High Resolution:
0.25° (angular velocity up to 3.25 rev/sec)



Dual-Range Force Sensor

2311.10

For studies in force and dynamics experiments

The Force Sensor can be easily mounted on a ring stand or dynamics cart or can be used as a replacement for a hand-held spring scale.

Use it to study friction, simple harmonic motion, impact in collisions, or centripetal force.

Specifications

- Ranges: -10 ÷ +10 N, -50 ÷ +50 N



25-g Accelerometer

2311.20

Measurement of g forces in dynamics experiments

This is great for studying one-dimensional collisions or any motion with larger accelerations.

Specifications

- Range: -250 ÷ +250 m/s²
- Typical Accuracy: ±1 m/s²

Also available

- Low-g Accelerometer (code 2311.21)
- Range: -50 ÷ +50 m/s²
- Typical Accuracy: ±0.1 m/s²



Barometer

2311.30

Ideal for use it for environmental monitoring

The Barometer can be used for barometric pressure in weather studies or for lab experiments involving pressures close to normal air pressure.

Specifications

- Ranges: 25.0 ÷ 31.5 in. Hg, 0.80 ÷ 1.05 atm,
81 ÷ 106 kPa, 608 ÷ 798 mm Hg
- 12-bit Resolution
(LabPro, Go!Link): 0.003 in. Hg
- 10-bit Resolution
(CBL, CBL 2): 0.01 in. Hg



Gas Pressure Sensor

2311.40

A complete kit for your pressure-temperature experiments

An ideal sensor for experiments in physics, biology and chemistry. The Gas Pressure Sensor is accurate and has a good range to work within all subject areas. Ideal for Boyle's Law experiments and also suitable for vapour-pressure or pressure-temperature experiments. The sensor also includes airtight tubing clamps for transpiration experiments, as well as fittings for respiration experiments in small containers.



COMPONENTS

- 20 mL syringe
- Plastic tubing with two Luer-lock connectors
- Two-hole rubber stopper with
- Two Luer-lock adapters
- Two-way valve
- One-hole rubber stopper with one adapter
- Two airtight tubing clamps

Specifications

- Range: $0 \div 210$ kPa, ($0 \div 2.1$ atm or $0 \div 1,600$ mm Hg)
- 12-bit Resolution (LabPro, Go!Link): 0.05 kPa (0.0005 atm or 0.40 mm Hg)
- 10-bit Resolution (CBL or CBL 2): 0.2 kPa (0.002 atm or 1.6 mm Hg)



Photogate

2312.10

The ideal sensor for dynamics experiments

The Photogate can be used to study free fall, rolling objects, collisions, and pendulum motion, to name but a few. The sensor also includes a built-in laser to allow detection of objects much greater than dynamic carts on a track. You can also connect up to four gates in a chain. The Photogate comes with an accessory rod for attachment to a ring stand or for adding the Ultra Pulley Attachment.



Picket Fence

2312.11

Accessory for free fall studies

The Picket Fence has eight opaque bars silk-screened at intervals of 5 cm directly onto clear plastic. These devices are especially good for dropping through a photogate to study free fall. A very accurate value for g can be achieved using this simple accessory and a photogate.



Ultra Pulley Attachment

2312.12

Accessory for motion detection

Add an Ultra Pulley to your Photogate to monitor motion as a string passes over the pulley, or as the pulley rolls along a table. Ideal for $F=ma$.



Bar Tape

2312.13

Accessory for mechanics experiments

Our Bar Tape is a flexible strip 3 m long and 1.6 cm wide with opaque bars spaced every 1.525 cm. This strip can be attached to a dynamics cart and pulled through a photogate, taking the place of a "ticker tape" in many mechanics experiments.

DATALOGGER & SENSORS

Sensors

Charge Sensor

2313.10

Ideal for quantitative measurements



The Charge Sensor is used as an electronic electrostatic voltmeter. Unlike a traditional electrostatic voltmeter, the Charge Sensor can make quantitative measurements. Numerical measurements improve many electrostatics experiments, such as charging by induction, charging by friction and charging by contact. The sensor can also be

Specifications

- Ranges: $\pm 0.5\text{ V}$ ($\pm 5\text{ nC}$), $\pm 2\text{ V}$ ($\pm 20\text{ nC}$), $\pm 10\text{ V}$ ($\pm 97\text{ nC}$)
- Typical bias current: 0.005 pA
- Input capacitance: $0.01\text{ }\mu\text{F}$

used to measure charge polarities. An extremely high impedance voltage sensor with a 0.01 F input capacitor makes these measurements possible. The sensor has three operating ranges and a zeroing switch to discharge the input capacitor.

Current Probe

2313.20

A practical sensor for current measurements

Use the Current Probe to measure currents in low-voltage AC and DC circuits. With a range of $\pm 0.6\text{ A}$, this probe is ideal for use in most battery and bulb circuits. Use it with a voltage probe to explore Ohm's Law, phase relationships in reactive components and much more. Use multiple sensors to explore series and parallel circuits. Can also be used in electrochemistry experiments.

Specifications

- Range: $-0.6 \div +0.6\text{ A}$



Voltage Probe

2313.30

A simple sensor for tension measurements

This Voltage Probe is included with each Vernier LabPro and TI CBL 2. It can be used to measure the potential in direct-current or alternating current circuits. In chemistry, physical science or middle school science classes, the Voltage Probe can be used to measure voltages developed in a variety of electrochemical (voltaic) cells.

Specifications

- Range: $-6.0 \div +6.0\text{ V}$
- Input Impedance: 10 MOhm



Differential Voltage Probe

2313.40

Used for voltage measurements

Use the Differential Voltage Probe to measure voltages in low-voltage AC and DC circuits. With a range of $\pm 6.0\text{ V}$, this system is ideal for use in most battery and bulb circuits. Use it with the Current Probe to explore Ohm's Law, phase relationships in reactive components and much more. This differs from the Voltage Probe that comes with your interface in that neither clip is connected to the ground. Use multiple sensors to explore series and parallel circuits.

Specifications

- Range: $-6.0 \div +6.0\text{ V}$
- Input Impedance: 10 MOhm



Magnetic Field Sensor

2313.50

Ideal sensor for magnetic field measurements

This sensor, which uses a Hall Effect transducer, is sensitive enough to measure the Earth's magnetic field. It can also be used to study the field around permanent magnets, coils, and electrical devices. Our newly designed sensor has a rotating sensor tip which allows you to measure both transverse and longitudinal magnetic fields.

Specifications

- Low Sensitivity: $-6.4 \div +6.4\text{ mT}$
- High Sensitivity: $-0.32 \div +0.32\text{ mT}$



Microphone

2313.60

Great for sound experiments

The Microphone sensor can be used to display and study the waveforms of sounds from a human voice and musical instruments. It is also ideal for speed of sound experiments.



Electrode Amplifier

2313.70

Sensor which is used to amplify BNC connector

The Electrode Amplifier is an mV/pH/ORP amplifier that accepts an electrode with a standard BNC connector. It amplifies a $-450 \text{ mV} \div +1,100 \text{ mV}$ signal to the $0 \div 5 \text{ V}$ range of the LabPro.



Instrumentation Amplifier

2313.80

Sensor to amplify chart recorder and many other instruments

The Instrumentation Amplifier monitors voltages from 20 mV to 1 V (DC or AC).

It has several switch settings to allow you to select the best gain. It is typically used to amplify the chart recorder or analogue output of any instrument (such as a Gas Chromatograph).



Thermocouple

2314.10

Sensor for temperature measurements

This sensor uses type-K thermocouple wire to measure temperatures over the range of -200 to $1,400^\circ\text{C}$. It can be used to measure flame temperatures as high as $1,400^\circ\text{C}$, or liquid nitrogen temperatures at -196°C . The Thermocouple has an internal ice-point compensation chip, so you do not need to place a reference wire in an ice-water bath. You can simply use one measuring lead to take temperature readings. Each Thermocouple is individually calibrated.



Specifications

- Range: $-200 \div 1,400^\circ\text{C}$
- Typical Accuracy: $0 \div 900^\circ\text{C}$: $\pm 2^\circ\text{C}$, $-200 \div 0^\circ\text{C}$: $\pm 5^\circ\text{C}$, $900 \div 1,400^\circ\text{C}$: $\pm 15^\circ\text{C}$

Stainless Steel Temperature Probe

2314.20

Rugged sensor for temperature measurements

This rugged and durable temperature probe has a sealed stainless steel shaft and tip that can be used in organic liquids, salt solutions, acids and bases.



Specifications

- Range: $-40 \div 130^\circ\text{C}$
- 12-bit Resolution (LabPro, Go!Link): 0.17°C ($-40 \div 0^\circ\text{C}$), 0.03°C ($0 \div 40^\circ\text{C}$), 0.1°C ($40 \div 100^\circ\text{C}$), 0.25°C ($100 \div 135^\circ\text{C}$)
- 10-bit Resolution (CBL, CBL 2): 0.68°C ($-40 \div 0^\circ\text{C}$), 0.12°C ($0 \div 40^\circ\text{C}$), 0.4°C ($40 \div 100^\circ\text{C}$)

Surface Temperature Sensor

2314.30

Versatile temperature sensor

Featuring an exposed Thermistor that results in an extremely rapid response time, the Surface Temperature Sensor is ideal for situations in which low thermal mass or flexibility is required or for a skin temperature measurement. For use in air only.



Specifications

- Range: $-25 \div 125^\circ\text{C}$
- 12-bit Resolution (LabPro, Go!Link): 0.08°C ($-25 \div 0^\circ\text{C}$), 0.03°C ($0 \div 40^\circ\text{C}$), 0.1°C ($40 \div 100^\circ\text{C}$), 0.25°C ($100 \div 125^\circ\text{C}$)
- 10-bit Resolution (CBL, CBL 2): 0.3°C ($-25 \div 0^\circ\text{C}$), 0.12°C ($0 \div 40^\circ\text{C}$), 0.4°C ($40 \div 100^\circ\text{C}$), 1.0°C ($100 \div 125^\circ\text{C}$)

DATALOGGER & SENSORS

Sensors

Relative Humidity Sensor

2314.40

Ideal for environmental measurements

The Relative Humidity Sensor contains an integrated circuit that can be used to monitor relative humidity over the range of 0 to 95% ($\pm 5\%$). Use this sensor for weather studies, monitoring greenhouses or for determining days when static electrical discharges could be a problem.



Specifications

- Range: 0 ÷ 100%
- Typical Accuracy: $\pm 5\%$

Light Sensor

2315.10

Sensor for experiments involving light

The Light Sensor emulates the human eye in spectral response and can be used over three different illumination ranges, which you select with a switch. Use it for inverse-square law experiments, studying polarizer, reflectivity, or solar energy.



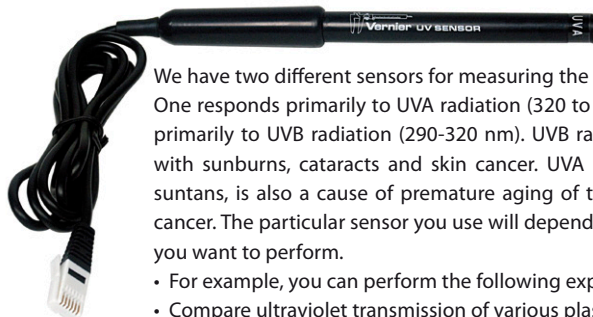
Specifications

- Low Range: 0 ÷ 600 lux
- Medium Range: 0 ÷ 6,000 lux
- High Range: 0 ÷ 150,000 lux

UVA and UVB Sensor

2315.20-21

Devices for measurements in the radiation field



We have two different sensors for measuring the intensity of ultraviolet radiation. One responds primarily to UVA radiation (320 to 390 nm), and another responds primarily to UVB radiation (290-320 nm). UVB radiation is commonly associated with sunburns, cataracts and skin cancer. UVA radiation, while responsible for suntans, is also a cause of premature aging of the skin and some types of skin cancer. The particular sensor you use will depend upon the particular experiment you want to perform.

- For example, you can perform the following experiments:
- Compare ultraviolet transmission of various plastics and glasses
- Compare ultraviolet intensity on cloudy and sunny days
- Study the absorption of ultraviolet by sunscreen lotions and clothing

Specifications

UVA Sensor (code 2315.20)

- Range: 0 ÷ 18,000 mW/m²
- Wavelength sensitivity region: approx. 320 to 390 nm
- UV peak sensitivity: one volt per 3,940 mW/m² at 340 nm
- 12-bit Resolution (LabPro, Go!Link): 5 mW/m²
- 10-bit Resolution (CBL, CBL 2): 20 mW/m²

UVB Sensor (code 2315.21)

- Range: 0 ÷ 900 mW/m²
- Wavelength sensitivity region: approx. 290 to 320 nm
- UV peak sensitivity: one volt per 204 mW/m² at 315 nm
- 12-bit Resolution (LabPro, Go!Link): 0.3 mW/m²
- 10-bit Resolution (CBL, CBL 2): 1 mW/m²

Radiation Monitor (alpha, beta, gamma)

2316.10

For your radioactivity experiments

The Radiation Monitor consists of a Geiger-Müller tube and rate meter mounted in a small, rugged, plastic case with an analogue meter. The unit is battery operated and can be used without a computer for measurement of alpha, beta and gamma radiation. It can be used to explore radiation statistics, measure the rate of nuclear decay and monitor radon progenies.



pH Sensor

2317.10

The ideal sensor for pH measuring

The pH Sensor is a Ag-AgCl combination electrode with a range of 0 to 14 pH units. This high quality electrode has many uses in chemistry, biology, and middle school classes, as well as water quality monitoring. Included is a convenient soaking bottle with storage solution.



Specifications

- Response time: 90% of full reading in 1 sec.
- Temp. range: 5 to 80°C
- 12-bit Resolution: 0.005 pH units
- Smart Sensor as of 5/2000

Conductivity Probe

2317.20

The ideal probe for environmental testing for salinity, total dissolved solids (TDS), or conductivity in water samples

Biology students can use this probe to demonstrate diffusion of ions through membranes or to monitor changes in ion levels in aquatic systems. Chemistry students can use it to investigate the difference between ionic and molecular compounds, strong and weak acids, or ionic compounds that yield different ratios of ions. The Conductivity Probe can monitor concentration or conductivity at three different sensitivity settings.



Specifications

- Automatic Temp. Compensation 5 °C \pm 35 °C
- Low Range: 0-200 μ S/cm (0-100 mg/L TDS)
12-bit Resolution (LabPro, Go!Link): 0.1 μ S/cm –
10-bit Resolution (CBL, CBL 2): 0.4 μ S/cm
- Medium Range: 0-2000 μ S/cm (0-1000 mg/L TDS)
12-bit Resolution (LabPro, Go!Link): 1 μ S/cm –
10-bit Resolution (CBL, CBL 2): 4 μ S/cm
- High Range: 0-20000 μ S/cm (0-10000 mg/L TDS)
12-bit Resolution (LabPro, Go!Link): 10 μ S/cm –
10-bit Resolution (CBL, CBL 2): 40 μ S/cm

3-axis Accelerometer

2311.22

Measure acceleration in a 3D space

This is really three low-g accelerometers mounted at right angles and all placed in a small box. Use it for studying the complex motion of an amusement park ride, a bungee jumper, or simply a toss in the air. With most of our data collection programs, you can graph the magnitude of the total acceleration vector.



Specifications

- For each axis: Range: \pm 50 m/s² (\pm 5g)
- Accuracy: \pm 0.5 m/s² (\pm 0.05g)
- Frequency Response: 0 to 100 Hz

Force Plate

2311.50

Measure large scale pushing and pulling forces

About the size of a bathroom scale, the Vernier Force Plate measures forces of stepping, jumping and other human-scale actions. For example, you can observe the change in normal force during an elevator ride, or measure the impulse delivered by the floor when you jump. You can use the Force Plate with any of Vernier interfaces, along with Logger Pro for computers and DataMate for TI calculators. The Force Plate has two ranges, one for larger forces up to 3500 N, and a more sensitive 800 N range for pushing experiments.



Specifications

- Force range: -800 to +3500 N or -200 to +800 N (positive value is a compression force)
- Maximum non-damaging force: 4500 N compression or 900 N pull
- 12-bit resolution (LabPro, Go!Link): 1.2 N or 0.3 N
- 10-bit resolution (CBL 2): 4.8 N or 1.2 N
- Size: 40.0x10.0x5.0 cm

Sound Level Meter

2313.90

The most handy instrument to measure sound levels

The Sound Level Meter is used to measure sound level in decibels (dB). An output port on the meter records sound level data. A switch on the meter is used to select dBA or dBC weighting. The Sound Level Meter also has an LCD panel, which allows you to use it as a stand-alone device. A dB range switch and a response switch provide flexibility in the standalone mode.



Specifications

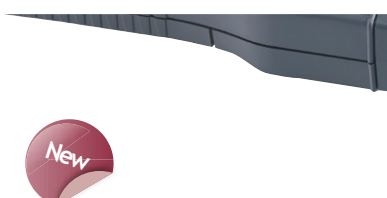
- Sensor: Electric condensor microphone, 13.2 mm
- Power: 4 AAA batteries
- Display: 18 mm 3 1/2 digit LCD
- Input ranges: 35 dB to 90 dB 75 dB to 13 dBC
- Frequency Range: 31.5 Hz to 8,000 Hz
- Resolution: 0.1 dB
- Accuracy: 1.5 dB (ref 94 dB at 1 kHz)
- Response: Slow, 500 ms; Fast, 200 ms
- Output: DC - 10 mV/dB AC- 1.0 Vrms corresponding to each range setup

Infrared Thermometer

2314.60

Measure every temperature from a distance

The Infrared Thermometer is a non-contact, fast-responding, temperature measuring device. The sensor works by measuring the infrared radiation emitted by objects. For most objects, you simply point the sensor at the object and read its temperature.



Specifications

- Temperature range: -20°C to 400°C
- Operating temperature range: 0°C to 50°C at < 70% relative humidity
- Display Resolution: 1 °C
- Accuracy: \pm 3% of reading or \pm 3°C
- Response time: 1 second
- Display Resolution on the meter: 1 °C
- Spectral Response: 6 to 14 mm nominal
- Emissivity: preset 0.95
- Detection element: Thermopile
- Field of view: 65 mm diameter circle at 1000 mm range
- Average battery life: 100 hours typical

DATALOGGER & SENSORS

Interfaceless Sensors

Go!Motion

2320.10

Easy to use and can connect direct to a USB port

Go!Motion is the next-generation motion detector from Vernier. Go!Motion connects directly to a computer's USB port, eliminating the need for a data-collection interface.

Go!Motion comes bundled with free LoggerLite software, which supports data collection on Windows or Macintosh computers.

- Teach important concepts in physics and physical science, such as position, velocity and acceleration
- Engage your students with hands-on activities
- Study the motion of a ball tossed in the air or a cart on a ramp
- Study the motion of a student walking, a toy car and much more... without an additional interface!

Specifications

- Sensitivity switch lets you customise settings to your experiment
- Objects can be as close as 15 cm and as far away as 6 m



Go!Temp

2320.20

USB temperature sensor

Go!Temp plugs directly into the USB port of your Windows or Macintosh computer's USB port without the need for an additional interface. This rugged, stainless-steel temperature probe will engage your students in hands-on science as they explore temperature investigations.

Collect temperature data on your computer with our award-winning USB temperature sensor!



Go!Link

2320.30

Easy to connect and collect data

A quick and affordable way to get started with data-collection technology. This single-channel USB interface is used by students to perform their own engineering experiments on or off campus. Students can use a Go!Link instead of a textbook for their course on sensors and data acquisition. Use our LabVIEW drivers or LoggerPro software for data collection and analysis. Sensors can be automatically recognized and calibrations automatically loaded. Dozens of experiments from our popular lab books may be conducted using Go!Link. Connect any one of the sensors to your computer and collect data such as light, pH, and more!



▲ Logger Lite software, included in Go! sensors for a quick datalogging

Calculator-Based Ranger 2

2330.10

Measure distances, speed and acceleration every time and everywhere

The least expensive and easiest way to collect motion data in your math, physical science, or physics classroom is with the CBR 2. The CBR 2 collects distance, velocity, and acceleration data while connected directly to a TI-84 Plus calculator, without any other interface.



Specifications

- Range: 0.15 m to 6 m
- Works with TI-84 Plus Calculator (code: 2300.40)

EasyTemp

2330.20

Easily measure every temperature with your TI-84 Plus

The Vernier EasyTemp is a rugged, general-purpose temperature sensor that connects directly to a TI-84 Plus Calculator (code: 2300.40). Its stainless steel housing and temperature range (-20°C to 110°C) make it perfect for a variety of activities in science and math. Just plug the EasyTemp into your calculator and watch your temperature data graphed in real time! There's no need to manually record temperatures during an experiment. Let your TI-84 Plus do it.

Specifications

- Range: -20°C – 110°C



Digital Large Display

2236.60

A new way to display experimental results

With the *Altay Digital Display* (DLD) you can easily show the results of your classroom experiments in any unit of measurement. The Altay Digital Large Display (DLD) shows data in two easy visible sections on the screen, which are large enough to be seen from the back of a classroom! The top section features: a large seven segment display of the value of the data received, whilst underneath we have a dot matrix display of the measured units (e.g. mmHg or $\mu\text{S}/\text{cm}$). The DLD has been designed so it can be mounted on a table top or wall mounting.



Specifications

- Size: 40x26x4cm
- Weight: 5 kg

Equipment needed

- Altay Docking Station (code 2236.65)

Main features

Table top/wall mounting

Two display lines

- top line: Data (4 digits - 7 segments - 4 inch. high)
- bottom line: Measure Units (dot matrix segment - 3 inch. high)

Altay Docking Station

2236.65

Low cost, high performance

The Altay Docking Station has been designed as a low cost, easy to use visual display unit for data collection. Designed for quick and easy measurements using our range of sensors, it can also be connected to the Altay Digital Large Display for numerous classroom experiments. Designed specifically to be a compact table top unit, it is compatible with the following Altay and Vernier sensors:

- | | |
|---|---------|
| • Vernier Dual-Range Force Sensor | 2311.10 |
| • Vernier Barometer | 2311.30 |
| • Vernier Thermocouple | 2314.10 |
| • Vernier Stainless Steel Temperature Probe | 2314.20 |
| • Vernier pH Sensor | 2317.10 |
| • Vernier Conductivity Probe | 2317.20 |
| • Altay Photogates | 2232.52 |



Specifications

- Mains Supply: 110 V / 230 V, 50 – 60 Hz
- Size: 30x15x10 cm
- Weight: 1 kg

Main features

- Large LCD display 16x2 cm for easy viewing of data
- Zeroing function for accuracy and for sensor calibration
- Hold function to freeze the data on screen
- Connectivity with Vernier sensors and Altay photogates
- Built in connection with the Altay Digital Large Display (code 2236.60)
- Stopwatch mode
- Electronic Timer mode (with Shadow Time, Pulse Time, Picket Fence, RPM counter measurement)

GENERAL ACCESSORIES

Measuring Instruments

Tape Measure

2211.10-15*

Basic measuring tools for the school lab

Specifications

Length: 2m (code 2211.10)

Length: 3m (code 2211.12)

Length: 5m (code 2211.15)

A low cost flexible steel ruler ideal for any school laboratory. Comes in different lengths with thumb lock.



* Minimum Order Quantity 5 pcs

Goniometric Circle

2216.10*

Angle measurement instrument

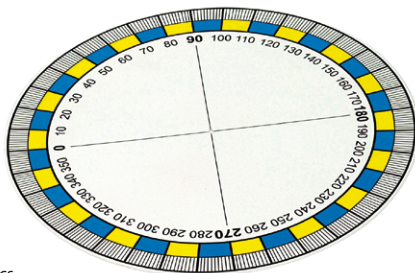
Specifications

Size: DN21X0,5 cm

Weight: 0,1 kg

Range: 0 ÷ 360°

Sensitivity: 1°



* Minimum Order Quantity 5 pcs

The Goniometric Circle is an useful device for measure angles. The yellow - blue scale facilitates the measure. For example, this instrument is used in Mechanics System 1 for the parallelogram of forces experiment. Also available Magnetic Goniometric Circle (code 2216.15* - size: dn 21x1 - weight 0,1 kg).

Spherometer

2215.01*

Precisely measure curve surfaces

Specifications

Range: -10 ÷ +10 mm

Sensitivity: 0.005 mm - Weight: 0,2 kg

The Spherometer is used for the precise measurement of the radius of a sphere or the thickness of a thin plate. It consists of a fine screw moving in a nut carried on the centre of a small three-legged table. In order to measure the curvature of the surface, the object is placed centred under the Spherometer and the screw turned until the point just touches it.



* Minimum Order Quantity 5 pcs

Vernier Caliper

2213.10*

The original accurate measuring tool

Specifications

Range: 0 ÷ 160 mm

Sensitivity: 0.05 mm

Weight: 0,2 kg



* Minimum Order Quantity 5 pcs

The Vernier Caliper is an extremely precise measuring instrument; the reading error is 0.05 mm. The Vernier Caliper is easy to use and is very similar to a slide rule. You simply move the sliding scale against the fixed and as the graduations match up and align, this is your reading!

Micrometer Screw Gauge

2213.15*

A precise instrument to measure thickness of a material

Specifications

Range: 0 ÷ 25 mm

Sensitivity: 0.01 mm

Weight: 0,2 kg



* Minimum Order Quantity 5 pcs

A Micrometer Screw Gauge, also called external micrometer, is typically used to measure wires, spheres, shafts and blocks. This instrument will give measurement of extremely high accuracy.

Micrometer Dial Gauge

2214.00*

Length comparator

Specifications

Range: 0 ÷ 10 mm

Sensitivity: 0.01 mm

Weight: 0,2 kg

* Minimum Order Quantity 5 pcs

The Micrometer Dial Gauge allows precise measurements of differences in length.

It is very useful in the study of the thermal expansion in solids.



GENERAL ACCESSORIES

Measuring Instruments

Precision Mass Set

2220.60-66*

Specifications

Range: 1 mg ÷ 50 g

* Minimum Order Quantity 5 pcs

Also available:

Range 10 mg ÷ 100 g (code 2220.61*)

Range 1 g ÷ 500 g (code 2220.64*)

Range 1 g ÷ 1 kg (code 2220.66*)

A complete set of masses for daily use in laboratory.
Available with different masses set, from 1 mg to 1 kg.



Ohaus Scout® Pro Balance

2219.60-66

Top quality balance

Specifications

Capacity: 200 g - Sensitivity: 0.01 g

Also available:

• Capacity 400 g - Sensitivity 0.01 g (code 2219.61)

• Capacity 400 g - Sensitivity 0.1 g (code 2219.62)

• Capacity 600 g - Sensitivity 0.1 g (code 2219.63)

• Capacity 2 kg - Sensitivity 0.1 g (code 2219.64)

• Capacity 4 kg - Sensitivity 0.1 g (code 2219.65)

• Capacity 6 kg - Sensitivity 1 g (code 2219.66)

Accurate and immediate weight measures in laboratory, industrial or education applications, the Ohaus Scout Pro continues the tradition set by the Ohaus Scout and Scout II products. Featuring easy-to-use two-button operation, a high-contrast LCD display, multiple weighing units, four application modes, and the option of either RS232 or USB connectivity, the Scout Pro Balance is the high quality portable balance for daily use.



Altay Electronic Balance

2219.30 - 34

Higher accuracy balance

Specifications

Capacity: 300 g - Sensitivity: 0.01 g

Also available:

• Capacity 200 g - Sensitivity 0.01 g (code 2219.31*)

• Capacity 500 g - Sensitivity 0.01 g (code 2219.32*)

• Capacity 1 kg - Sensitivity 0.01 g (code 2219.33*)

• Capacity 2 kg - Sensitivity 0.01 g (code 2219.34*)

A high quality electronic balance for schools laboratory usage. Simple to use and calibrate, provides high-precision measurements.

* Minimum Order Quantity 5 pcs

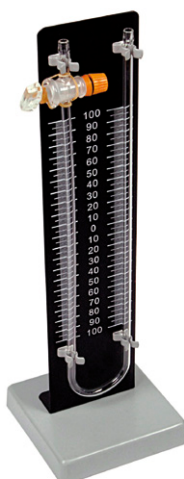
U-Tube Manometer

2242.20

Specifications

Range: 0 ÷ 100 mm

Sensitivity: 1 mm



A manometer made from a glass U-tube, with a valve attached to a metric scale plate mounted on a secure base. The measured pressure is applied to one side of the tube whilst the reference pressure (which may be atmospheric) is applied to the other. The difference in liquid level represents the applied pressure.

Tubular Spring Balances (Metal)

4110.01-07*

Dynamometer



Specifications

Range:

1 N (code 4110.01)

3 N (code 4110.03)

6 N (code 4110.05)

10 N (code 4110.07)

For additional ranges, please contact our sales department

* Minimum Order Quantity 5 pcs

A range of spring balances constructed with high quality tubular metal case, with load hook and suspension ring. Each balance is dual scaled in Newton and grams, with zero adjustment and protection against over load. Available in different ranges and colour coded for convenience.

Tubular Spring Balances (Plastic)

4110.20-24*

Dynamometer



Specifications

Range:

1 N (code 4110.20)

2.5 N (code 4110.21)

5 N (code 4110.22)

10 N (code 4110.23)

20 N (code 4110.24)

For additional ranges, please contact our sales department

* Minimum Order Quantity 5 pcs

Barometer

2242.62

Complete with thermometer and hygrometer with wooden frame.



Specifications

Dial diameter: 140 mm

Pressure: 973÷1053 millibar

Temperature: -25÷65°C

Humidity: 0%÷100%

Measuring Instruments

Stopwatch

2231.25

Specifications

Range: 0 ÷ 60 sec, 1 ÷ 100 min
Accuracy: 1 sec

The best solution for schools and laboratories.
Easy to use and accurate.



Digital Chronometer

2231.52

Specifications

Accuracy: 0.01 sec

Handy to use LCD stopwatch with single
memory function.



Analogue Chronometer

2231.05

Specifications

Main quadrant: 0 ÷ 60 sec
Secondary quadrant: 0 ÷ 30 min
Sensitivity: 0.1 sec

Mechanical stopwatch for time measurement.



Photogate

2232.52



Photogate to be used with the Electronic Digital
Timer Set (code 2232.56).
(Comes with Varec magnet for an easy setup).

Electronic Oscillation Counter

2237.12



Specifications

Size: 13,5x9x5 cm - Weight: 0,2 kg
Range: 0 ÷ 100 periods
• Manual stop function
• Automatic stop function after: 1, 2, 5, 10, 20,
50, 100 oscillations
• Power Electronic Digital Timer Set
(code 2232.56)

The Electronic Oscillation Counter can be used
with the Electronic Digital Timer Set
(code 2232.56). You can control oscillations
for pendulum experiments, allowing you to
easily measure the mean oscillation period of a
pendulum.

Large Display

2236.50



Specifications

Size: 40x26x4 cm
Weight: 4,5 kg
Power Supply: AC Adaptor (supplied)
Connection cable (supplied) to connect Electronic Digital
Timer Set (code 2232.56)

The Altay Large LED Display is very useful in classroom experiments. This
four digit, 10cm height display has good visibility even from the back of
classroom. Ready to use, with bases and suspension cord. To be used with
the Electronic Digital Timer Set (code 2232.56).

GENERAL ACCESSORIES

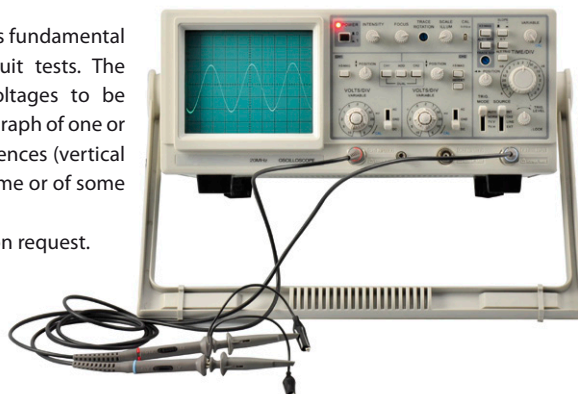
Measuring Instruments

Oscilloscope

2280.70-90

This cathode ray Oscilloscope is fundamental in all electronic labs for circuit tests. The Oscilloscope allows signal voltages to be viewed, as a two-dimensional graph of one or more electrical potential differences (vertical axis) plotted as a function of time or of some other voltage (horizontal axis).

Technical datasheet available on request.



Specifications

Vertical system

Bandwidth (-3dB): DC/ 10Hz—25MHz; Mode: Ch1, Ch2, Dual, ADD; Deflection: 5mV/div ~ 5V/div, 10 step, $\pm 5\%$; Mag. ratio: $\times 5$, $\pm 10\%$; Rise time: $< 8.8\text{ns}$; Impedance: $1\text{M}\Omega$, 25pF (direct); Max. voltage: 300V(DC+ACpeak), 400V via probe

Horizontal system

Sweep mode: X1, X5; X1, X5alter; Sweep rate: $0.25\sim 0.1\mu\text{S}/\text{div}$, $\pm 5\%$; Mag. ratio: $\times 5$, $\pm 10\%$; Trigger System; Mode: auto, normal, TV-V, TV-H; Trig source: INT, CH2, LINE, EXT; Trig sensitivity: 10Hz—25MHz 2div, Ext: 0.2Vp-p; TVsync: Int 1div, Ext 1Vp-p; X-Y Mode; Deflection: 5mV/div ~ 5V/div; Bandwidth(-3dB): DC- 500kHz; Calibrate signal; Rectangle wave, 0.5Vp-p $\pm 2\%$, 1kHz

Also available:

40 Mhz Oscilloscope (code 2280.80) ; 100 Mhz Oscilloscope (code 2280.90)

Digital Teslameter

2280.50

Specifications

Ranges: 20 mT, 200 mT, 2,000 mT



All in one solution for measuring alternating and direct magnetic fields. With digital display, zero point adjustment, analogue output. Supplied with probe, and power supply.

Mounted Electric Meters

2264.40-45*

Specifications

Size: 13x10x5,5 cm

Plugs: 4 mm sockets



* Minimum Order Quantity 5 pcs

A complete set of ammeters and voltmeters for every necessity in measuring electrical quantities on low voltage circuits (max 50 V). Based on a moving coil, this instrument allows an easy read of the measure value. The ABS plastic boxes are of practical use in laboratory and the 4 mm sockets allow an easy mount to circuits with simple connection wires. The code refers to the category, please contact our sales department.

Main ranges are $0 \div 1\text{ A}$, $0 \div 1\text{ V}$, $0 \div 5\text{ A}$, $0 \div 5\text{ V}$, $0 \div 15\text{ A}$, $0 \div 15\text{ V}$

Available all in AC and DC modes.

Digital Multimeter

2275.10



Specifications

Ranges:

AC: 20 mA, 200 mA, 10 A – 2 V, 20 V, 200 V, 700 V

DC: 2 mA, 20 mA, 200 mA, 10 A – 200 mV, 2 V, 20 V, 200 V, 1 kV

Ohm: 200 Ω , 2 k Ω , 20 k Ω , 200 k Ω , 2 M Ω , 20 M Ω , 200 M Ω

Farad: 2 nF, 20 nF, 200 nF, 2 μF , 20 μF

Designed according to IEC – 1010, Cat II, Pollution 2, this multimeter is capable of performing functions such as:

- DC and AC voltage and current measurement
- Resistance, capacitance measurement
- Diode, transistor and audible continuity test
- Frequency and temperature measurement.

Alcohol Thermometer

2245.15 -25*

Measure temperature

* Minimum Order Quantity 5 pcs

Specifications

- 2245.15 - Range: $-10^{\circ}\text{C} \div +110^{\circ}\text{C}$

Accuracy: 1°C

- 2245.25- Range: $-10^{\circ}\text{C} \div +200^{\circ}\text{C}$

Accuracy: 2°C

Those mercury-free thermometers allow simply and accurate temperature measurements.

The use of alcohol instead of mercury guarantees safety and non-toxicity even in case of accidental breakage of the thermometer. Available with different ranges and accuracies.

GENERAL ACCESSORIES

Measuring Instruments • Power Supply & Function Generator

Geiger Müller Counter

2236.00

A simple radiation measuring instrument

Specifications

- On-off switch
- Manual start
- x1, x2, x3, x4, x5 acquisition time multipliers
- Automatic stop after 10 and 60 sec intervals or manual stop



The Altay Geiger Müller Counter detects radioactivity data from alpha, beta and gamma sources. You can also analyse the data received with our all in one unit. The probe contains a Geiger-Müller tube which briefly conducts electricity when a particle or photon of radiation is detected. An audible sound is released and the rate counter records the reading.

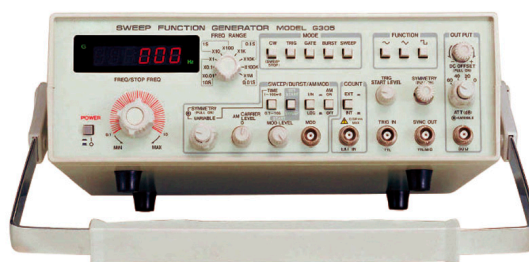
Function Generator

2290.10

Advanced functions generator for circuit tests

Specifications

Input: 220 V, 50 Hz
 Output: Frequency Range: $0.01 \div 10$ Mhz
 Amplitude Range: 10 Vpp 50 W
 Output Impedance: $50 \Omega \pm 10\%$
 Complete datasheet available on request



This Function Generator is a crucial part of any electronics lab for testing circuits. This unit offers a complete solution in generating sine, triangle, square, ramp and pulse signals. Features include: gate and trigger outputs, burst waveform outputs, sweep functions, VCG inputs, GCV functions, AM modulations, frequency counters and much more.

Electronic Digital Timer Set (Stopwatch edition)

2232.56

Specifications

Stopwatch function
 (up to 999 sec.)

Two function modes:

- measurement of the time interval between two pulses or the duration of a pulse
- Three timing ranges: $1/10$ s (up to 999.9 s), $1/100$ s (up to 99.99 s), $1/1000$ s (up to 9.999 s)
- Automatic or manual reset feature

Two start modes:

- chronometer and electromagnet release or electromagnet release only
- Auxiliary 12 V DC power supply unit for use with release electromagnet
- Input: 220 V, 50 - 60 Hz

The Stopwatch Edition of the Electronic Digital Timer is the direct evolution of the Altay's best selling Electronic Digital Timer, a multipurpose instrument for dynamics experiments; this new version has improved functionalities, such as the possibility to use the apparatus as a Stopwatch, up to 999 seconds.



Audio Frequency Generator

2290.50

Ideal for generating different frequencies in circuits



The versatile Audio Frequency Generator is indispensable in electronics labs. Ideal for testing circuits, with its multiple function and frequency outputs it is an absolute must to teaching labs.

Specifications

Input: 220 V, 50 Hz
 Waveform: sine, square, triangular
 Frequency Range: $10 \div 200$ kHz,
 $100 \div 2$ kHz, 1 kHz $\div 20$ kHz
 Amplitude Range: $0 \div 20$ Vpp
 Output Impedance: 4Ω , 600 Ω

GENERAL ACCESSORIES

Power Supply & Function Generator

Transformer

2403.64-61

AC Transformer for multiple applications

2403.64

Input:
110/220 V AC 50/60 Hz
Universal Plug
Output:
12 V DC 2,5 A

2403.61

Input:
110/220 V AC 50/60 Hz
Universal Plug
Output:
5 V DC 600 mA



These general purpose transformers are useful in many applications in schools, as supply unit for lamps, circuits and so on.

Universal Base

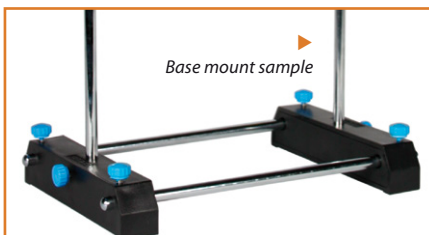
5405.70-71*

Universal base designed for a wide variety of uses

Specifications

Complete Universal Base (code 5405.70*)
Universal Base 3 Knobs (code 5405.71*)

* Minimum Order Quantity 5 pcs



Very stable and versatile, this base allows the simultaneous use of two vertical rods of variable height between 20 and 300 mm. Very easy and fast to use, simple to break down and store away.

Metal Bosshead

5401.20*

Metal bosshead allows the clamping of two rods (diameter up to 10 mm) with an angle of 0° or 90°. Easy to use and strong, for heavy duty purposes.

Specifications

Size: 4x2x2 cm
Weight: 0,1 kg
Allows clamping of rods up to 10 mm diam.



* Minimum Order Quantity 5 pcs

Universal Retort Stand

5404.52-60*

General purpose retort stand with a single vertical rod

High quality enamel finished cast iron stands provided with a threaded chromium-plated rod, are particularly suitable for use with ring supports, burette clamps or other similar supports.

Specifications

- 5404.52
Base 30x10 cm
Rod length 65 cm
- 5404.55
Base 30x10 cm
Rod length 35 cm
- 5404.60
Base 35x10 cm
Rod length 80 cm



* Minimum Order Quantity 5 pcs

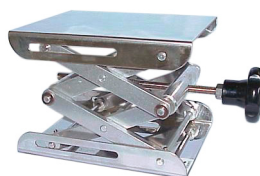
Laboratory Jack

5406.30-34*

Specifications

10x10cm, 4.5 ÷ 14cm height (code 5406.30*)
15x15cm, 5.5 ÷ 26cm height (code 5406.32*)
20x20cm, 6 ÷ 29.5cm height (code 5406.34*)

The laboratory jacks, are designed with strength, precision, safety, easy handling, stability and resistance to chemical aggression in mind. They can be used as ideal supports for precise vertical adjustment of laboratory equipment, hot plates, baths, flasks and other glassware in general.



* Minimum Order Quantity 5 pcs

Bosshead

5401.22*

This Bosshead is the simplest solution to clamp 10 mm diameter rods.
Made of hard PVC, is inexpensive but really durable.

* Minimum Order Quantity 5 pcs



Connecting Leads

2522.02-14*

Fundamental to all electrical and electronics experiments

Specifications

Red – Length 25cm (code 2522.02)
Red – Length 50cm (code 2522.03)
Red – Length 100cm (code 2522.04)
Black – Length 25cm (code 2522.07)
Black – Length 50cm (code 2522.08)
Black – Length 100cm (code 2522.09)
Yellow – Length 25cm (code 2522.12)
Yellow – Length 50cm (code 2522.13)
Yellow – Length 100cm (code 2522.14)

* Minimum Order Quantity 5 pcs

These flexible leads allow rapid connection with low contact resistance between laboratory equipment. Fitted with four mm stackable plugs at each end. Available in different lengths and terminals, also crocodile clips and banana plugs.



GENERAL ACCESSORIES

Laboratory General Accessories

Squared Bosshead

5401.23*

ABS plastic. Only one securing screw for simultaneous clamping of two pairs of rods, 10 mm diameter, at 90°.

This item is specifically designed to be used with the multiuse Universal Base (code 5405.70) for a quick set up of experimental environment.

* Minimum Order Quantity 5 pcs



Swivel Bosshead

5401.43*

ABS plastic. Only one securing screw for simultaneous clamping and varying inclination of two rods, 10 mm diameter.

This item is specifically designed to be used with the multiuse Universal Base (code 5405.70) for a quick set up of an experimental environment.

* Minimum Order Quantity 5 pcs



Manual Vacuum Pump

4184.13

This simple and low-cost pump is capable of handling all laboratory experiments not requiring a vacuum below a few millimetres of mercury. Since the pump is hand operated and of sturdy construction, it can be easily used by students and presents no maintenance problems.



Rods

5408.81.L350-L 1000*

Altay offers a wide range of support rods.

They are robust and perfect to use with the Multiuse Universal Base (code 5405.70) or Squared and Swivel Bossheads (code 5401.23 – 5401.43) for a quick set up of an experimental environment.

Specifications

Length 35 cm (code 5408.81.L350)

Length 50 cm (code 5408.81.L500)

Length 100 cm (code 5408.81.L1000)



* Minimum Order Quantity 5 pcs

Vacuum Pump

4184.21

Specifications

Air bleeding speed: 1.5 m³/h

Pressure limit: 10 ÷ 30 Pa

Noise: ≤ 65 dB

Size: 30x15x25cm

Weight: approx. 7,5 kg



Specially designed pump that removes gas molecules from a sealed volume in order to leave behind a partial vacuum.

Bunsen Burner with Accessories

5511.00

General purpose Bunsen Burner for thermology experiments

The multigas Bunsen Burner is available in nickel-plated brass on a chromium plated steel base. The unit also comes with a gas control stopcock and air regulator. Supplied with tripod stand, wire gauze and connecting tube.



Extension Clamp with Rod

5416.20*

Extension clamps are available in painted aluminium in various sizes. Ranging from a minimum of 5 mm to a maximum of 80 mm. Clamps have cork-lined jaws that make them particularly suitable when holding glassware. This item is available in different lengths and diameter, and is perfect for use with the Squared and Swivel Bossheads (code 5401.23– 5401.43). The code refers to the category.

* Minimum Order Quantity 5 pcs



Consumables

* Minimum Order Quantity 5 pcs

4200.31 *	Cast iron pins
4207.60	Food Colouring
4612.12*	Iron Filings
4822.51*	Radioactive Beta/Gamma Source (Co-60)
4822.52*	Radioactive Beta Source (Sr-90)
4822.53*	Radioactive Alpha Source (Po-210)
5424.52	Silicone Grease

PACKAGING DIMENSION

Code	Description	Gross Weight Kg	Width cm	Length cm	Height cm
2211.10	Tape Measure - 2m	0,2	10	10	15
2211.12	Tape Measure - 3m	0,2	10	10	5
2211.15	Tape Measure - 5m	0,2	10	10	5
2213.10	Vernier Caliper	0,3	30	16	12
2213.15	Micrometer Screw Gauge	0,4	15	10	7
2214.00	Micrometer Dial Gauge	0,3	10	10	7
2215.01	Spherometer	0,4	10	10	7
2216.10	Goniometric Circle	0,2	25	25	4
2216.15	Magnetic Goniometric Circle	0,2	25	25	4
2219.30	Electronic Balance (300g / readability 0.01g)	0,6	30	20	10
2219.31	Electronic Balance (200g / readability 0.01g)	0,6	30	20	10
2219.32	Electronic Balance (500g / readability 0.01g)	0,6	30	20	10
2219.33	Electronic Balance (1000g / readability 0.01g)	0,6	30	20	10
2219.34	Electronic Balance (2000g / readability 0.01g)	0,6	30	20	10
2219.60	Ohaus Scout® Pro Balance - 200 ± 0.01g	1	30	25	10
2219.61	Ohaus Scout® Pro Balance - 400 ± 0.01g	1	30	25	10
2219.62	Ohaus Scout® Pro Balance - 400 ± 0.1g	1	30	25	10
2219.63	Ohaus Scout® Pro Balance - 600 ± 0.1g	1	30	25	10
2219.64	Ohaus Scout® Pro Balance - 2 kg ± 0.1g	1	30	25	10
2219.65	Ohaus Scout® Pro Balance - 4 kg ± 0.1g	1	30	25	10
2219.66	Ohaus Scout® Pro Balance - 6 kg ± 1g	1	30	25	10
2220.60	Precision Mass Set - 1 mg ÷ 50 g	0,124	14	10	18
2220.61	Precision Mass Set - 10 mg ÷ 100 g	0,48	14	10	18
2220.64	Precision Mass Set - 1 ÷ 500 g	1	14	10	18
2220.66	Precision Mass Set - 1 g ÷ 1 kg	1,092	20	15	10
2231.05	Analogue Chronometer	0,1	15	10	10
2231.25	Stopwatch	0,4	15	10	10
2231.52	Digital Chronometer	0,094	10	4	10
2232.52	Photogate	0,1	15	10	10
2232.56	Electronic Digital Timer Set	1,032	30	20	15
2236.00	Geyger Müller Counter	1,032	30	20	15
2236.50	Large Display	4,5	50	45	15
2236.60	Digital Large Display	5	50	45	15
2236.65	Altay Docking Station	1	30	15	10
2237.12	Electronic Oscillation Counter	0,26	20	10	10
2238.10	Stroboscope	2	30	25	20
2242.20	U - Tube Manometer	0,6	15	15	40
2242.62	Barometer	0,5	25	20	10

Code	Description	Gross Weight Kg	Width cm	Length cm	Height cm
2245.15	Alcohol Thermometer - -10° ÷ +110° ± 1° C	0,1	3	3	50
2245.25	Alcohol Thermometer - -10° ÷ +200° ± 2° C	0,1	3	3	50
2264.40	Mounted Electric Meter, 0 ÷ 1 A	0,47	10	10	15
2264.41	Mounted Electric Meter, 0 ÷ 1 V	0,45	10	10	15
2264.42	Mounted Electric Meter, 0 ÷ 5 A	0,5	10	10	15
2264.43	Mounted Electric Meter, 0 ÷ 5 V	0,28	10	10	15
2264.44	Mounted Electric Meter, 0 ÷ 15 A	0,5	10	10	15
2264.45	Mounted Electric Meter, 0 ÷ 15 V	0,45	10	10	15
2275.10	Digital Multimeter	0,6	25	20	10
2280.50	Digital Teslameter	1,23	30	15	10
2280.70	Oscilloscope - 20Mhz	9	50	40	20
2280.80	Oscilloscope - 40Mhz	9	50	40	20
2280.90	Oscilloscope - 100Mhz	9	50	40	20
2290.10	Function Generator	5,7	45	40	25
2290.50	Audio Frequency Generator	1,53	20	20	25
2300.10	LabPro	0,99	30	25	5
2300.20	Wireless Dynamics Sensor System	0,5	20	15	5
2300.30	LabQuest	0,79	20	20	10
2300.40	TI-84 Plus Calculator	0,412	15	10	5
2300.41	Easy-Link	0,2	15	10	5
2300.42	TI USB GRAPH LINK Connectivity Kit	2	15	10	5
2300.50	Logger Pro 3	0,24	25	20	10
2300.61	Starter Bundle	2,55	40	35	20
2300.63	Deluxe Bundle	3,156	30	35	25
2310.10	Motion Detector	0,365	20	15	5
2310.20	Rotary Motion Sensor	0,26	25	20	10
2311.10	Dual-Range Force Sensor	0,196	25	20	10
2311.20	Accelerometer 25-g	0,06	25	20	10
2311.21	Accelerometer Low-g	0,058	25	20	10
2311.22	3-axis accelerometer	0,3	25	20	10
2311.30	Barometer	0,1	25	20	10
2311.40	Gas Pressure Sensor	0,206	20	10	5
2311.50	Force plate	0,2	40	10	5
2312.10	Vernier Photogate	0,14	25	20	10
2312.11	Picket Fence	0,086	40	10	3
2312.12	Ultra Pulley Attachment	0,011	10	10	5
2312.13	Bar Tape	0,021	25	20	10
2313.10	Charge Sensors	0,208	25	20	10
2313.20	Current Probe	0,2	10	10	5
2313.30	Voltage Probe	0,07	25	20	10
2313.40	Differential Voltage Probe	0,065	25	20	10
2313.50	Magnetic Field Sensor	0,06	25	20	10
2313.60	Microphone	0,069	25	15	3

PACKAGING DIMENSION

Code	Description	Gross Weight Kg	Width cm	Length cm	Height cm	Code	Description	Gross Weight Kg	Width cm	Length cm	Height cm
2313.70	Electrode Amplifier	0,104	25	15	3	4110.01	Tubular Spring Balance (Metal) - 1N	0,1	3	3	24
2313.80	Instrumentation Amplifier	0,18	25	20	10	4110.03	Tubular Spring Balance (Metal) - 3N	0,1	3	3	24
2313.90	Sound level meter	0,4	20	10	5	4110.05	Tubular Spring Balance (Metal) - 6N	0,1	3	3	24
2314.10	Thermocouple	0,168	25	20	10	4110.07	Tubular Spring Balance (Metal) - 10N	0,1	3	3	24
2314.20	Stainless Steel Temperature Probe	0,065	25	20	10	4110.20	Tubular Spring Balance (Plastic) - 1N	0,1	3	3	24
2314.30	Surface Temperature Sensor	0,041	25	20	10	4110.21	Tubular Spring Balance (Plastic) - 2.5N	0,1	3	3	24
2314.40	Relative Humidity Sensor	0,099	25	20	10	4110.22	Tubular Spring Balance (Plastic) - 5N	0,1	3	3	24
2314.60	Infrared thermometer	0,3	20	10	5	4110.23	Tubular Spring Balance (Plastic) - 10N	0,1	3	3	24
2315.10	Light Sensor	0,173	25	20	10	4110.24	Tubular Spring Balance (Plastic) - 20N	0,1	3	3	24
2315.20	UVA Sensor	0,067	25	20	10	4114.11	Force Table	5,32	35	35	55
2315.21	UVB Sensor	0,1	25	20	10	4114.11-003	Dual-Range Force Sensor Adapter	0,2	12	6	4
2316.10	Radiation Monitor (alpha, beta, gamma)	0,305	25	20	10	4114.18	Demonstration Balance Model	2	50	10	6
2317.10	pH sensor	0,09	25	20	10	4114.30	Magnetic Board	17	100	90	15
2317.20	conductivity probe	0,278	25	20	10	4114.35	Mechanics Accessories Set	2,85	45	30	15
2320.10	Go!Motion	0,111	25	20	10	4114.36	Falling Bodies Upg for Magnetic Board	0,4	30	30	10
2320.20	Go!Temp	0,08	25	20	10	4114.37	Optics Accessories Set	0,48	35	20	15
2320.30	Go!Link	0,105	25	20	10	4115.10	Inclined Plane	2,9	80	20	10
2330.10	CBR 2	0,2	25	20	10	4130.20	Elastic and Inelastic Collision 2D	0,5	30	30	10
2330.20	EasyTemp	0,2	25	20	10	4130.50	Collision Balls Apparatus	5,5	50	30	40
2403.61	Universal Transformer Output 5V	0,1	9	7	6	4132.10	Linear Air Track System	45	220	35	40
2403.64	Universal Transformer Output 12V	0,1	16	11	6	4132.60	Air Blower Set	2,5	30	20	30
2403.70	Multitap Transformer	1,5	30	25	16	4132.90	Force sensor adaptor for Air Track Slider	0,1	10	6	4
2404.13	Bridge Rectifier	0,2	15	10	10	4134.00	Newton's Tube	1	110	15	10
2407.05	Power Supply 5 kV	2,8	30	32	19	4134.70	Free Fall and Pendulum Apparatus	9,4	5	40	20
2407.65	Power Supply 30 A	3	30	32	19	4134.75	Remote Control Upgrade for Free Fall and Pendulum Apparatus	0,3	16	10	8
2407.70	Power Supply 1.5 A	1,4	30	25	16	4135.10	Projectile Launcher	2,5	35	30	15
2407.75	Power Supply 10 A	3	30	32	19	4136.50	Simple Pendulum	1,75	75	15	3
2407.80	Power Supply 3-4,5-6-7,5-9-12V 1A	1,6	30	25	16	4137.40	Multiple Pendulum Apparatus	2	15	10	3
2522.02	Stackable Plug Lead, Plug 4mm, Red, Length 25 cm	0,1	5	5	3	4138.50	Moment of Inertia Apparatus	7,8	60	50	20
2522.03	Stackable Plug Lead, Plug 4mm, Red, Length 50 cm	0,1	5	5	3	4142.70	Centrifugal Force Apparatus	3,2	70	15	15
2522.04	Stackable Plug Lead, Plug 4mm, Red, Length 100 cm	0,1	5	5	3	4150.00	Maxwell Wheel	2,6	32	22	42
2522.07	Stackable Plug Lead, Plug 4mm, Black, Length 25 cm	0,1	5	5	3	4163.10	Hooke's Law Apparatus	2,18	25	25	90
2522.08	Stackable Plug Lead, Plug 4mm, Black, Length 50 cm	0,1	5	5	3	4170.00	Torsion Balance	5,4	55	50	95
2522.09	Stackable Plug Lead, Plug 4mm, Black, Length 100 cm	0,1	5	5	3	4180.12	Pascal's Apparatus	1,57	25	30	25
2522.12	Stackable Plug Lead, Plug 4mm, Yellow, Length 25 cm	0,1	5	5	3	4180.20	Pellat Apparatus	3	55	25	30
2522.13	Stackable Plug Lead, Plug 4mm, Yellow, Length 50 cm	0,1	5	5	3	4180.42	Spouting Jar	1,33	50	20	10
2522.14	Stackable Plug Lead, Plug 4mm, Yellow, Length 100 cm	0,1	5	5	3	4180.60	Communicating Vessels	0,5	30	20	10

PACKAGING DIMENSION

Code	Description	Gross Weight Kg	Width cm	Lenght cm	Height cm
4182.20	Capillary Tubes	0,5	30	21	8
4183.11	Lift Pump on Stand	2,5	40	20	20
4184.13	Manual vacuum pump	0,2	27	15	6
4184.21	Vacuum Pump with accessories	7,5	30	15	25
4184.48	Magdeburg Hemispheres	1,26	15	15	20
4184.90	Sphere with two stopcocks	0,4	25	10	10
4184.93	Buoyancy balance	0,3	20	15	20
4184.95	Aluminum Cuboid for Buoyancy	0,2	10	15	10
4187.19	Boyle's Law Apparatus	4,3	130	30	15
4200.10	Gravesande Ball and Ring	0,18	30	10	10
4200.15	Bar and Gauge	0,514	25	15	3
4200.18	Thermal Expansion Bar	0,75	50	20	15
4200.22	Gunther Expansion Apparatus	2,08	60	15	10
4200.30	Pin shearing apparatus	4	40	10	10
4200.31	Cast Iron Pins	0,1	10	8	4
4200.35	Thermal Leakage System	1,985	25	21	20
4200.36	Thermal Conductivity Apparatus	1,192	15	20	25
4200.60	Compound Bar	0,07	30	10	10
4200.80	Bimetallic Strip with Electric Contact	0,2	15	15	15
4207.60	Food Colouring	0,1	5	5	10
4210.10	Hope's apparatus	2,5	40	20	20
4210.32	Expansion of Liquids Apparatus	4	40	15	40
4210.73	Thermal Conductivity Apparatus	0,111	35	15	3
4210.91	Convection Apparatus	0,17	40	30	15
4215.20	Crooke's Radiometer	0,28	20	15	15
4230.60	Mixing Calorimeter	1,003	15	15	25
4230.65	Joule's Law Unit for Calorimeter	0,097	15	15	15
4230.97	Different bodies with equal mass	0,5	10	10	15
4230.98	Small cubes with equal volume	0,5	10	10	15
4235.10	Mechanical Equivalent of Heat Apparatus	8,5	30	30	25
4250.00	Stirling Engine	2	35	25	20
4311.80	Ripple Tank	13,5	60	50	20
4315.00	Wave Form Helix (Slinky)	0,56	10	10	15
4315.02	Helix Spring	0,582	45	15	5
4315.16	Spring Set	1,447	35	30	15
4315.35	Melde Apparatus	1,363	30	25	10
4315.60	Vacuum Bell with Plate	3,5	24	24	34
4315.80	Seismic Waves Propagation Apparatus	7	80	50	10
4316.05	Three-Wire Sonometer	1,85	70	15	15
4317.40	Pair of LA3 Tuning Forks	1,02	30	25	10
4317.90	Set of Tuning Forks	0,87	35	30	10
4331.27	Resonance Apparatus	5,3	125	35	25
4333.00	Kundt's Tube	4	90	15	15

Code	Description	Gross Weight Kg	Width cm	Lenght cm	Height cm
4412.00	Swivel Joint Bench	1	30	15	15
4417.50	Optical Bench with Accessories Deluxe Edition	8,546	125	35	25
4417.60	Optical Bench with Accessories Standard Edition	5,4	125	35	25
4453.22	Newton's Disk	0,76	25	15	25
4455.02	Spectrometer	11,2	50	35	35
4455.30	Hand-held spectrometer	0,56	35	25	15
4470.10	Spectrum Tube - Helium	0,099	25	5	5
4470.11	Spectrum Tube - Neon	0,08	25	5	5
4470.12	Spectrum Tube - Argon	0,08	25	5	5
4470.13	Spectrum Tube - Mercury	0,095	25	5	5
4470.14	Spectrum Tube - Hydrogen	0,096	25	5	5
4470.15	Spectrum Tube - Oxygen	0,09	25	5	5
4470.16	Spectrum Tube - Nitrogen	0,098	25	5	5
4470.17	Spectrum Tube - Carbon Dioxide	0,09	25	5	5
4470.50	Spectrum Tubes Holder	0,2	25	5	5
4503.00	Frank/Hertz Apparatus	6	50	50	25
4504.00	Planck's Constant Apparatus	6	55	20	30
4506.00	Laser He-Ne	1,5	35	10	15
4611.18	Cylindrical Magnets - 0.8 x 2.5 cm	0,1	10	10	15
4611.40	Plastic Cased Bar Magnets	0,6	10	10	5
4611.50	Chrome Steel Bar Magnets - 5 x 1 x 0.5 cm	0,08	15	10	3
4611.65	Bar Magnets - (ALNICO) - 5 x 1.5 x 1 cm	0,12	5	5	3
4611.71	U-Shaped Magnet	0,27	5	5	3
4611.72	Horseshoe Magnet - Flat	0,11	10	10	15
4611.81	Horseshoe Magnet - (ALNICO)	0,1	5	5	5
4611.86	Neodymium-Iron-Boron Magnets - 2.5 x 0.5 cm	0,135	10	10	15
4612.03	Ring Magnets - 2.4 x 0.7 x 0.5 cm	0,1	5	5	5
4612.09	Ferrite Magnet	0,1	5	5	5
4612.12	Iron Filings	0,32	5	5	10
4613.80	Magnetic Needle on Stand	0,06	20	10	10
4614.50	Demonstration Compass	0,1	17	17	5
4622.20	Wimshurst Machine	3,8	45	35	50
4623.20	Van de Graaff Generator	6,1	45	35	55
4625.00	Pith Ball Electroscope	0,18	45	10	10
4625.50	Gold Leaf Electroscope	0,6	15	10	20
4628.32	Aepinus Air Condenser	3,28	40	25	30
4640.50	Circular Coil	1,17	30	20	25
4640.60	Rotating Coil	2,65	40	40	25
4640.70	Gimbals magnetic field sensor	0,1	20	10	3
4640.73	Coil Flux Max	0,1	10	8	4
4640.75	Induction coils	4	15	15	20
4640.76	Induction Coil 600 turns	0,2	10	10	5
4640.77	Induction Coil 1100 turns	2	20	20	10

PACKAGING DIMENSION

Code	Description	Gross Weight Kg	Width cm	Length cm	Height cm	Code	Description	Gross Weight Kg	Width cm	Length cm	Height cm
4640.79	Coil 1200 Turns	2,4	15	15	40	4861.29	Mechanics System 2	3,2	DN10x130		
4640.80	Waltenhofen's pendulum	9	40	25	30	4861.29	Mechanics System 2	8	50	45	15
4640.90	Double Winding Coil	3	75	20	15	4861.39	Mechanics System 3 case 2	4	75	55	20
4645.02	Barlow's Wheel	2,7	30	30	35	4861.39	Mechanics System 3 case 1	9	75	55	20
4646.10	Laplace apparatus	1,7	55	25	30	4862.19	Heat System	12	75	55	20
4646.15	Laplace Rail	1	35	20	20	4864.19	Optics System 1	1,9	DN10x110		
4652.10	U-Shaped Electromagnet	0,34	10	15	5	4864.19	Optics System 1	7	50	45	15
4690.00	Capacitance Box - 1 ÷ 1000 nf	0,2	15	10	10	4864.29	Optics System 2	1,2	DN10x70		
4690.02	Capacitance Box - 1 ÷ 1000 uf	0,18	15	10	10	4864.29	Optics System 2	6,5	50	45	15
4690.04	Capacitance Box - 100pf ÷ 10 uf	0,18	15	10	10	4864.39	Optics System 3	1,5	30	25	10
4693.00	Decade Resistance Box - 0.1 ÷ 1 Ohm	0,175	15	10	10	4865.19	Electrostatics System	6,5	78	55	20
4693.10	Decade Resistance Box - 1 ÷ 10 Ohm	0,175	15	10	10	4866.19	Electricity System 1	5,5	50	45	15
4693.20	Decade Resistance Box - 10 ÷ 100 Ohm	0,175	15	10	10	4866.29	Electricity System 2	5	50	45	15
4693.30	Decade Resistance Box - 100 ÷ 1 kOhm	0,175	15	10	10	4867.19	Magnetics System 1	5	50	45	15
4693.40	Decade Resistance Box - 1 ÷ 10 kOhm	0,175	15	10	10	4867.29	Magnetics System 2	5	50	45	15
4693.50	Decade Resistance Box - 10 ÷ 100 kOhm	0,175	15	10	10	4868.19	Electronics System 1	4,5	50	45	15
4694.11	Sliding Contact Rheostat - 2.9 Ohm	2,5	35	10	15	4868.29	Electronics System 2	4	50	45	15
4694.21	Sliding Contact Rheostat - 10 Ohm	2,5	35	10	15	4869.09	Alternative Energy Sources System	5,5	50	45	15
4694.31	Sliding Contact Rheostat - 50 Ohm	2,5	35	10	15	4870.00	Electrolyzer	0,4	15	15	20
4694.41	Sliding Contact Rheostat - 120 Ohm	2,5	35	10	15	4870.01	Carbon Electrode for Electrolizer	0,1	6	6	6
4694.51	Sliding Contact Rheostat - 300 Ohm	2,5	35	10	15	4870.03	Nichel Electrode for Electrolizer	0,1	6	6	6
4694.61	Sliding Contact Rheostat - 1400 Ohm	2,5	35	10	15	4922.10	Timing Set	1,2	35	25	15
4697.00	Potentiometer Bridge	3	DN13	0	130	4941.12	Altay Cart without Plunger	0,48	15	10	10
4697.30	Ohm Apparatus	3,5	DN13X130			4941.13	Altay Cart with Plunger	0,48	15	10	10
4715.00	Electrical Safety simulator	5,5	50	45	15	4941.14	Mechanics Upgrade 1	4,38	35	20	15
4729.00	Demonstration Transformer	6,17	30	20	15	4941.16	Coupled Pendulum Set	0,8	55	10	5
4731.00	Variable Inductance	8	25	15	25	4941.17	EM Trigger&Launcher for Cart	0,6	20	15	15
4739.20	Generator model	0,45	15	15	20	4941.21	Mechanics Upgrade 2	1	30	20	15
4739.40	Demonstration Dynamo	0,95	25	15	20	4941.21-RC	Mechanics Upgrade 2 (with remote control)	1	30	20	15
4743.05	Motor Unit	0,95	15	15	15	4941.51	Eddy Current Set	1	20	20	15
4822.51	Radioactive Beta/Gamma Source (Co-60)	4,2	45	35	20	4941.60	Ball Launcher for Cart	1,25	20	20	25
4822.52	Radioactive Beta Source (Sr-90)	0,1	12	7	6	4941.65	Fan for Cart	1	30	25	20
4822.53	Radioactive Alpha Source (Po-210)	0,1	12	7	6	4941.70	Track Coupler	0,6	20	10	5
4832.00	Radioactivity Bench	2,25	45	35	15	4942.00	Force Sensor Adaptor for Altay Cart	0,2	15	10	6
4851.04	Helmoltz Coils	0,1	12	7	6	4944.11	Optics Upgrade 1	1,65	25	20	20
4861.19	Mechanics System 1	1,6	D10x70			4944.20	Optics Upgrade 2	1,6	30	20	20
4861.19	Mechanics System 1	7,4	50	45	15	4944.30	Optics Upgrade 3	0,8	30	20	15
						4954.11	Track Set - 1,45m	2,8	DN13x150		
						4954.12	Track Set	2,4	DN13x130		
						5401.20	Metal Bosshead	0,3	10	10	5
						5401.22	Bosshead	0,3	10	10	5
						5401.23	Squared Bosshead	0,3	10	10	5
						5401.43	Swivel Bosshead	0,08	10	5	10

PACKAGING DIMENSION

Code	Description	Gross Weight Kg	Width cm	Lenght cm	Height cm
5404.52	Universal Retort Stand Base 170x150 mm, rod lenght 500mm	1,5	30	65	10
5404.55	Universal Retort Stand Base 252x163 mm, rod lenght 650mm	2	30	35	10
5404.60	Universal Retort Stand Base 317x200 mm, rod lenght 800mm	2,5	35	80	10
5405.70	Complete Universal Base	0,9	45	10	10
5405.71	Universal Base, 3 Knobs	0,4	20	10	10
5406.30	Laboratory Jack, 10x10 cm 4.5÷14 cm height	1,35	5	5	10
5406.32	Laboratory Jack, 15x15 cm 5.5÷26 cm height	1,4	5	5	10
5406.34	Laboratory Jack, 20x20 cm 6÷29.5 cm height	1,4	5	5	10
5408.81. L1000	Support Rod - 100 cm	0,6	5	5	100
5408.81. L350	Support Rod - 35 cm	0,2	5	5	35
5408.81. L500	Support Rod - 50 cm	0,29	5	5	50
5416.20	Extension Clamp with Rod	0,7	15	50	3
5424.52	Silicone Grease	0,1	4	4	12
5511.00	Bunsen Burner with Accessories	0,9	10	10	25
7610.01	Advanced Chemistry System	8,5	75	55	20
7615.01	General Chemistry System	9	75	55	20
7620.01	Electrochemistry System	8,5	75	55	20
7810.01	Plant Physiology System	9	75	55	20