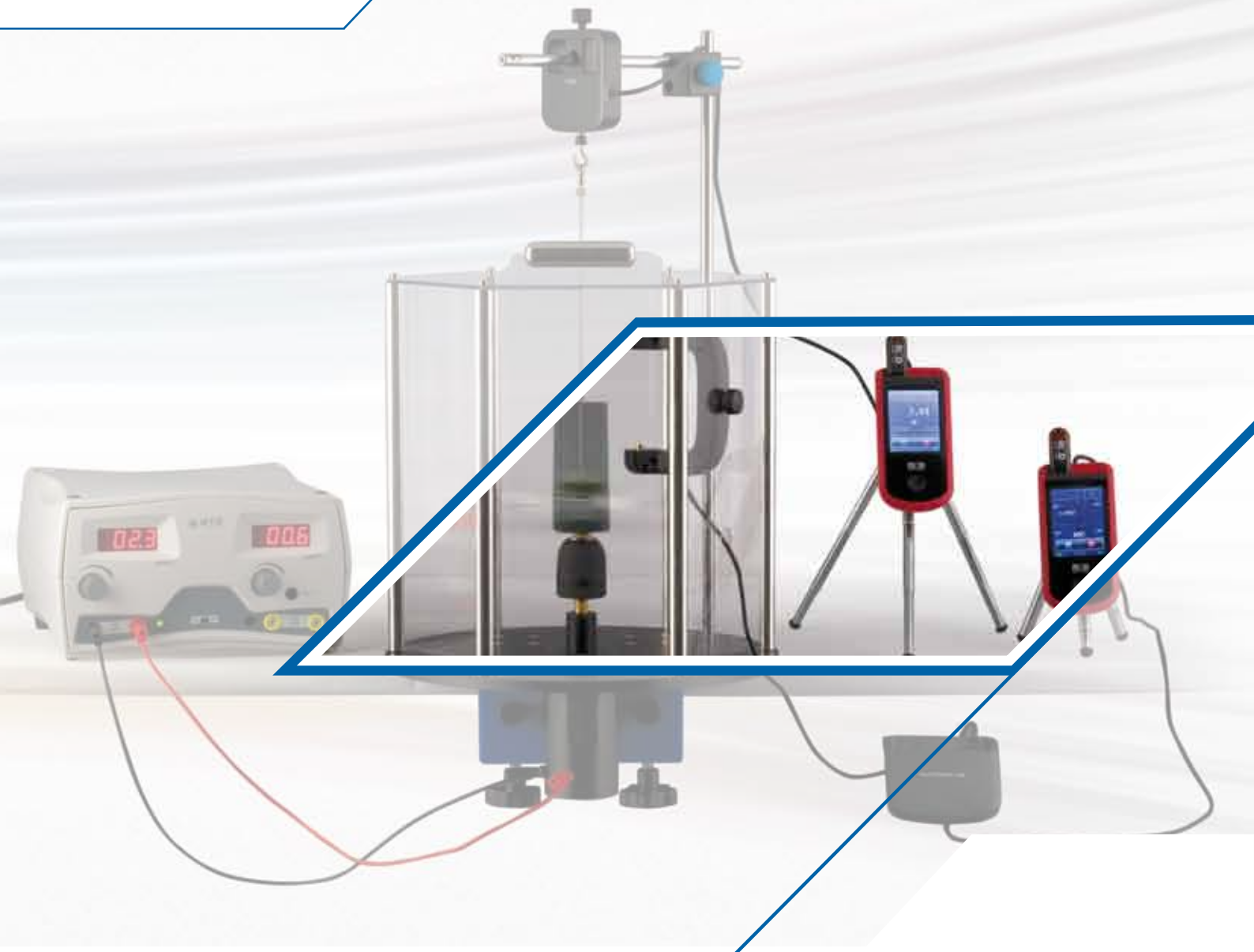
Science Educational Systems and Appliances 2013



Crafted for your world.

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SCIENTIFIC

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Crafted for your world.

Altay's Production Plant in Suzhou - China

Altay's Manufacturing Facilities and Material Handling in San Cesareo - Italy

Altay's Warehouse in San Cesareo - Italy

About Altay

Started as a family business more than 60 years ago, Altay has grown into a 21st century, international company with operations on 5 continents employing more than 500 people.
But, family traditions and values are still the basis of our work.
We are ready to meet today's market demands with the passion and dedication of the past, together with the technology and tools of tomorrow.

Altay Vision

Altay Scientific is a leading company in the global market for science education sold through a worldwide network of authorized dealer partners.
Altay produces a full line of innovative and user friendly products based upon the highest technology research and development married to high quality, low cost production techniques and processes.
The Altay brand stands for innovation, value and customer orientation.
The global Altay organization remains committed to investing the necessary human and financial capital in the Altay Vision.

Altay Mission

The search for knowledge is a need that comes from human nature.
To satisfy this need is to overcome the social, economic and intellectual differences that can only divide us.
Our mission is to develop and market innovative, user friendly and affordable products, "Instruments of Knowledge," to allow and facilitate this search for knowledge.
Altay will continue to support technology development, continually improving goods and services maximizing a humanistic vision of society and progress.
In pursuing our corporate goals, we will adhere to the most rigorous professional ethics regarding every aspect of our business.
We will be part of and "give back" to all of the communities where we do business.

Our R&D Physics Department

Thanks to our highly qualì ed scientists who work in our R&D Physics Dept., Altay has become a leader in developing and crafting physics equipment specì cally designed to be safe, durable and easy to use.
Our dedicated, creative team of experts strives to develop a range of new products that facilitate teaching and motivate learners by bringing science to life!

Dear Customer,

Altay operates under one simple notion: to create high-quality teaching products that are affordable. Research into modern teaching methods and their practical applications in classrooms have helped us to develop our product line. To do that, we've spent a lot of time in schools teaching, watching and learning.
We truly believe that effective learning comes from direct experiences. Altay is engaged in designing and developing a full range of products that will both motivate students and help teachers to convey theory in a stimulating and exciting way.
In other words, Altay's products are CRAFTED FOR YOUR WORLD, crafted just for you!

Pierpaolo Barzan
CEO

CONTENTS

ALTAY's NEW PRODUCTS

Winner of the 15th Worlddidac Award 2012

RED – Really Easy Data Sensors

Record data easily, quickly and accurately.

RED is an exclusive set of data collector devices and sensors that provides exactly what it promises - really easy data. It's the solution to probeware that teachers and administrators like you have been waiting for!

RED MOTION SENSOR

RED pH SENSOR

RED PHOTOGATE SENSOR

To find out more about the complete range of RED sensors, adapters and accessories specifically developed to enable sensors to work with Altay's physics products, please go to page 122.

RED sensors can also be purchased in convenient sets crafted just for you!

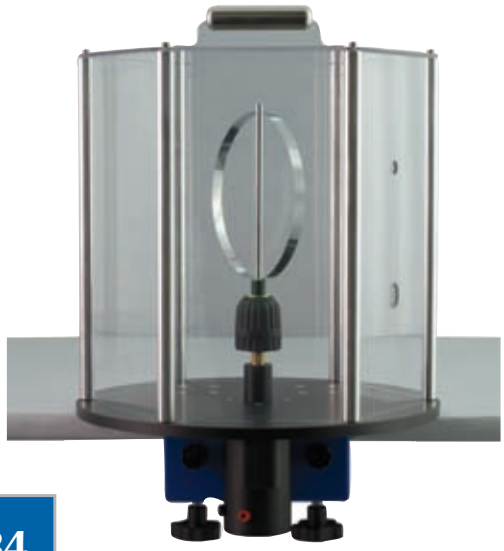
RED STORAGE CASE

MIDDLE SCHOOL RED SET 1

PRODUCTS HIGHLIGHTS

50 INCLINED PLANE STEM SYSTEM

53 ELECTRICITY STEM SYSTEM



84 CENTRIFUGAL FORCE APPARATUS

85 TORSION BALANCE

97 THERMAL CONDUCTIVITY APPARATUS

115 ELECTRICAL SAFETY SIMULATOR

EDUCATIONAL SYSTEMS

With Altay Educational systems, teachers have everything they need to easily demonstrate all the main scientific principles within Optics, Electricity, Electrostatics, Mechanics, Magnetism, Thermodynamics and Chemistry.
Our flexible, time-saving and easy to set-up systems cover a wide range of experiments interfacing with dataloggers, loggers and sensors.
They are supplied in a sturdy portable case guaranteeing durability, safety and simple storage.

User-friendly instruction manuals provide the guidance necessary to assure a successful learning experience-science principles become simple and clear to understand while enhancing students' curiosity and learning.
Altay's full line of Educational systems offer you quality, precision and economy in one package – designed by teachers, for teachers.

6 MECHANICS SYSTEM 1

18 OPTICS SYSTEM 1

Mechanics System 1

4861.19

An introductory system to study basic mechanics

Specifications
Size: 50x45x15 cm
Weight: 7.4 kg
Track Lenght: 60 cm
Weight: 1.2 kg
Packing: external suitcase in aluminium, internal foam to prevent accidental breakage

Equipment Suggested
Electronic Balance (code 2219.30)
RED Force Sensor (code 4840.14)
Tripod Stand (code 4830.46)

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.

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

▲ *Full set of basic measuring instruments*

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

EXAMPLE OF USE

Analytical Balance • **In-depth investigation of the analytical balance**

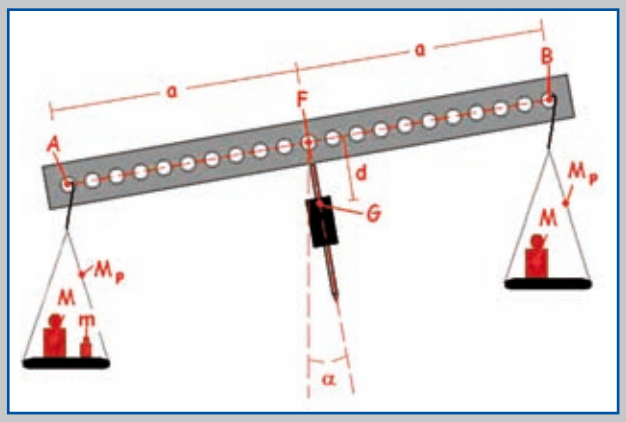
The balance is an instrument that allows, in a gravitational field, to measure the unknown masses by comparison with sample masses. One sample experiment is the determination of the sensitivity of a balance which has arms of equal length. The more sensitive a balance is, the smaller the variation in 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**.

$$\sigma = \frac{\alpha}{m} = \frac{a}{\mu d}$$

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



Assembled analytical balance

Study of the tangential component of the weight force with an inclined plane and a Force Sensor

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 pulleies
- 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

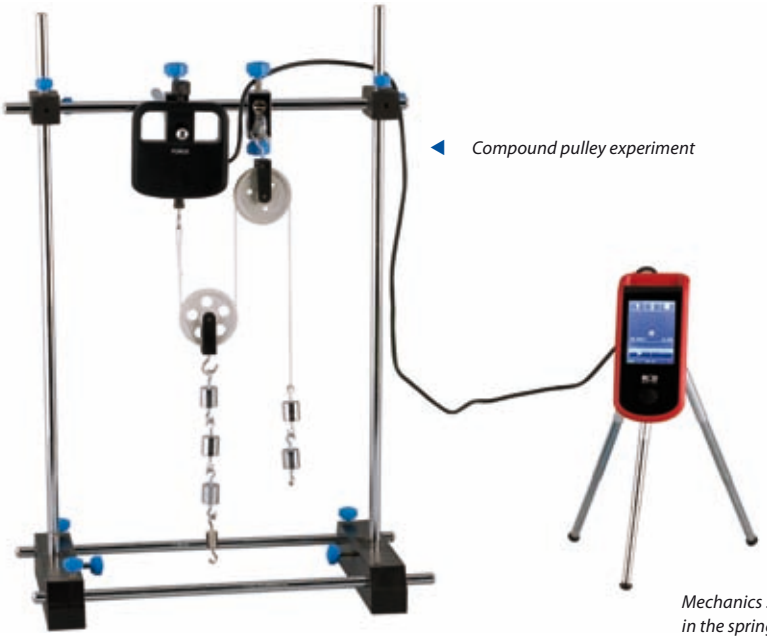
Many of these experiments will also be suitable for applied mathematics.

Mechanics

▲ *Measuring the tangential component of the weight force with an inclined plane*

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



◀ *Compound pulley experiment*

Mechanics System 1 assembled in the spring pendulum configuration ▲

Mechanics System 2

4861.29

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

Specifications
Size: 50x45x15 cm
Weight: approx. 8 kg
Track Lenght: 117 cm
Weight: 2.4 kg
Packing: external suitcase in aluminium, internal foam to prevent accidental shock

Equipment Suggested
Electronic Balance (code 2219.30)
RED Motion Sensor (code 4840.12)
RED Sensor Universal Adapter (code 4831.00)
Tripod Stand (code 4830.46)
RED Photogate Sensor (code 4840.15)
RED Photogate Support for Track Set (code 4831.07)

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.

Studying acceleration with reflection photogates

Mechanics

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

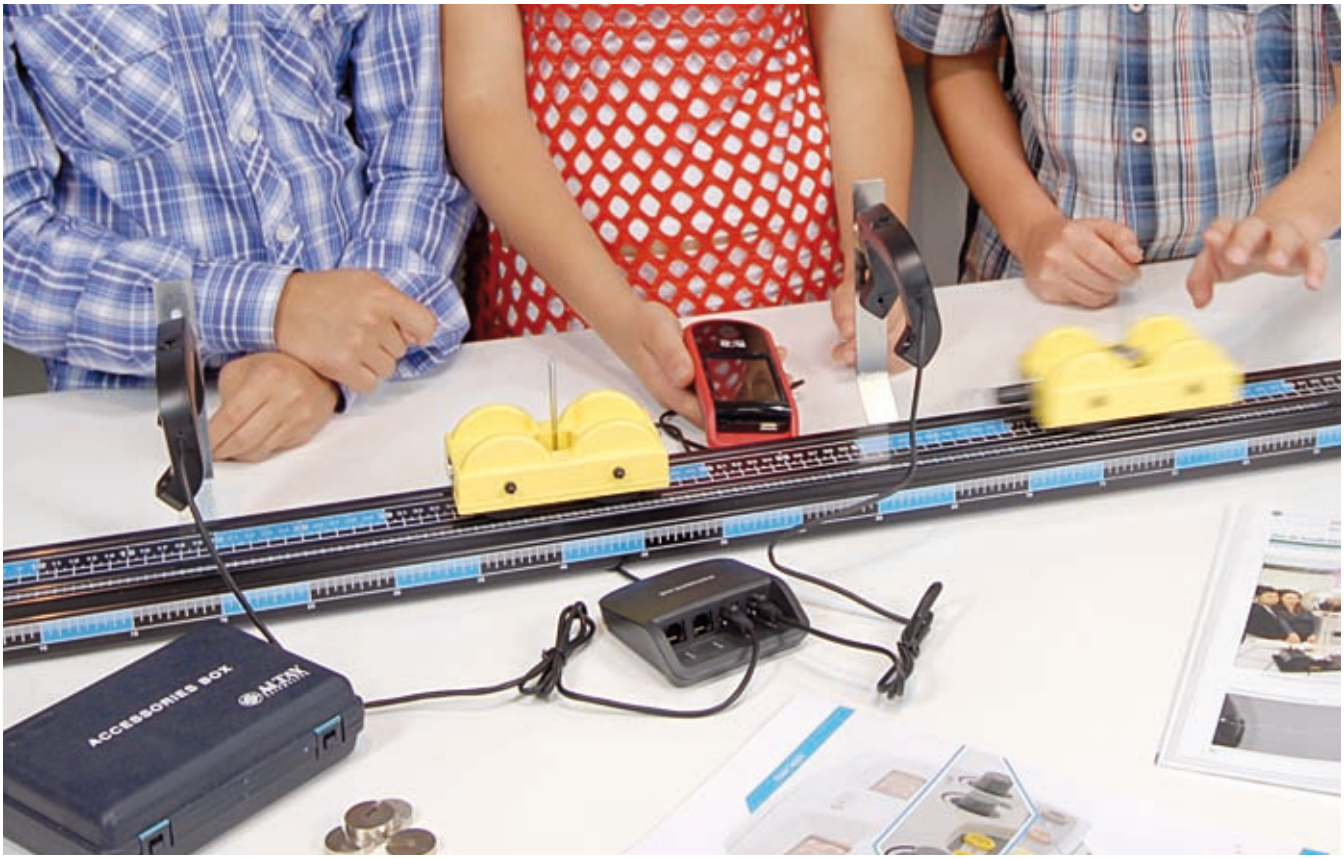
MAIN COMPONENTS

- 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

▲ *Electronic timer with electromagnet and photogates*

▲ *Contents of accessories boxes*

▼ *RED Photogate Sensor usage to study collisions*



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.

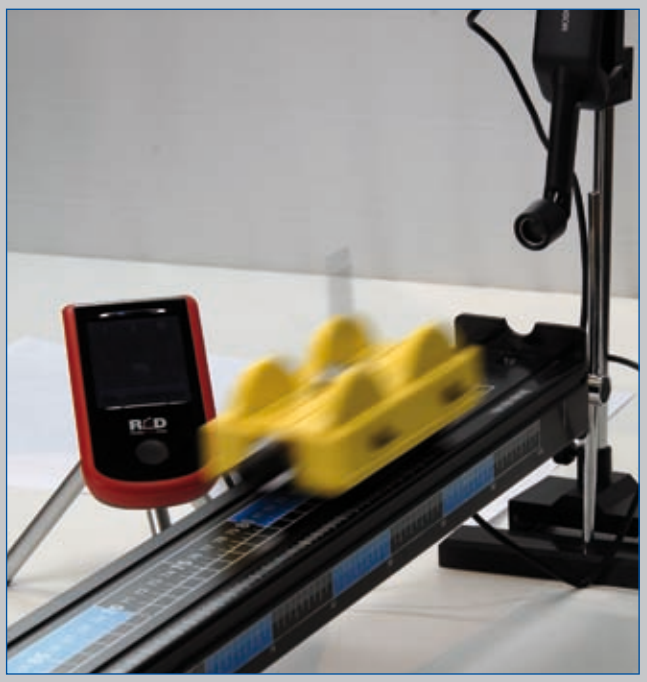
There are four physical quantities which can be investigated: force, time, mass and velocity change. The force multiplied by the time is known as the impulse and the mass multiplied by the velocity change is known as the change in momentum. The impulse experienced by the cart is always equal to the change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

This can be approximated as follows:

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

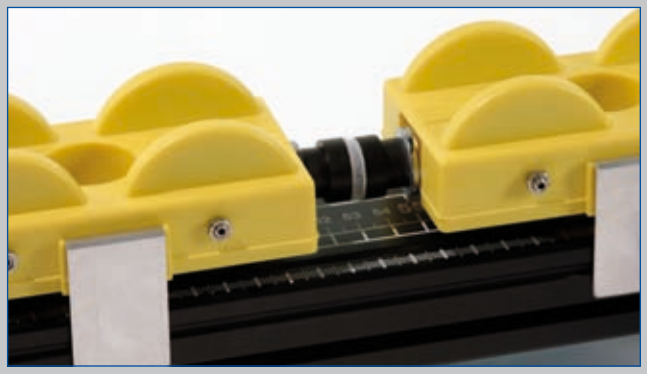
◀ *Impulse – momentum theorem*

▼ *Studying acceleration with RED Motion Sensor*

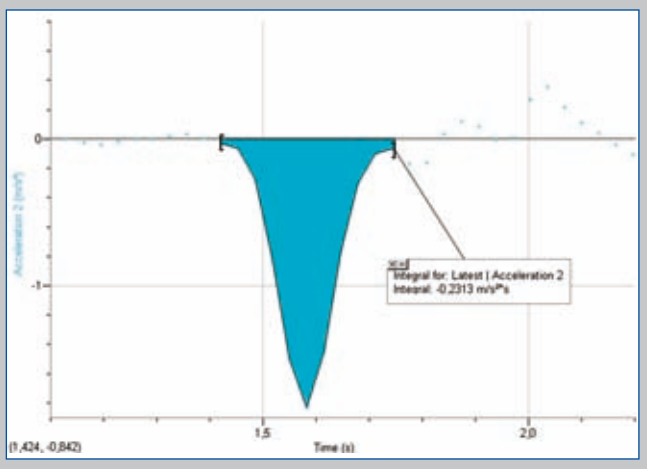


Further examples of workable experiments

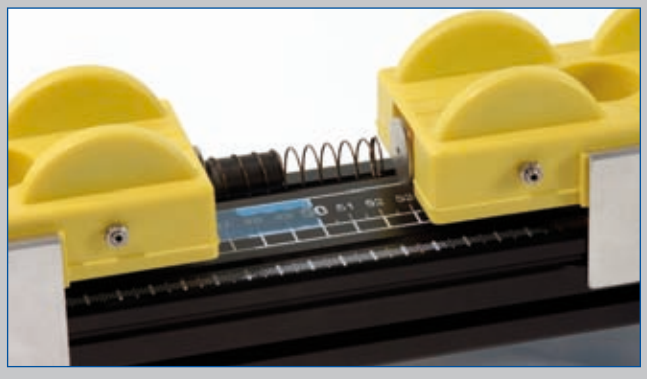
The area enclosed by the curve represents the rate of change of momentum.



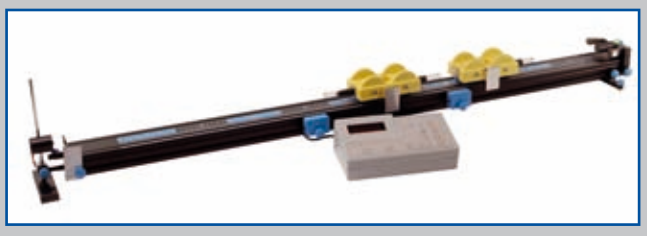
▲ *Inelastic collision between two carts*



▲ *Impulse-momentum theorem experimental testing*



▲ *Elastic collision between two carts*



▲ *Setup to study different types of collisions*

Mechanics System 3

4861.39

A basic introductory mechanics system for mechanics of fluids

◀ *Glassware case*

Specifications

Case 1
Size: 75x55x20 cm
Weight: approx. 4 kg

Case 2
Size: 75x55x20 cm
Weight: approx. 9 kg
Packing: external suitcase in aluminium, internal foam to prevent accidental breakage

Equipment Suggested
RED Force Sensor (code 4840.14)
RED Gas Pressure Sensor (code 4840.17)
Tripod Stand (code 4830.46)
Vernier Caliper (code 2213.10)
Tape Measure (code 2211.10)

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 ▶

▲ *Boyle's Law with a RED Gas Pressure Sensor*

MAIN COMPONENTS

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

▲ *Hardware case content*

◀ *Different unit of measures for RED Gas Pressure Sensor*

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's tube

▶ *Mariotte's bottle, Cartesian diver, Hare's apparatus*

▶ *Force pump, capillary tubes, communicating vessels, Venturi's tube and Ostwald viscometer*

▶ 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.

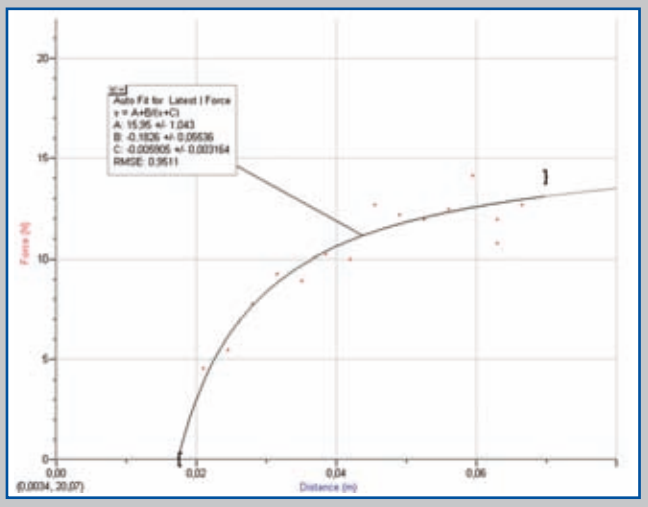
One vessel is filled with water and the other with a fluid of unknown density.

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*



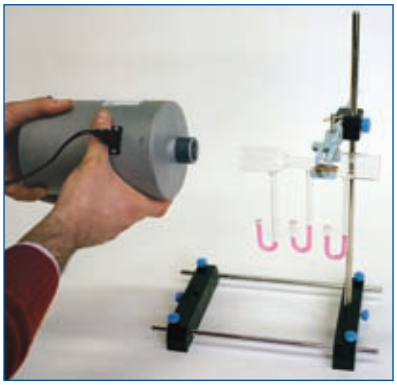
▲ *Pressure force graph vs. syringe piston position*

Students acquiring data from Hare's apparatus ▲

Venturi's tube experiment configuration ▲

Other apparatus and setups for this system • **Examples of various experiments on the mechanics of fluids**

▲ *Force pump*



▲ *Venturi's tube*

▲ *Bernoulli's Blower*

▲ *Capillary tube apparatus*

▲ *Communicating vessels apparatus*

Heat System

4862.19

Study thermology with this compact and easy to use system

Specifications
Size: 75x55x20 cm
Weight: approx. 12 kg
Packing: external suitcase in aluminium, internal foam to prevent accidental breakage

Equipment Needed
Methane/Butane Cylinder
Power Supply 10 A (code 2407.75)

Equipment Suggested
RED Temperature Sensor (code 4840.42)
RED Temperature Sensor Plug-in (code 4830.11)
RED Gas Pressure Sensor (code 4840.17)
RED Voltage & Current Sensor (code 4840.16)
Tripod Stand (code 4830.46)

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.

▼ *Calorimeter with Joule's Law Apparatus*

◀ *Components for experiments*

MAIN COMPONENTS

- Universal base
- Bosshead
- Swivel bosshead
- Digital multimeter
- Thermocouple
- Beakers
- Cylinder graduated
- Centrifuge Tube
- Filtering Flask
- Drying Tube
- Extension clamp with rod
- Alchool thermometer, range: -10°C/+110°Cx1°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

◀ *Mixing calorimeter experiment with a RED Voltage & Current Sensor*

Thermodynamics

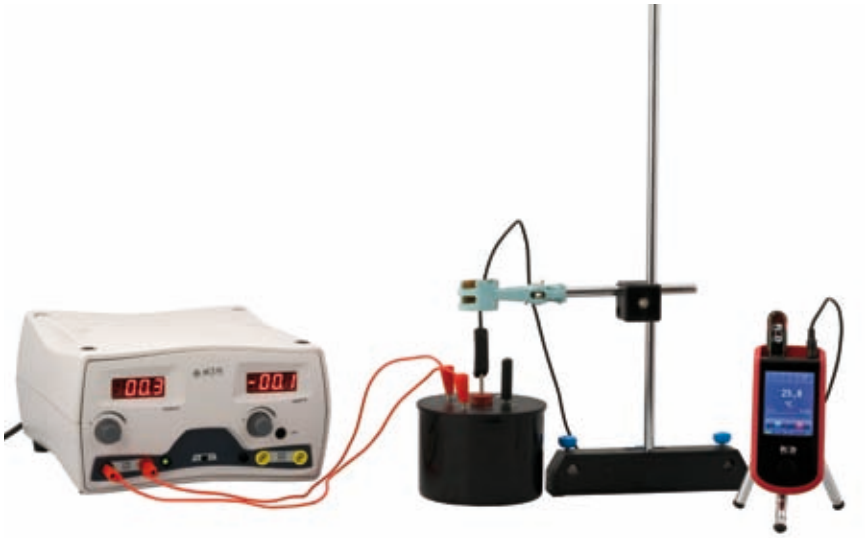
LAWS AND PRINCIPLES INVESTIGATED

- 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

Students involved in the thermocouple experiment. ▶

▲ *RED Voltage & Current Sensor and Bimetallic Strip as a Thermostat*

Measuring temperature of a mixing solution ▶



Thermodynamics

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

Phase transition temperature measurement ▼

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

▲ *Centrifuge tube, beakers, filtering flask and graduated cylinder*

▶ EXAMPLE OF USE

Setup for the experiment ▶

Wet and dry bulb hygrometer • **The basic concepts of psychrometry can be demonstrated in this experiment**

The amount of water vapor in the air at any given time is usually less than 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.

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

▲ *Relative humidity definition formula*

Optics System 1

4864.19

A complete system to study the principal laws of geometric optics

Set of lens – mirror holders ▲

Shadow formation studied with a RED Light Sensor ▼

Specifications
Size: 50x45x15 cm
Weight: 7 kg
Track Lenght: 102 cm
Weight: 1.2 kg
Packing: durable aluminium carry case with foam inserts

Equipment Suggested
RED Light Sensor (code 4840.18)
RED Sensor Universal Adapter (code 4831.00)
Tripod Stand (code 4830.46)

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.

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

Optics

◀ *Set of mirrors, lenses and prism holder*

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*

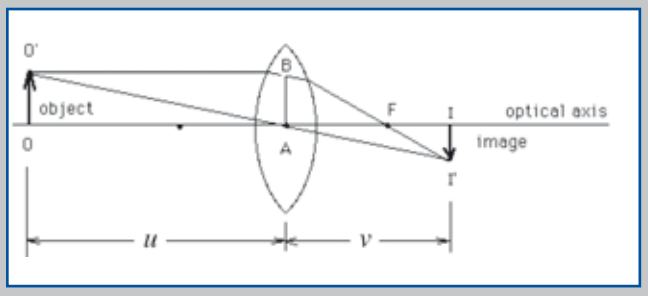
▶ EXAMPLE OF USE

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 Lenght: 61 cm
Weight: 7.0 kg
Packing: durable aluminium carry case with foam inserts

Equipment Needed
Dextrose

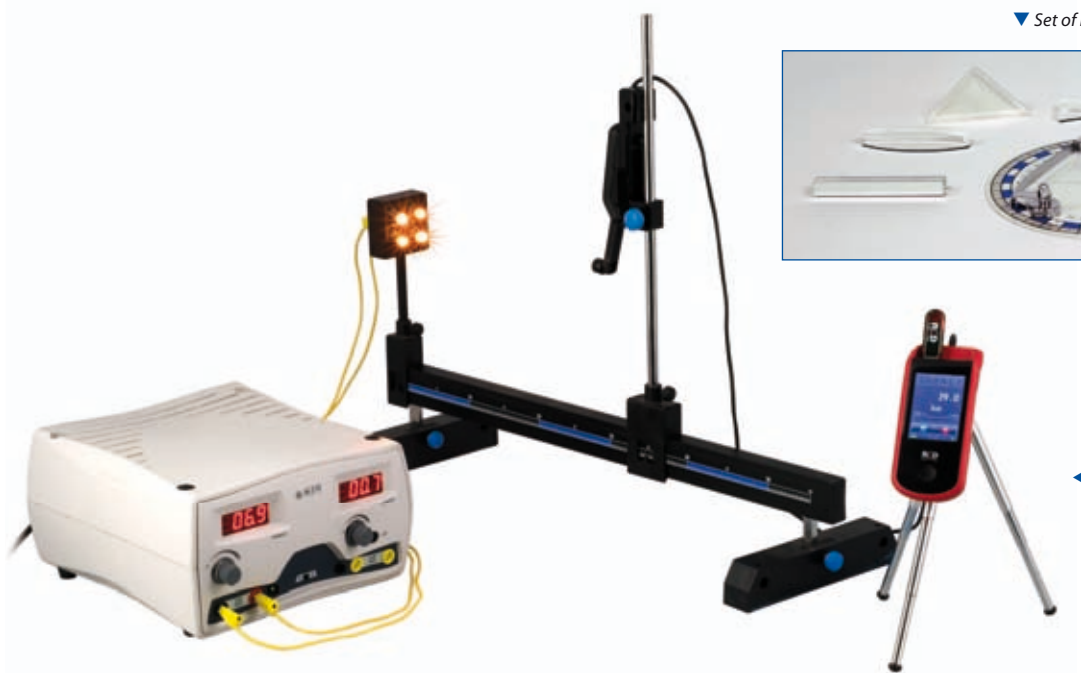
Equipment Suggested
RED Light Sensor (code 4840.18)
RED Sensor Universal Adapter (code 4831.00)
Tripod Stand (code 4830.46)

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.

▼ *Set of lenses with flexible mirror and Hartl disk*



◄ *Inverse square law investigation*

Optics

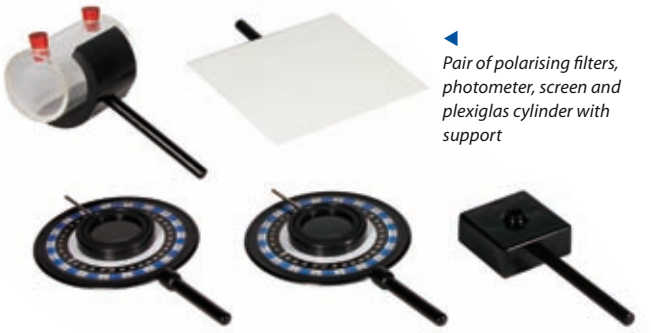
MAIN COMPONENTS

- 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

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

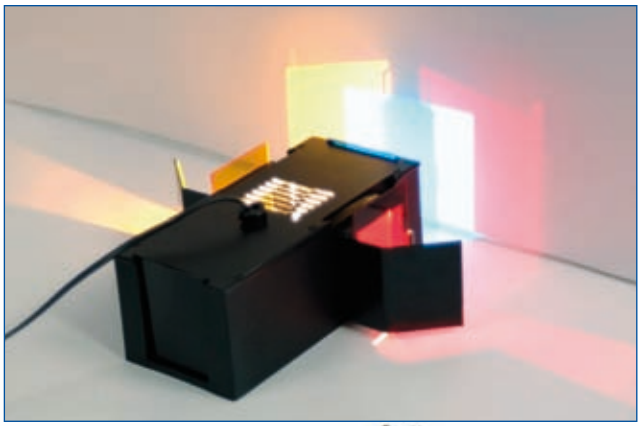
LAWS AND PRINCIPLES INVESTIGATED

- 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



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

Composition of colours



Preparing the Laurent polarimeter

Optics

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

▲ *A biconvex lens placed on the Hartl disk*

▼ *Using a flexible mirror*

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

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!

Specifications
Size: 30x25x10 cm
Weight: 1.5 kg
Packing: durable aluminium carry case with foam inserts

Equipment Needed
Vernier Caliper (code 2213.10)
Tape Measure (code 2211.10)

Equipment Suggested
RED Light Sensor (code 4840.18)
RED Sensor Universal Adapter (code 4831.00)
Tripod Stand (code 4830.46)

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

▲ *Multiple diffraction grating mounted on holder*

▲ *Solid state laser with cylindrical lens and polariser*

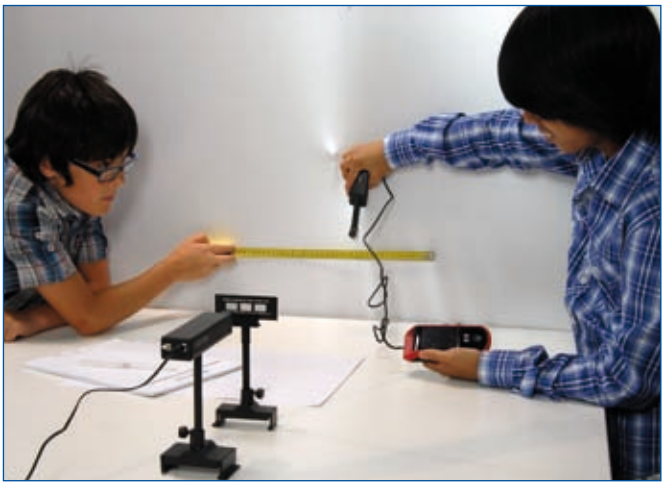
◄ *Grating on plastic holder* ▼

Optics

LAWS AND PRINCIPLES INVESTIGATED

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

▼ *Different greating experiment with a RED Light Sensor*



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

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)

▶ EXAMPLE OF USE

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

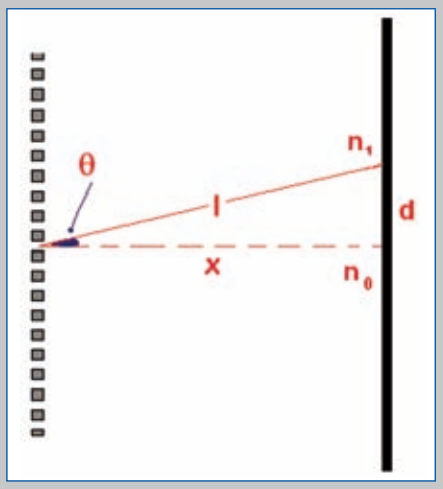
Diffraction of light occurs when a light wave passes by a corner or through an opening or slit that is physically the approximate size of, or even smaller than that light's wavelength.
Diffraction describes a specialized case of light scattering in which an object with regularly repeating features (such 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.

▼ *Constructive interference*

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

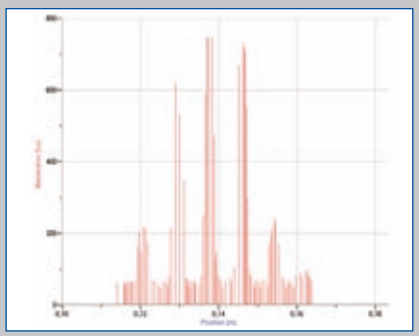
Where **(p)** is the pitch of the diffraction grating.

▶ *Assembly example for the diffraction grating experiment*



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

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 cm and a diffraction grating with a pitch **(p)** of 0.13 mm we get the following result.



▶ *Experimental data of luminous intensity vs. position for a diffraction grating*

Electrostatics System

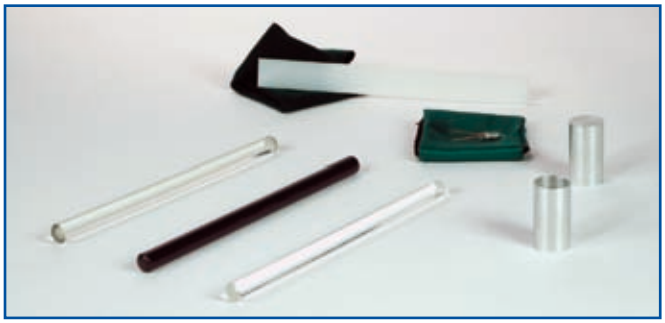
4865.19

A qualitative and quantitative overview of the concepts of electrostatics

Specifications
Size: 75x55x20 cm
Weight: approx. 6.5 kg
Packing: durable aluminium carry case with foam inserts

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.



Full set of materials for electrostatics experiments

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

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

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

Electrostatics

▲ *Leaf electroscope with accessories*

▲ *Measuring charge in a hollow sphere with electroscope and datalogger*

▶ EXAMPLE OF USE

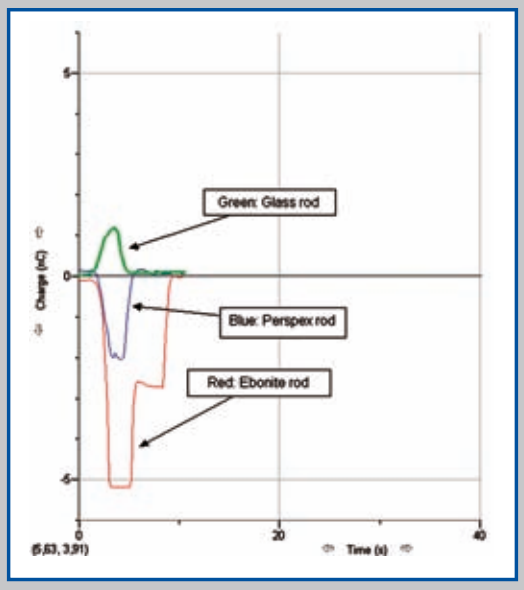
Electroscope usage • **Using the electroscope to measure the charges by induction and conduction**

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).

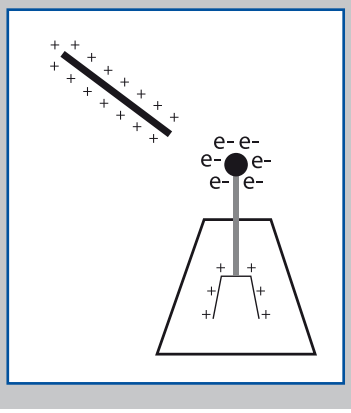
Either way, the leaves are now charged the same way as each other so they repel each other. The amount they open up is proportional to the charge of the source (if the sources are always held at the same distance from the hook).

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.

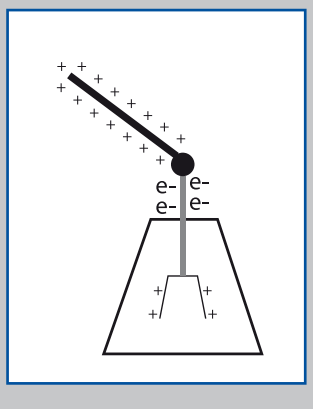


▲ *Different charges induced by rubbing ebonite, Perspex and glass with wool*



◀ *Induction*

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.



Conduction ▶

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 aluminium, internal foam to prevent accidental breakage

Equipment Suggested
RED Magnetic Field Sensor (code 4840.25)
Tripod Stand (code 4830.46)
Overhead Projector

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

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*

▶ *Magnetic field lines of force demonstrated by series of 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

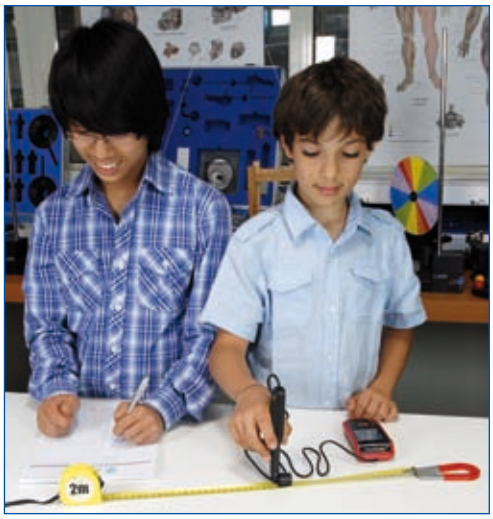
EXPERIMENTS DETAILED IN THE MANUAL

- 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

LAWS AND PRINCIPLES INVESTIGATED

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

◀ *2D Magnetic field visualizer*

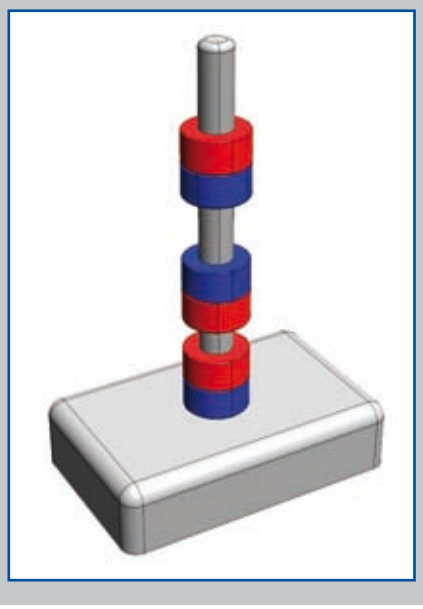


▶ *Magnetic field dipole approximation experiment with RED Magnetic Field Sensor*

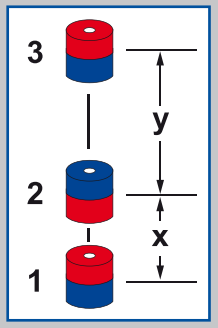
▶ EXAMPLE OF USE

Floating magnets • A simple experiment demonstrating the interaction between magnetic dipoles

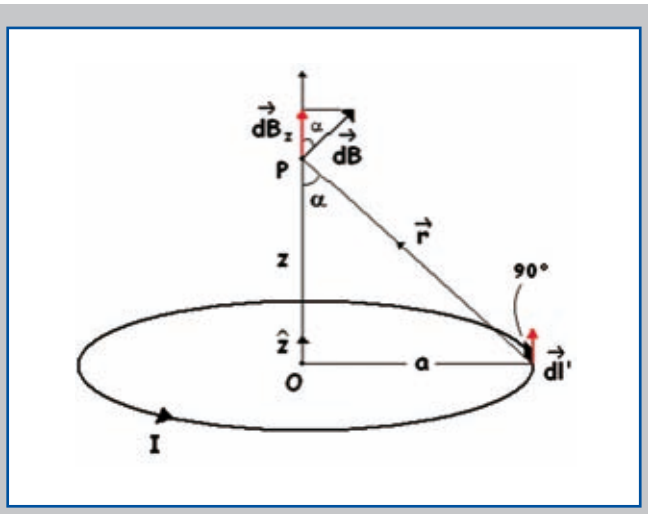
Andre Marie Ampère hypothesised (the so called "elementary current hypothesis"), that a small permanent magnet (magnetic dipole) behaves as a coil in which is flowing a direct electric current (Ampère's Equivalence Theorem).



◀ *Floating magnets experiment*



▲ *Variables used in the floating magnets experiment*



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

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

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).

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: external suitcase in aluminium, internal foam to prevent accidental breakage

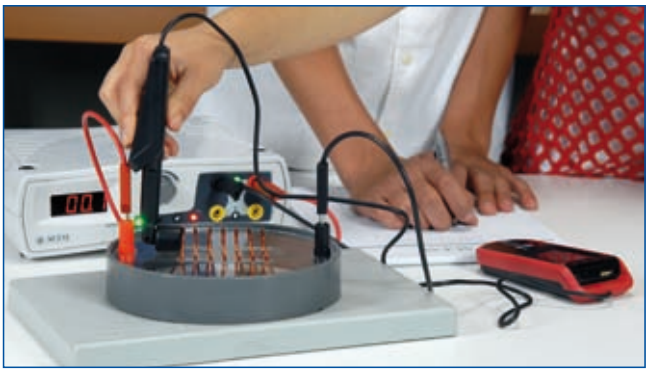
Equipment Needed
Power Supply 30 A (code 2407.65)

Equipment Suggested
RED Magnetic Field Sensor (code 4840.25)
Tripod Stand (code 4830.46)
Overhead Projector

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.

▼ *Magnetic Field produced by a solenoid and measured with a RED Magnetic Field Sensor*

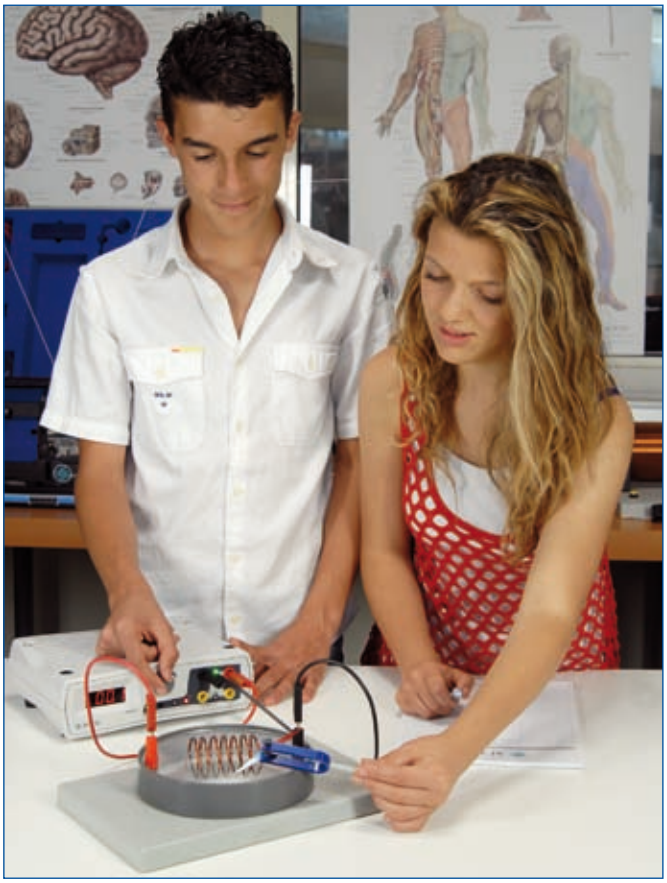


Magnetics System 2 components ▼

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

Magnetism & Electromagnetism



Investigating the magnetic compass principle ▶

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

EXPERIMENTS DETAILED IN THE MANUAL

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

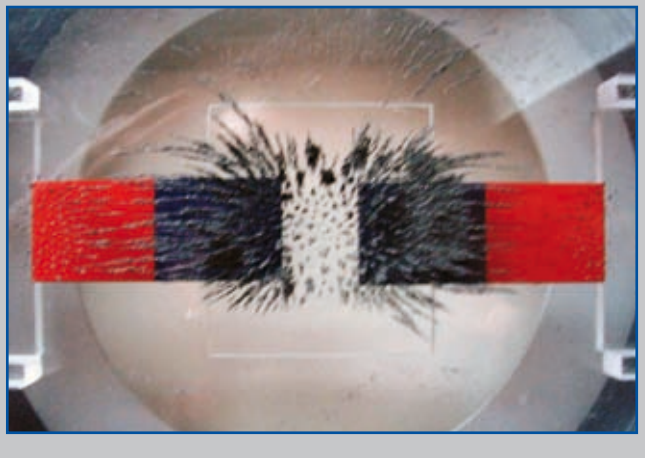
▶ EXAMPLE OF USE

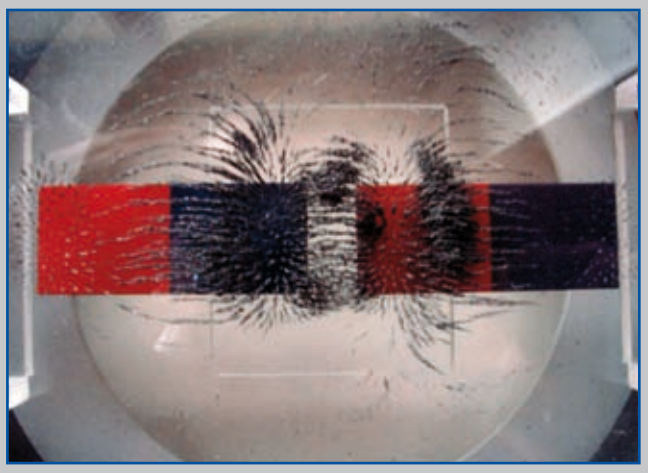
Magnetic field produced by a permanent magnet

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

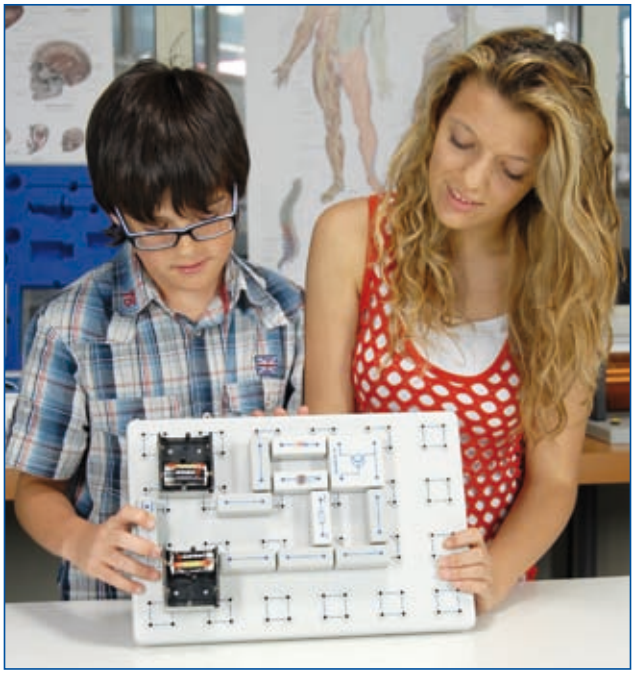
Specifications
Size: 50x45x15 cm
Weight: approx. 5.5 kg
Packing: durable aluminium carry case with internal foam

Equipment Needed
Power Supply 1.5 A AC/DC (code 2407.70)

Equipment Suggested
Oscilloscope (code 2280.70)
RED Voltage & Current Sensor (code 4840.16)
RED Magnetic Field Sensor (code 4840.25)
Tripod Stand (code 4830.46)
RED Universal magnet Support (code 4831.06)
Altay Magnetic Board (code 4114.30)

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.



Example of an LDR application usage

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

Electricity & Electronics

Logging the current flowing in an electric motor using Electricity System 1 and 2

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

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

EXAMPLE OF USE

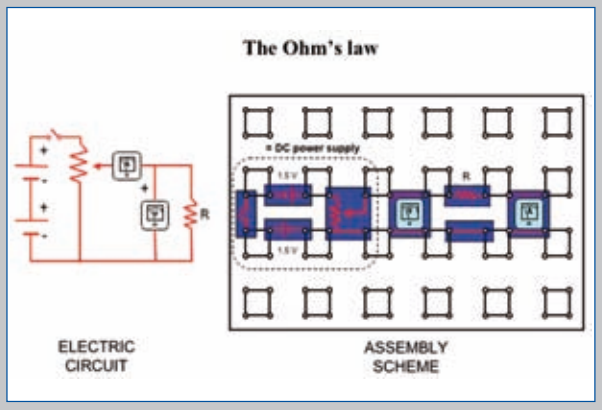
Ohm's Law • The fundamental principle of electricity

The Ohm's Law is the fundamental law of electricity and it helps us understand the relationship 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)**:

$$V = IR$$

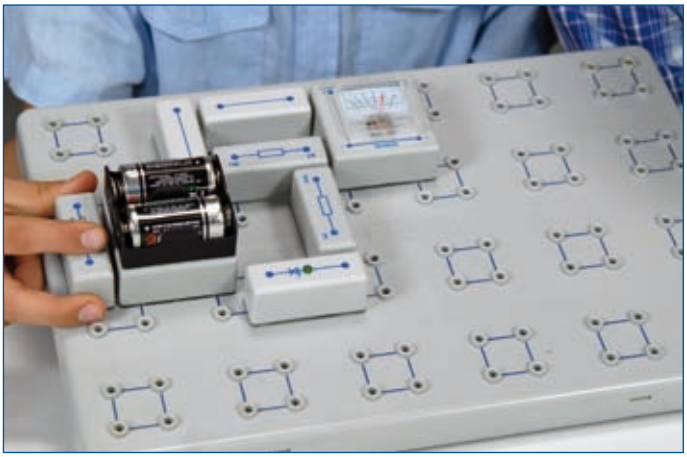
Ohm's Law

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.



Circuit schematics

Voltammetric method in action



Electricity System 2

4866.29

An advanced electricity lab for electrical circuit projects

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.

Specifications
Size: 50x45x15 cm
Weight: 5 kg
Packing: durable aluminium carry case with internal foam

Equipment Needed
Electricity System 1 (code 4866.19)

Equipment Suggested
RED Voltage & Current Sensor (code 4840.16)
RED Magnetic Field Sensor (code 4840.25)
Tripod Stand (code 4830.46)
Digital Multimeter (code 2275.10)

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

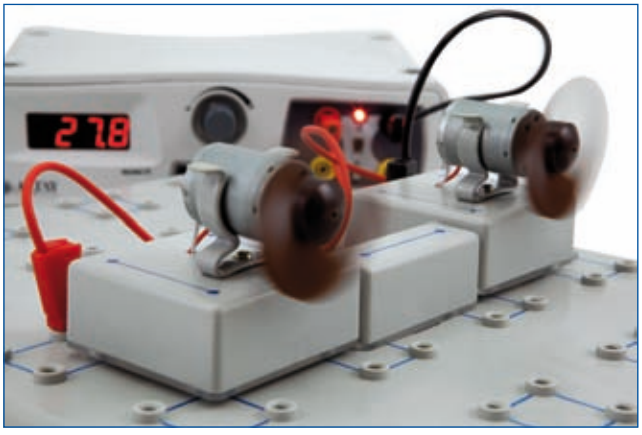
Electricity System 2 is easy to use and quick to set up.
Using the experiment circuit board in System 1, you can now perform advanced electricity experiments.

MAIN COMPONENTS

- Relais
- Motor
- Propeliers
- 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

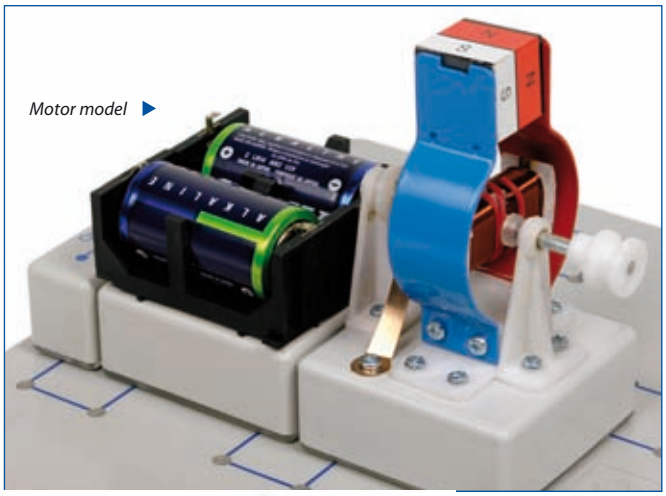


▲ *Mounting detail for a sample experiment*

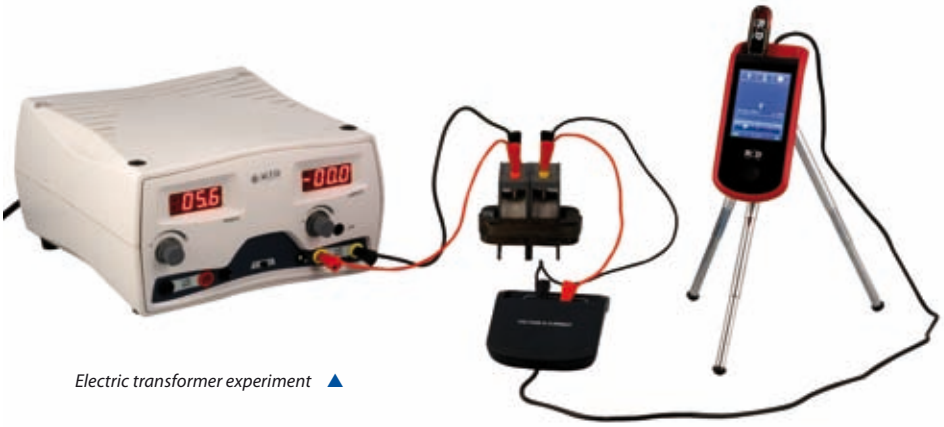
EXPERIMENTS DETAILED IN THE MANUAL

- 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

◀ *Transforming energy using a dynamo*



Motor model ▶



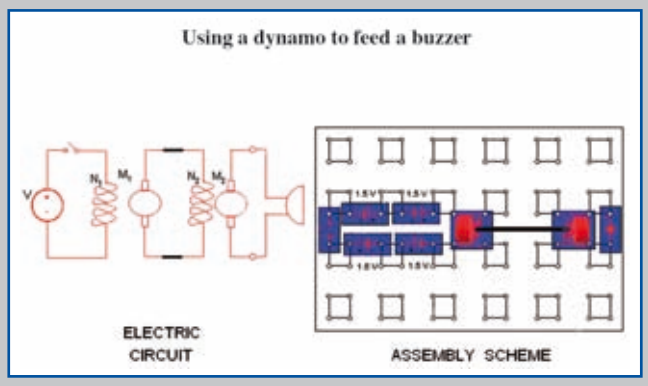
Electric transformer experiment ▲

▶ 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.

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.



▲ *The electrical energy can then be used to power a buzzer*

Electronics System 1

4868.19

A comprehensive system introducing the principles of electronics

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.

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

Equipment Needed
Electricity System 1 (code 4866.19)
Power supply 1.5 A AC/DC (code 2407.70)

Equipment Suggested
RED Voltage & Current Sensor (code 4840.16)
Tripod Stand (code 4830.46)
Digital Multimeter (code 2275.10)
RED Universal magnet Support (code 4831.06)
Altay Magnetic Board (code 4114.30)

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

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)

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
- Phototransistor
- Photoresistance v
- Zener diode 6.2 V
- PTC resistor
- NTC resistor
- Potentiometer

Electricity & Electronics

Studying the astable multivibrator configuration

EXPERIMENTS DETAILED IN THE MANUAL

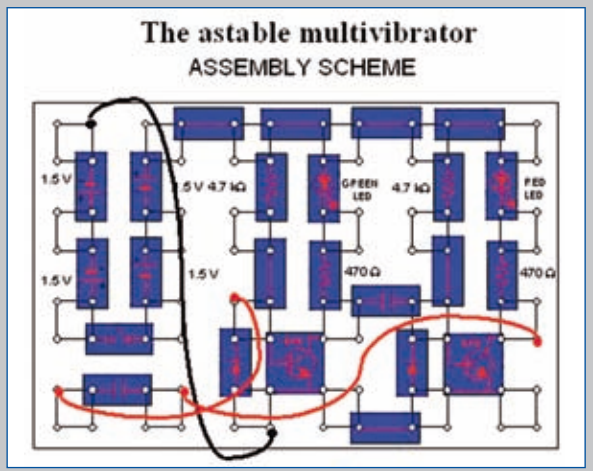
- Investigating the diode and the PN junction
- LED diodes
- Experiments with rectifier diodes
- Working with Zener diodes
- Experiments with the PNP transistor
- Experiments with the NPN transistor
- Comparison between the signal and power transistor
- Experiments with the unijunction transistor UJT
- 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

Circuit setup for a current amplifier using a NPN transistor

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

Together with our Electronics System 1, you can perform many advanced experiments. The system allows the student to quickly setup and assemble circuits by simply plugging each electrical circuit "blocks" into the lab circuit board. Using our System 2 upgrade, you take students from the basic properties of transistors right through to practical applications of electronic amplifiers.

Specifications
Size: 50x45x15 cm
Weight: 4 kg
Packing: external suitcase in aluminium, internal foam to prevent accidental shock

Equipment Needed
Electronics System 1 (code 4868.19)
Power supply 1.5 A AC/DC (code 2407.70)

Equipment Suggested
RED Voltage & Current Sensor (code 4840.16)
Tripod Stand (code 4830.46)
Digital Multimeter (code 2275.10)

Electronics System 2 consists of a set of components mounted in handy to use plug-in "blocks" with two or four plug sockets.

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

▼ *Students using the amplifier.*

EXPERIMENTS DETAILED IN THE MANUAL

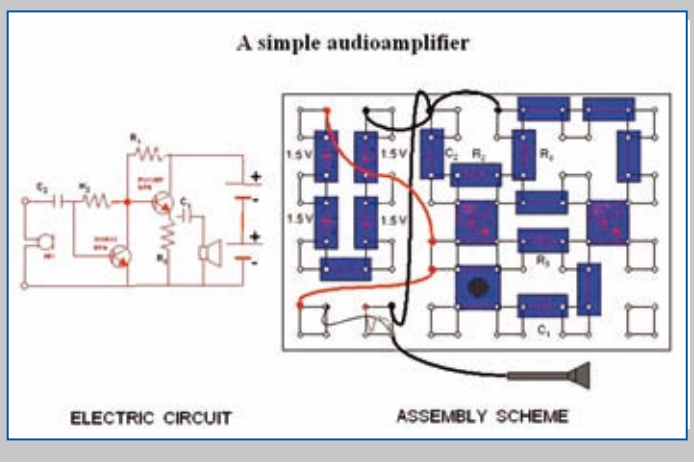
- The bridge rectifier
- The voltage follower
- The common emitter amplifier
- The common base amplifier
- The common collector amplifier
- The current mirror amplifier
- The audio amplifier

Simple circuit design of basic audio amplifier ▶

▶ EXAMPLE OF USE

Audio amplifier • **How to design a basic amplifier**

With Electronics System 2 it is possible to design a basic audio amplifier. This is a simple circuit that will boost the input audio signal then generating an output signal by means of a speaker. The circuit is composed of two transistors, one being the driver, the other being the power transistor.
The input audio signal, generated by a microphone, is boosted by the circuit and is picked up at the output by means of a speaker.
The circuit provides the student with a good way to observe the practical behaviour of an amplifier.



Audio amplifier circuit setup ▶

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
RED Voltage & Current Sensor (code 4840.16)
Tripod Stand (code 4830.46)
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)

LAWS AND PRINCIPLES INVESTIGATED

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

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

Pelton turbine, Solar panel, Wind turbine ▼

Environmental Awareness

▲ *Connectors board*

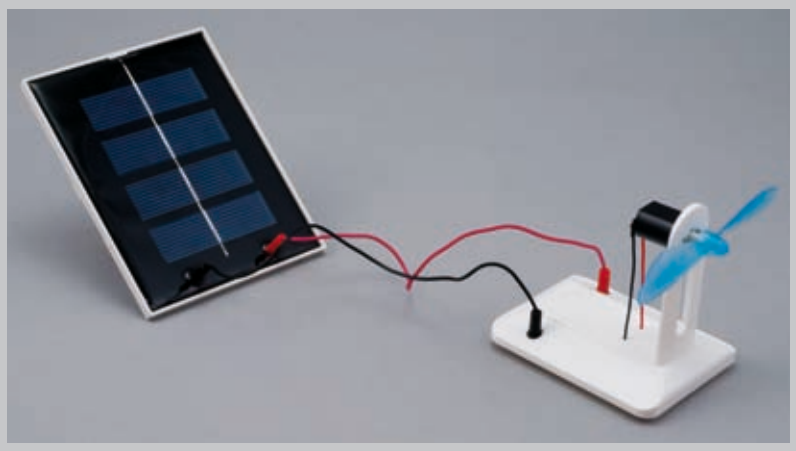
▲ *Electric energy detector*

Electric fan ▶

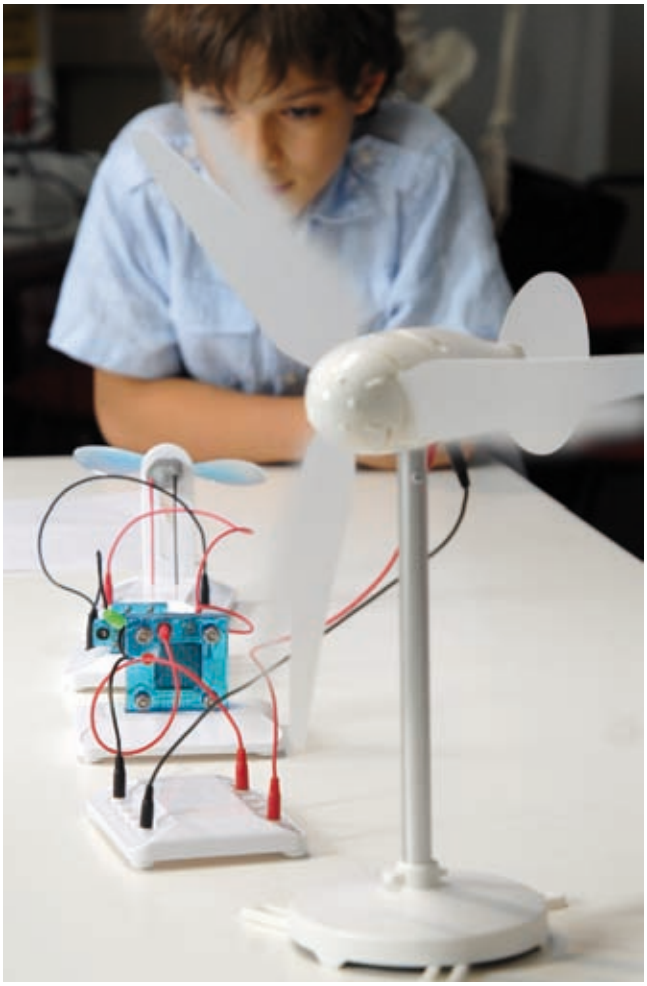
▶ EXAMPLE OF USE

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.



▲ *Measuring the current produced by a photovoltaic panel*



Energy conversion chain ▶

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

Equipment Suggested
RED pH Meter (code 4840.13)
Tripod Stand (code 4830.46)

Altay's General Chemistry System consists of a complete set of laboratory equipment and glassware stored in a foam cushioned aluminium storage case.

Setting up a demonstration is quick and simple. The Instruction Manual includes over 60 experiments that students or teachers can prepare in minutes. Altay always pays particular attention to safety so our set includes personal safety equipment.

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 aldheydes
- 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

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

▲ *All you need for teching the basics of chemistry*

▶ 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 $CuSO_4 \cdot 5H_2O$ 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.

$$Cu^{2+} + 2OH^- \rightarrow Cu(OH)_2$$

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.

$$Cu(OH)_2 + 4NH_3 \rightarrow [Cu(NH_3)_4]^{2+} + 2OH^-$$

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

Chromatography Set

4480.10

Paper chromatography is an analytical chemistry technique for separating and identifying mixtures that are or can be colored, especially pigments.

The Altay Chromatography set is based on an analytical chemistry technique called paper chromatography ideal for separating and identifying mixtures that are or can be coloured, especially pigments. This technique can also be used in secondary or primary colours ink experiments. Even though this method has been largely replaced by thin layer chromatography, it is still a powerful teaching tool.

◀ *Example of use ink chromatography*

Specifications
Approx. dimensions: 23x7x22 cm

Equipment Needed
Solvent (element)
Compounds
Hair dryer

MAIN COMPONENTS

- Glass Envelope
- Support For Runnel
- Runnel
- Rod ø10x150 mm
- Cap/Bottom Panel
- Paper for chromatography

LAWS AND PRINCIPLES INVESTIGATED

- Paper chromatography
- Separating and identifying mixtures

▶ EXAMPLE OF USE

Chromatography is used to separate mixtures of substances into their components. All forms of chromatography work on the same principle. They all have a stationary phase (a solid, or a liquid supported on a solid) and a mobile phase (a liquid or a gas called also element). The mobile phase flows through the stationary phase and carries the components of the mixture with it. Different components travel at different rates. In paper chromatography, the stationary phase is a very uniform absorbent paper. The mobile phase is a suitable liquid solvent or mixture of solvents.

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

Equipment Suggested
RED pH Meter (code 4840.13)
Tripod Stand (code 4830.46)

The Advanced Chemistry System was designed to enhance the potential of the General Chemistry System.

Used alongside the General Chemistry System, the Advanced Chemistry system allows users to perform all the experiments described in the Manuals and discover even more chemical reactions and laboratory analysis techniques.
In only a few minutes students or teachers can set up several different organic, inorganic and analytic chemistry experiments.
The experiments included in the Instruction Manual allow users to perform over 90 experiments in association with the equipment in the General Chemistry System.

LAWS AND PRINCIPLES INVESTIGATED

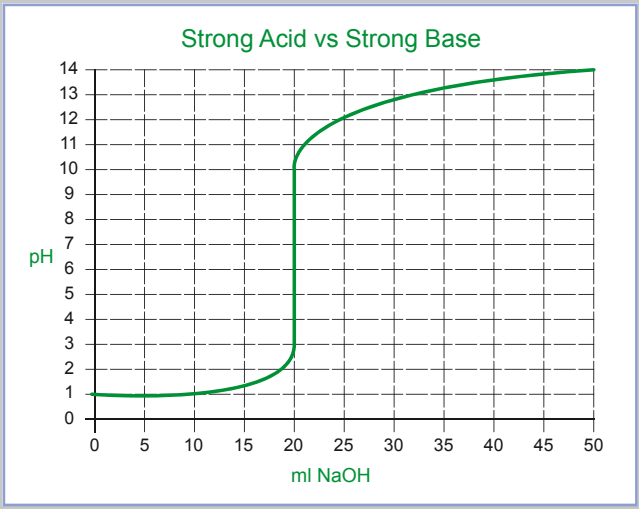
- Purification techniques:
- Gravity filtration
- Vacuum filtration
- Chromatography
- Room pressure and reduced pressure distillations
- Crystallization
- Chemical and physical properties and analysis
- Boiling point
- Polarity of solvents
- Brönsted acids and bases
- Strong and weak acids
- pH indicators
- 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

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

Example of vacuum filtration ▼

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
- Brönsted'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 Tritation
- 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

▼ *Example of glassware and accessories provided*

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.

Specifications
Size: 77x55x20 cm
Weight: approx. 8.5 kg
Packing: durable aluminium carry case with foam inserts

Equipment Suggested
RED pH Meter (code 4840.13)
RED Voltage & Current Sensor (code 4840.16)
Tripod Stand (code 4830.46)

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
- Test cell covers
- 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

Electrochemistry

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 glassware and accessories provided*

▶ EXAMPLE OF USE

Hoffman apparatus for water electrolysis ▶

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 **(–)** $4H^+ + 4e^- \rightarrow 2H_2$

At the anode **(+)** $6H_2O \rightarrow O_2 + 4H_3O^+ + 4e^-$

At the anode, water molecules are oxidised because their electrode potential ($E^0_{(O_2/H_2O)} = +1.23$ V) is lower than that of the sulphate ions SO_4^{2-} ($E^0_{(SO_4^{2-}/S_2O_8^{2-})} = +2.05$ V).

At the cathode, H_3O^+ ions are reduced because their potential ($E^0_{(H^+/H_2)} = +0$ V) is greater than that of water molecules H_2O ($E^0_{(H_2O/H_2)} = -0.83$ 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 ($E^0_{(H_2O/H_2)} = -0.83$ V) is greater than that of the sodium ions ($E^0_{(Na/Na^+)} = -2.73$V)

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

At the anode, OH^- ions are oxidised because their potential ($E^0_{(O_2/OH^-)} = +0.40$ V) is lower than the potential of the redox couple ($E^0_{(O_2/H_2O)} = +1.23$ V).

So the reactions will be :

At the cathode **(–)** $4H_2O + 4e^- \rightarrow 2H_2 + 4OH^-$

At the anode **(+)** $4OH^- \rightarrow O_2 + 2H_2O + 4e^-$

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.

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.

Specifications
Size: 75x55x20 cm
Weight: approx. 9 kg
Packing: durable aluminium carry case with foam inserts

Osmotic pressure demonstration

Accessories' box

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

Plant Physiology

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
- Photosyntesis
- 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 material of the tube, the liquid will fall.

▲ *Capillarity apparatus*

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.

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

◀ *Dissolved oxygen in water experiment*

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

High Performance Force Table STEM System

4831.16

Specifications
Size: Dia. 33x37 cm
Weight: 5.5 kg

Equipment Suggested
Tripod Stand (code 4830.46)

The Force Table apparatus is dedicated to the study of composition of forces. It is suitable both for early classes and for advanced courses allowing usage of RED Force Sensor.
Thanks to the RED Force Sensor data logging is fast and easy to take.

MAIN COMPONENTS

- Force Table
- RED Force Sensor
- Adaptor for Force Table
- Low Friction Pulleys
- Slotted Masses
- Polyester string
- Ring set

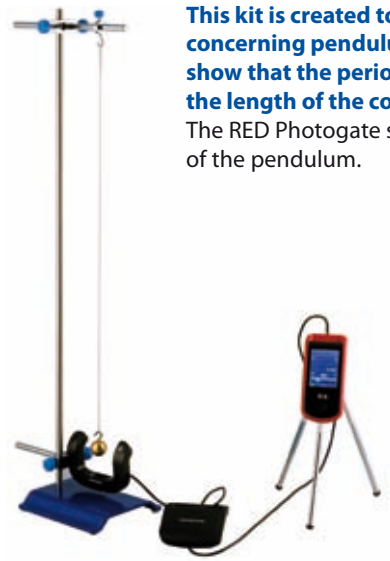
LAWS AND PRINCIPLES INVESTIGATED

- Balancing force
- Concept of force
- Direction of a force
- Intensity of a force
- Rule of the parallelogram
- Equilibrium of a material point
- Intensity of different forces
- Measure the

Parallelogram of forces study with a RED Force Sensor

Simple Pendulum STEM System

4831.19



This kit is created to show the fundamental experiments concerning pendulum and its laws. Two different diameter balls show that the period of oscillation of pendulum depends only on the length of the cord.
The RED Photogate sensor allows to measure the period of oscillation of the pendulum.

Specifications
Size: 17x15x70 cm
Weight: 1.6 kg

Equipment Needed
Metallic Bosshead (code 5401.20)
RED Support Rod (code 4830.91)

Equipment Suggested
Tripod Stand (code 4830.46)

MAIN COMPONENTS

- Simple Pendulum
- RED Photogate sensor

LAWS AND PRINCIPLES INVESTIGATED

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

Inclined Plane STEM System

4831.18

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. The RED Force sensor allows measuring force along the plane's direction, storing and then analyzing experimental data.

Specifications
Size: Height (fully open): approx. 40 cm
Weight: 2.9 kg
Max angle: 45°

Equipment Suggested
Tripod Stand (code 4830.46)

MAIN COMPONENTS

- Inclined Plane
- RED Force sensor
- Red Force Sensor Adaptor for inclined plane

LAWS AND PRINCIPLES INVESTIGATED

- Balance of a heavy body on an inclined plane
- Weight: as force
- Static and dynamic Friction
- Tangential/normal components of the weight force

Thermal Leakage STEM System

4831.10

This apparatus is used to show heat losses; the kit supplies two different kind of metals, copper and aluminium, of same volume and external surface (cylindrical shape) and one aluminium block carved as a dissipator; insulation tube is also supplied for further experimentation
Thanks to the RED standalone temperature sensor it is possible to study and verify the thermal metal proprieties with high accuracy.

Specifications
Size: 50x45x15 cm
Weight: approx. 5.5 kg
Packing: durable carry case aluminium with internal foam

Equipment Suggested
RED Temperature Plug-In (code 4830.11)
Tripod Stand (code 4830.46)
Bunsen burner with accessories (code 5111.00)
Beaker 500 ml

MAIN COMPONENTS

- Stand alone temperature
- Aluminium cylinders
- Aluminium dissipator
- Brass cylinder
- Insulator

LAWS AND PRINCIPLES INVESTIGATED

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

Centrifugal Force STEM System

4831.17

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

The apparatus is designed to study centrifugal forces. It can also be used to study the phenomenon also known as "flattening of Earth's poles ". Thanks to its new transparent cover it allows to conduct experiments in a safe and efficient way.

Thanks to the RED Force Sensor it is possible to measure the centrifugal force while through the RED Photogate Sensor students can collect speed of the rotating arm.

Specifications
Size: Dia. 32 cm
Length: 65 cm

Equipment Needed
Power Supply 1.5 A AC/DC (code 2407.70) or similar

Equipment Suggested
Tripod Stand (code 4830.46)

MAIN COMPONENTS

- Centrifugal Force Apparatus
- RED Force sensor
- RED Photogate sensor

LAWS AND PRINCIPLES INVESTIGATED

- Centrifugal and centripetal force
- Earth's poles flattening demonstrator

Hope's Apparatus STEM System

4831.13

The Hope's apparatus allows to demonstrate a specific property of water linked to the its maximum density.

Thanks to the RED standalone temperature sensor used along with the Plug In temperature it is possible to determine with very high accuracy at which temperature water has its maximum density.

Specifications
Size: Dia. 14x30 cm
Weight: 2.5 kg

Equipment Suggested
RED Temperature Sensor Plug-In (code 4830.11)
Tripod Stand (code 4830.46)

MAIN COMPONENTS

- Hope's Apparatus
- Stand alone temperature

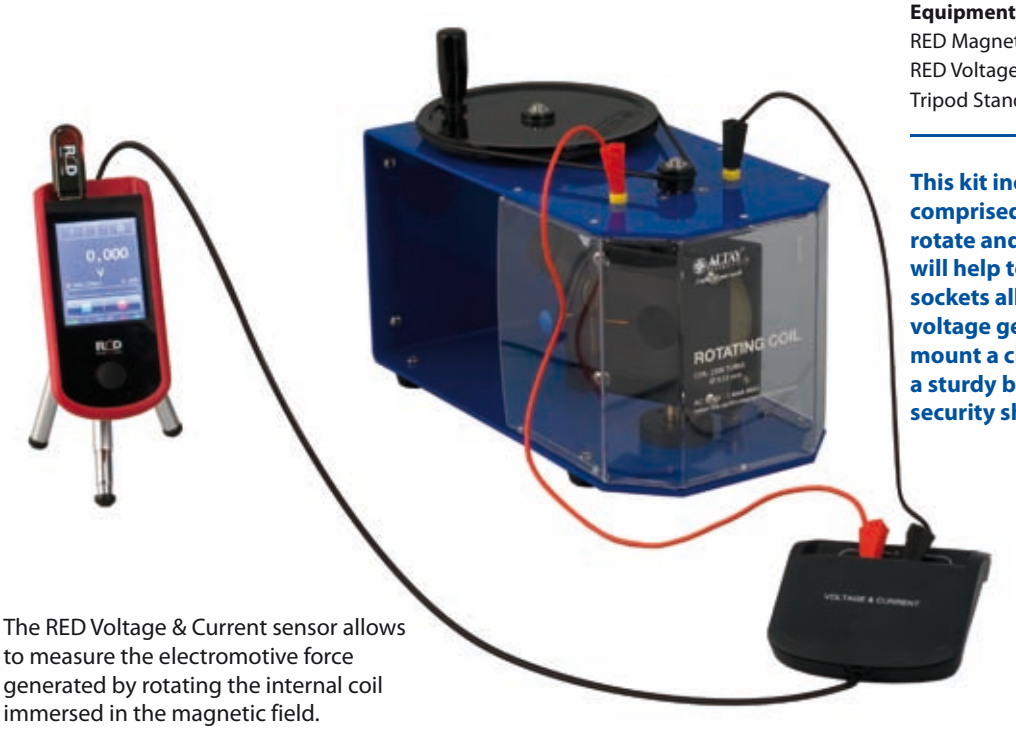
LAWS AND PRINCIPLES INVESTIGATED

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

Rotating Coil STEM System

4831.15

Rotating Coil STEM system is an attractive device to study Faraday-Neumann-Lenz's law and the Earth magnetic field



The RED Voltage & Current sensor allows to measure the electromotive force generated by rotating the internal coil immersed in the magnetic field.

Specifications
Size: 20x20x25 cm
Weight: 2.7 kg

Equipment Suggested
RED Magnetic Field Sensor (code 4840.25)
RED Voltage & Current Sensor (code 4840.16)
Tripod Stand (code 4830.46)

This kit includes a device that 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.

LAWS AND PRINCIPLES INVESTIGATED

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

MAIN COMPONENTS

- Rotating Coil
- RED Voltage & Current Sensor
- Connecting Leads Yellow Length 50 cm

Thermal Conductivity STEM System

4831.14

MAIN COMPONENTS

- RED Temperature Sensor
- Thermal Conductivity Apparatus
- Glass jar with rods

LAWS AND PRINCIPLES INVESTIGATED

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

Specifications
Size: Dia. 13x20 cm
Weight: 1.2 kg

Equipment Needed
Vernier Caliper (code 2213.10)

Equipment Suggested
RED Temperature Sensor (code 4840.42)
RED Temperature Sensor Plug-in (code 4830.11)
Tripod Stand (code 4830.46)

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

Electricity STEM System

4831.11

The Electricity STEM System helps students to learn basic laws such as Ohm's law, Kirchoff's laws, law of inductance, law of capacitance, the use of RED current and voltage sensor and more

Specifications
Size: 50x45x15 cm
Weight: approx. 5.5 kg
Packing: durable carry case aluminium with internal foam

Equipment Suggested
Power Supply 1.5 A AC/DC (code 2407.70) or similar
Altay Magnetic Board (code 4114.30)
Oscilloscope (code 2280.70)
RED Magnetic Field Sensor (code 4840.25)
RED Voltage & Current Sensor (code 4840.16)
Tripod Stand (code 4830.46)

Compatible with
Electricity System 2 (code 4866.29)
Electronics System 1 (code 4868.19)
Electronics System 2 (code 4868.29)

The Electricity STEM System provides a strong foundation for studies in electricity, it 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 and connectors are made of special metal alloys that allow excellent conduction of current to give accurate results. The Electricity STEM System can be mounted on the Altay Magnetic Board (code 4114.30) for class demonstration experiments.

The RED Voltage & Current Sensor coming with it allows measuring voltage drops and currents flowing through electric circuits.

MAIN COMPONENTS

- RED Voltage & Current Sensor
- 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

LIST OF EXPERIMENTS

- 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

The Altay Multiuse System

A unique physics bench that can be used for mechanics and optics experiments

▼ *Multiuse System different configurations*

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!

▼ *Multiuse System used as an optical bench*

MAIN COMPONENTS

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

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

Track Set

4954.12

The Altay Multipurpose Track Set

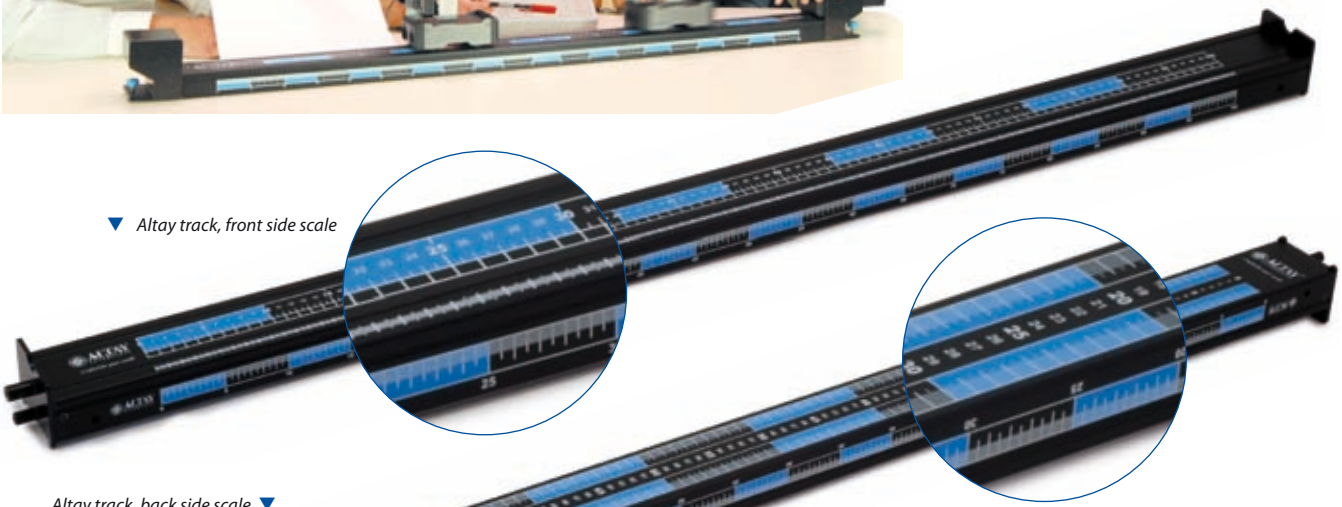
Designed to produce an almost frictionless track for the Altay Carts, it is also an Optical Bench, a Free Fall Stand for determination of "g" and a Pendulum Stand. The Track Set has clearly defined scales printed on an attractive black anodised base.

Specifications
Length: 116x7x4 cm
Weight: 2.4 kg

Also Available
Altay Track Set (code 4954.11)
Size: 145x7x4 cm
Weight: 2.8 kg

MAIN COMPONENTS

- Altay Track
- Track terminals
- Fixing nuts



▼ *Altay track, front side scale*

Altay track, back side scale ▼

▶ *Studying acceleration with reflection photogates*

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 to 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.

Mechanics Upgrade 1

4941.14

Equipment Needed
Altay Track Set (code 4954.12)
Timing Set (code 4922.10)

Equipment Suggested
RED Photogate Sensor (code 4840.15)
Two RED Motion Sensor (code 4840.12)

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
- Altay Cart with Plunger
- Track Terminals
- Slotted Masses with Hanger 250g
- Additional Weight: for Cart - Same Mass as Cart
- Additional Weight: for Cart - Double Mass of Cart
- Low Friction Pulley with Screw
- Ziggurat Flag
- Spring Holder for Cart
- Springs
- Support for Photogates

▲ *Elastic collision study between two carts using the Timing set*

LAWS AND PRINCIPLES INVESTIGATED

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

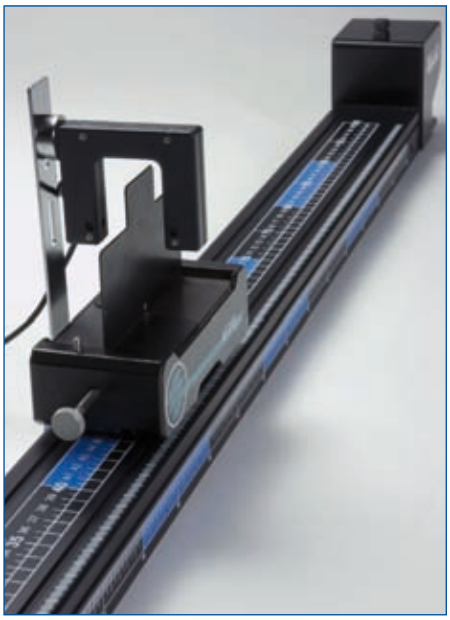
Example of use of the Mechanics Upgrade 1 with the Timing Set ▶

EXAMPLE OF USE

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

▲ *Coupled harmonic oscillators experiment setup*

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).



◀ *Altay Cart passing under the Photogate*

▼ *Main components*

Elastic collision study between two carts using RED Photogate ▼

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*

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*

MAIN COMPONENTS

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

LAWS AND PRINCIPLES INVESTIGATED

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

▲ *Free fall 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**'.

$$v_y = gt$$

$$y = \frac{1}{2} g t^2$$

◀ *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**).

Coupled Pendulum Set

4941.16

Studying the coupled oscillators effect

▲ *Coupled pendulums at work*

Equipment Needed
Mechanics Upgrade 1 (code 4941.14)

Equipment Suggested
RED Motion Sensor (code 4840.12)

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.

MAIN COMPONENTS

- Rods
- Spheres with Hook

LAWS AND PRINCIPLES INVESTIGATED

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

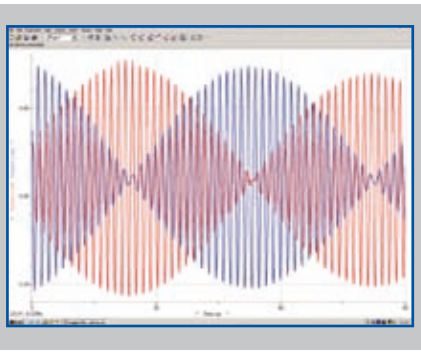
▼ *Resonance oscillations between two coupled pendulum bobs*

▶ 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). Afterwards, 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

4941.51

Studying the Foucault Currents

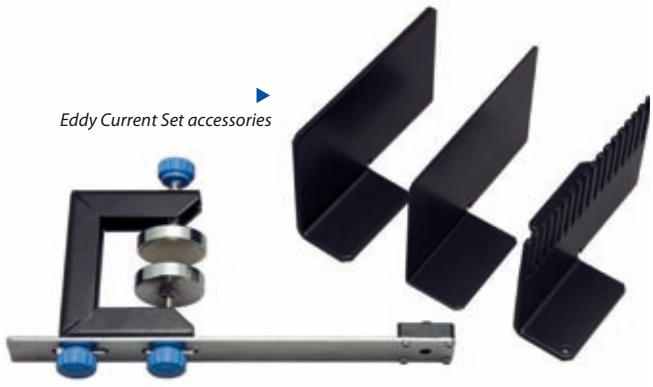
Eddy current (also known as Foucault current) is a phenomenon caused by a moving magnetic field intersecting a conductor or vice-versa.
The relative motion causes a circulating flow of electrons, or currents, within the conductor. With this kit, students can easily study "electromagnetic brakes" (also 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.

Equipment Needed
Track Set (code 4954.12)
Mechanics Upgrade 1 (code 4941.14)
or Altay Cart with Plunger (code 4941.13)

Equipment Suggested
RED Motion Sensor (code 4840.12)
RED Photogate Sensor (code 4840.15)

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.

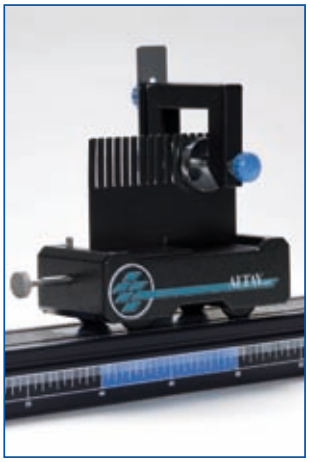
◀ *Eddy Current configuration experiment*

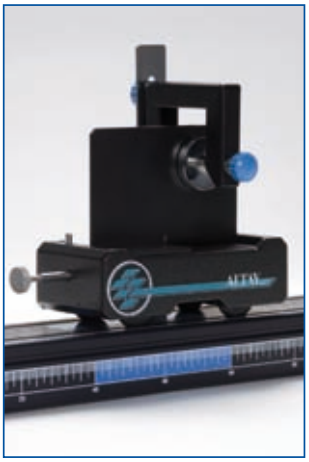


▶ *Eddy Current Set accessories*

MAIN COMPONENTS

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





▲ *Observe the different behaviour of the slitted and the solid flag*

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)

Equipment Suggested
RED Light Sensor (code 4840.18)

◀ *Focus of a convergent lens using a RED Light Sensor*

▲ *The Optical Bench using Altay Track*

The Optics Upgrade 1 allows students to configure the Altay Track as an optical bench.
You will have all you need to study geometric optics, photometry, focal length of lenses, mirrors and much more.

Focal length experiment detail ▼

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

▶ *Projector and optical bench accessories*

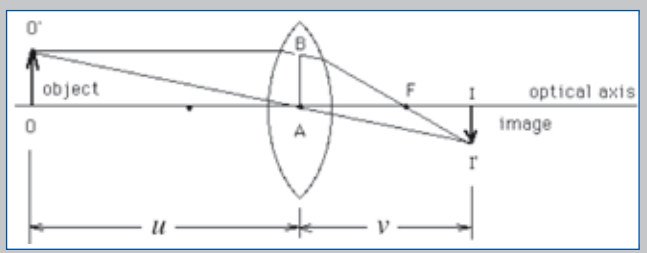
▶ EXAMPLE OF USE

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

The lens 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*

Optics Upgrade 2

4944.20

The advanced upgrade on geometric optics

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.

Equipment Needed
Altay Track Set (code 4954.12)
Transformer 12 V (code 2403.64)

Equipment Suggested
RED Light Sensor (code 4840.18)

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

Optics Upgrade 2 components on the optical bench

A biconvex lens placed on the Hartl disk

Light from projector

LAWS AND PRINCIPLES INVESTIGATED

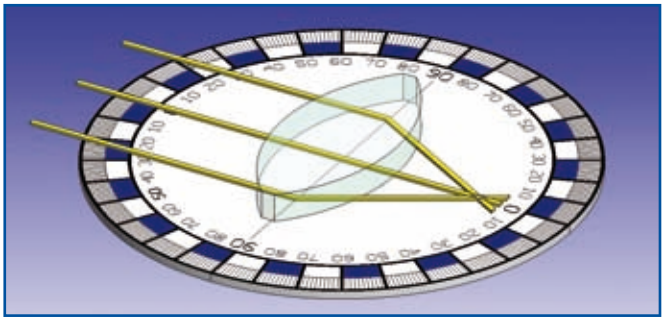
- Principles of biconcave, biconvex lenses and mirrors
- Mixing of colours
- Fermat's principle
- Determination of the focal length of a lens
- Hartl apparatus
- Inverse square law of light
- Light reflection and refraction

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.

▲ *Lenses set with flexible mirror and Hartl disk*



▲ *Path of light through a biconvex lens on the Hartl disk*

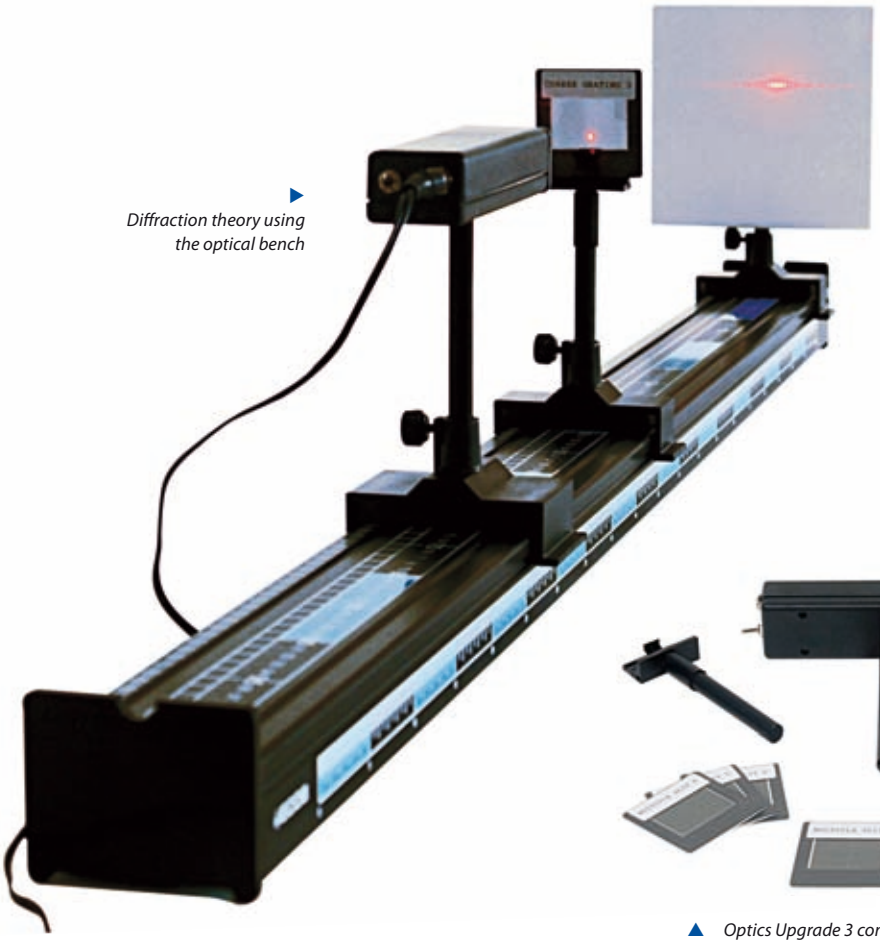
Optics Upgrade 3

4944.30

Diffraction using a laser

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

Equipment Suggested
White Metal Screen
RED Light Sensor (code 4840.18)



▶ *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 diodе 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 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*

Altay Cart

4941.12 - 4941.13

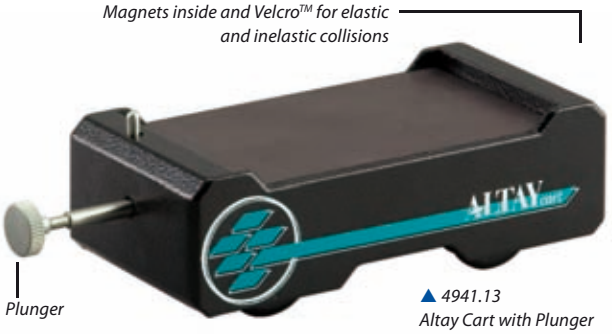
Elastic and inelastic collisions with our new cart

Specifications
Size: 14x7x4 cm
Weight: 0.5 kg
Cart without plunger (code 4941.12)
Cart with plunger (code 4941.13)

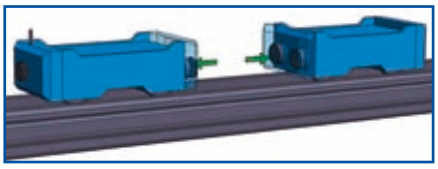
▲ *4941.12*
Altay Cart without Plunger

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.



▲ *4941.13*
Altay Cart with Plunger



▶ *Elastic collision, magnets-magnets sides*

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.

EM Trigger & Launcher for Cart

4941.17

An automatic trigger/launcher for dynamics experiments

Specifications
Specially designed to fit on Altay Track Set (code 4954.12)
Size: 12x7x9 cm - Weight: 0.5 kg

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

▲ *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).

Ball Launcher for Cart

4941.60

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

Ball Launcher ready on a track

Equipment Needed
Size: 16x11x15 cm - Weight: 1.3 kg
Altay Track Set (code 4954.12)
Mechanics Upgrade 1 (code 4941.14)
or Altay Cart with Plunger (code 4941.13)

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

MAIN COMPONENTS

- Ball launcher
- Balls
- Trigger flag

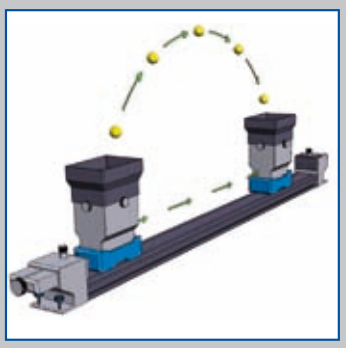
LAWS AND PRINCIPLES INVESTIGATED

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

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 at 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 subject 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

Fan for Cart

4941.65

Perform many experiments on pressure and thrust

Fan for cart in action

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)

LAWS AND PRINCIPLES INVESTIGATED

- Pressure
- Thrust

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

Timing Set

4922.10

Photogate head with magnetic support

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

Altay Timing Set can also be used as a chronometer.

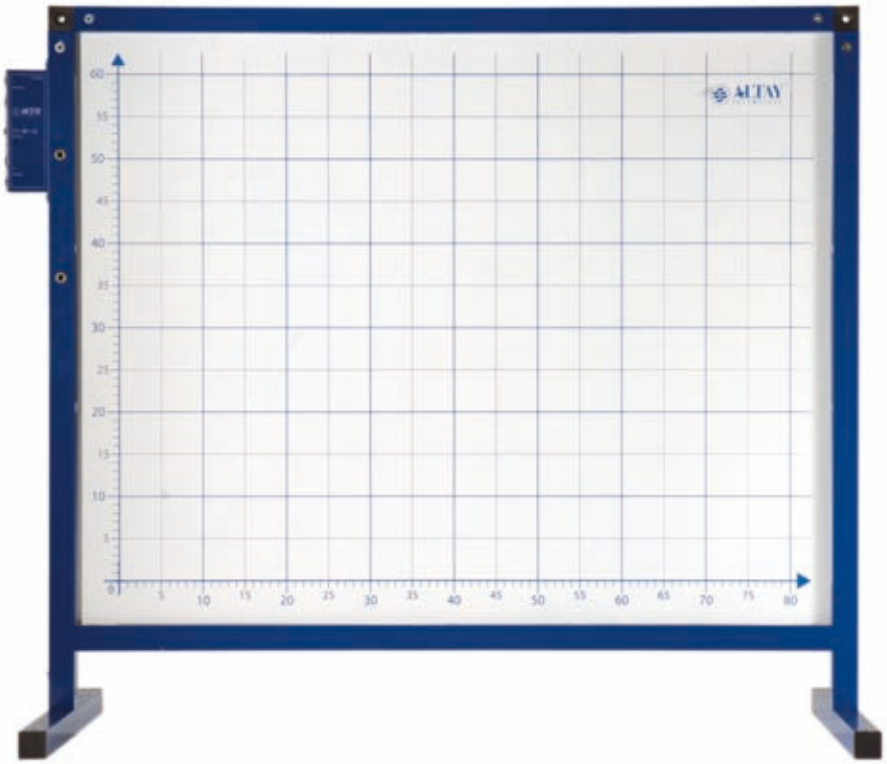
MAIN COMPONENTS

- Electronic Timer
- Photogates

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
Transformer 12 V (code 2403.64)

Equipment Suggested
RED Force Sensor (code 4840.14)

Embedded Power Supply
output 3.3 V – 5 V – 12 V DC, 1A

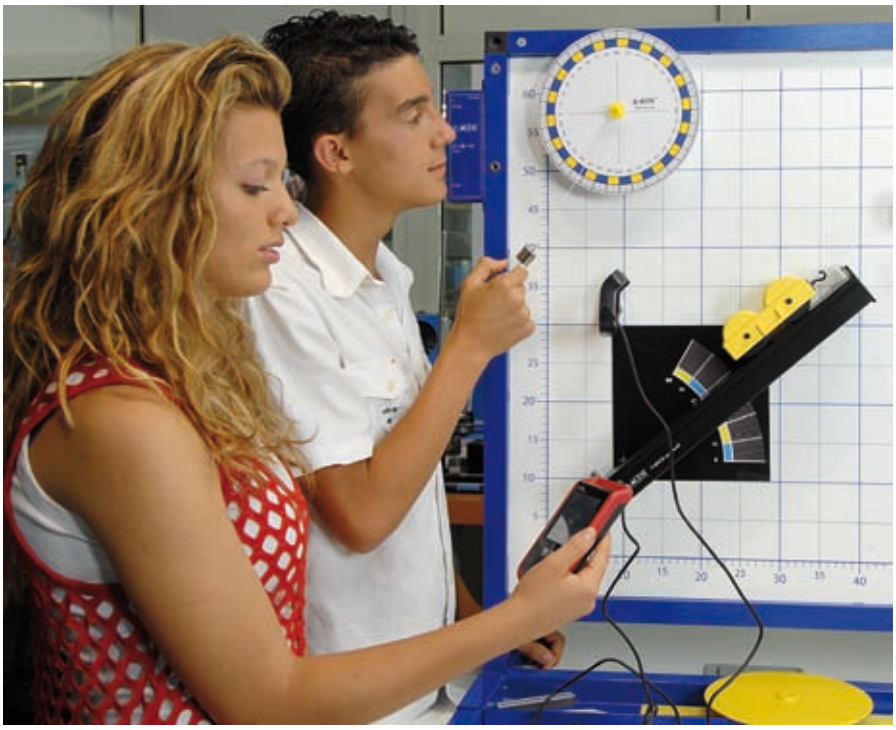
Compatible Equipment
Mechanics Accessories Set (code 4114.35)
Falling Bodies Upgrade (code 4114.36)
Optics Accessories Set (code 4114.37)
Electricity System 1 (code 4866.19)
Electronics System 1 (code 4868.19)
Radioactivity Bench (code 4832.00)

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.

▼ *Magnetic Board power supply*

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.

▼ *Pendulum's laws investigation with a RED Photogate*



Mechanics Accessories Set

4114.35

Discover static forces with the Magnetic Board

Equipment Needed
Altay 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*

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

▼ *Block and Tackle experimental study*

Magnetic board

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

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

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.

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.

◄ *Various pulleys, pins and closing caps*

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

▼ *Influence of the starting angle on the pendulum's period*

Falling Bodies Upgrade

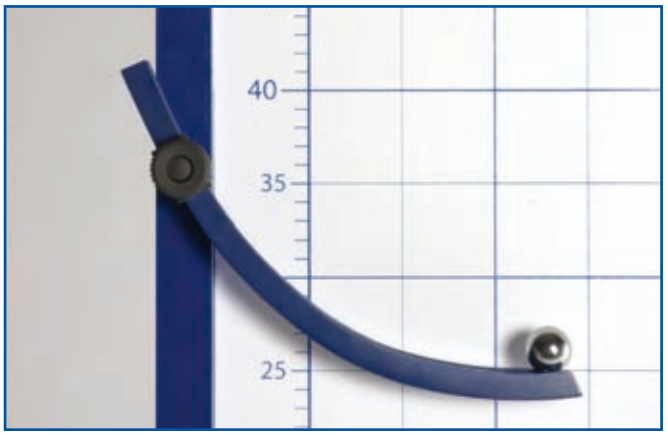
4114.36

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

Equipment Needed
Altay Magnetic Board (code 4114.30)

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*



MAIN COMPONENTS

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

LAWS AND PRINCIPLES INVESTIGATED

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

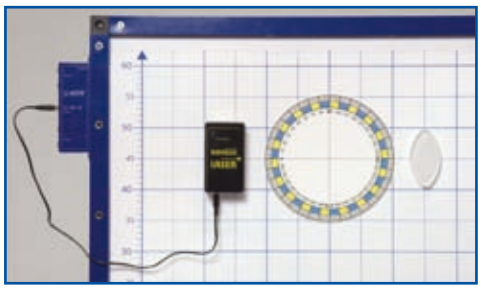
Optics Accessories Set

4114.37

Show to the whole class interesting optics experiment

Equipment Needed
Altay Magnetic Board (code 4114.30)

◀ *Optics Accessories Set*



▲ *Example of set up*

MAIN COMPONENTS

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

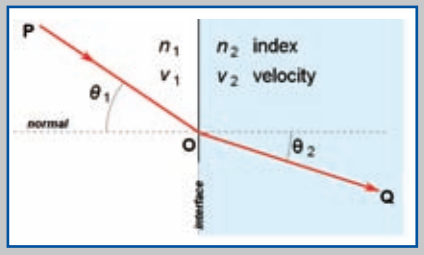
Snell's Law

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.

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_2}{n_1}$$

◀ *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.



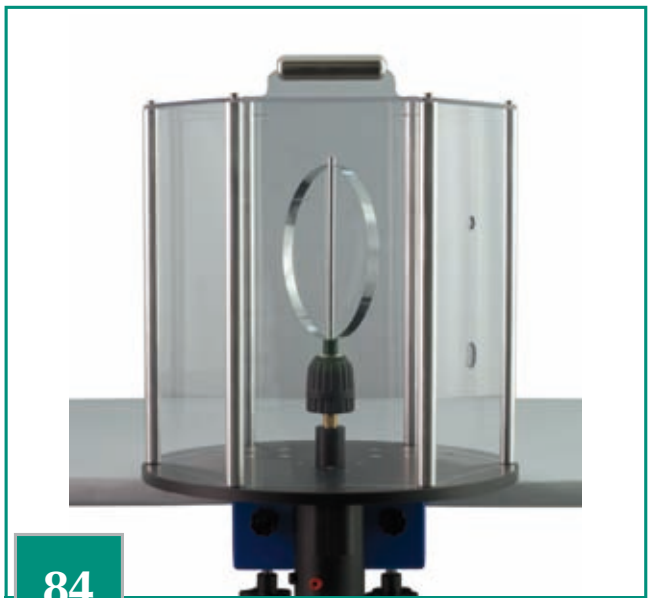
▲ *Refraction of light*

SINGLE ITEMS

Our belief in hands-on science has been the inspiration behind the development of Altay's Single Items. In addition, our single items focus on selective experiments to demonstrate scientific principles in depth while capable of working with a complete range of data loggers and sensors assuring consistent accuracy. Carefully designed and crafted with significant input from teachers, our single items guarantee high quality at competitive prices.

73 INCLINED PLANE

81 PROJECTILE LAUNCHER



84 CENTRIFUGAL FORCE APPARATUS

Force Table

4114.11

Discover the addition of forces in an easy way

The Altay Force Table is ideal for teaching composition and addition of vectors and provides an ideal platform for determination and addition of forces.

Also known as a Varignon Table, our quality Force Table comes complete with a set of weights and self clamping low friction pulleys to allow accurate measurement of resultant vectors sums and associated angle measurements.
Altay Force Table is easy to set up by simply attaching weights (forces) to the mass holder and attach to central ring, which then hangs over the edge of the table through the pulleys. By varying the magnitude the forces and moving the pulleys to adjust the angles, you can easily measure the resolving angles using the printed protractor on top of table A bubble level bob is also supplied for increased accuracy.

Specifications
Dia. 33x37 cm
Weight: 5.5 kg

Equipment Suggested
RED Force Sensor (code 4840.14)
RED Force Sensor Adaptor for Force Table (code 4831.03)

MAIN COMPONENTS

- Force Table
- Low Friction Pulleys
- Slotted Masses
- Polyester String
- Ring Set

LAWS AND PRINCIPLES INVESTIGATED

- Balancing force
- Concept of force
- Direction of a force
- Equilibrium of a material point
- Intensity of different forces
- Measure the intensity of a force
- Rule of the parallelogram

▲ *Composition and resolution of forces*

▶ EXAMPLE OF USE

The Rule of the Parallelogram

Consider two vectors **a** and **b**, with $\mathbf{e}_1$, $\mathbf{e}_2$ and $\mathbf{e}_3$ orthogonal unit vectors:

$$\boldsymbol{a} = a_1\boldsymbol{e}_1 + a_2\boldsymbol{e}_2 + a_3\boldsymbol{e}_3$$

$$\boldsymbol{b} = b_1\boldsymbol{e}_1 + b_2\boldsymbol{e}_2 + b_3\boldsymbol{e}_3$$

The sum of **a** and **b** is:

$$\boldsymbol{a} + \boldsymbol{b} = (a_1 + b_1)\boldsymbol{e}_1 + (a_2 + b_2)\boldsymbol{e}_2 + (a_3 + b_3)\boldsymbol{e}_3$$

This result can be graphically represented using arrows, placing the end of the **b** arrow on the tip of the **a** arrow. Drawing another arrow from the end of the **a** to the tip of the **b**, we obtain the sum **a+b** of the two vectors.

This is usually called "rule of the parallelogram" for the shape of the graph. With the Force Table we can vary the angle between different forces, to observe how the resultant changes.

Dual-Range Force Sensor Adapter

4114.11-003

Use the Force Table with your Vernier Dual-Range Force Sensor

The Dual-Range Force Sensor Adapter allows the use of the Vernier Dual-Range Force Sensor (code 2311.10) with the Force Table (code 4114.11); with it, it's easy to acquire data and to have more accurate results for the experiments.

Specifications
Size: approx. 4x1x10 cm
Weight: 0.2 kg

Equipment Needed:
Force Table (code 4114.11)
Vernier Dual-Range Force Sensor (code 2311.10)

Hooke's Law Apparatus

4163.10

The Hooke's Law experiment set allows students to investigate the relationship 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.

MAIN COMPONENTS

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

LAWS AND PRINCIPLES INVESTIGATED

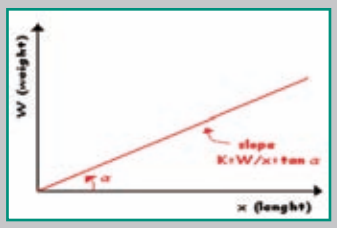
- Hooke's Law
- Determination of the elastic constant of a spring
- Hydrostatic balance

▲ *Measuring the elastic force with RED Force Sensor*

▶ 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*

Inclined Plane

4115.10

The most famous simple machine, revisited by Altay

▼ *Students using the Inclined Plane*

Tangential component of the weight force with the inclined plane and a Force Sensor ▶

Specifications
Height (fully open): approx. 40 cm
Weight: 2.9 kg
Max angle: 45°

Equipment Suggested
RED Force Sensor (code 4840.14)
RED Force Sensor Adapter for Inclined Plane (code 4831.05)

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.

MAIN COMPONENTS

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

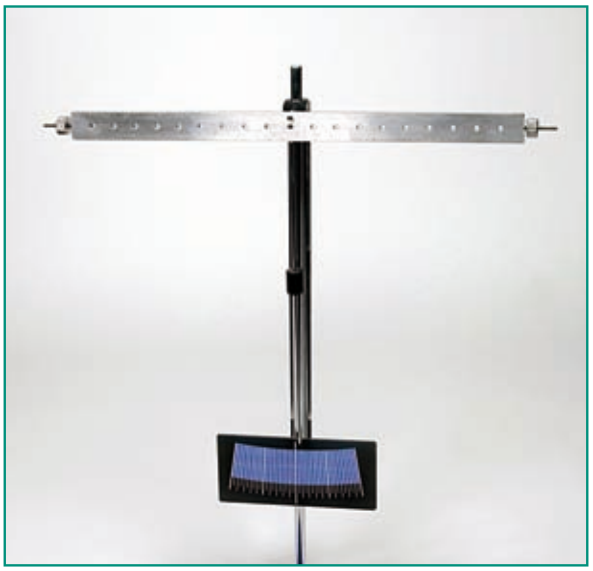
LAWS AND PRINCIPLES INVESTIGATED

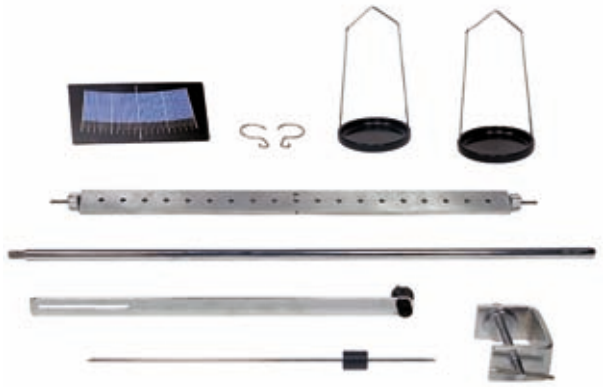
- Balance of a heavy body on an inclined plane
- Weight: force
- Static and dynamic friction

Demonstration Balance Model

4114.18

Designed to demonstrate levers, static forces and the analytic balance





Specifications
Size: 20x60x50 cm
Weight: 1.7 kg
Arm length: 10.0 cm
With bench clamp for table mount

We developed this as more than just a balance.
It is easy to mount thanks to the bench clamp.
With the graduated scale you can demonstrate the effects of different static forces and equilibrium.
Predict what the result might be and see if you are correct!

LAWS AND PRINCIPLES INVESTIGATED

- Calibration of a balance
- Analytical Balance usage
- Moment of a force
- Mass determination by comparison
- Levers

▶ EXAMPLE OF USE

Static equilibrium • How to balance different weights at different arms lengths

Easy to use and set up, the balance introduces the principles of static friction. Set up the system including scale pans and hooks, then tare (or "zero") the apparatus with masses.
When the needle matches the zero-offset rod, you are ready to start.
Place some weights on one pan and let students guess or calculate how many weights should be placed on the other pan in order to take back the balance to equilibrium.

◀ *Altay's Demonstration Balance Model in static equilibrium*

◀ *Balance adjustment*

Different Bodies with Equal Mass

4230.97

A set of cylinders to perform various experiments

Specifications
Dia. 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.

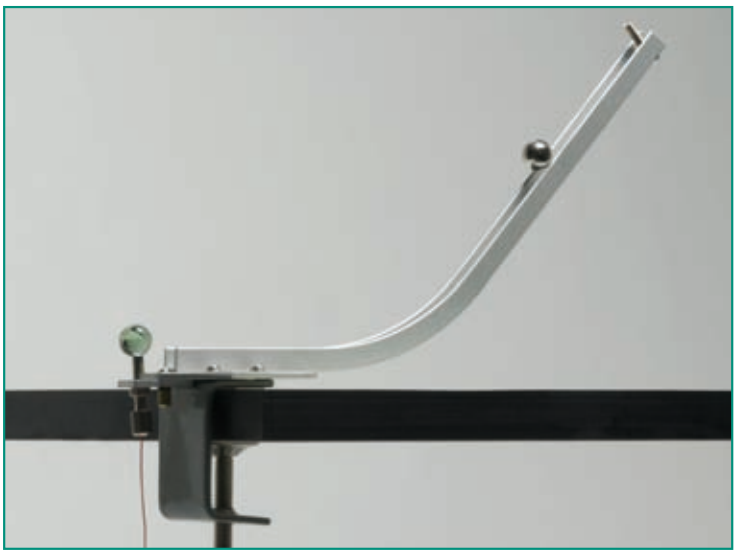
LAWS AND PRINCIPLES INVESTIGATED

- Density
- Specific heat

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.

MAIN COMPONENTS

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

LAWS AND PRINCIPLES INVESTIGATED

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

Elastic and Inelastic Collision in 2D apparatus components

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

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

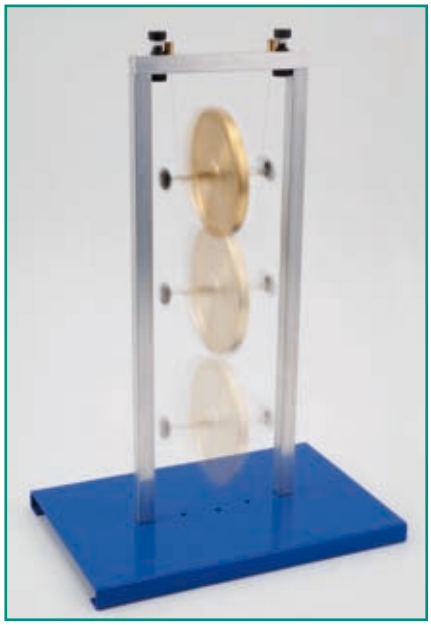
Maxwell Wheel

4150.00

Perform the most famous experiment on mechanical energy conservation

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

▲ *Maxwell Wheel at its deepest point*



▲ *Maxwell Wheel accelerating downwards*

LAWS AND PRINCIPLES INVESTIGATED

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

Specifications
Size: approx. Dia. 30x20x40 cm
Weight: 2.5 Kg

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 kinetic energy and vice-versa, without considering friction of the air and of the wires.

▶ 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 compensate 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.

The acceleration of the center of mass is:

$$a = \frac{g}{1 + \frac{I}{mr^2}}$$

Where I is the moment of inertia.

Fall in a fluid

4180.10

Simple apparatus to study the spherical objects fall in different kind of fluids

◀ *Dynamic viscosity determination*

In many apparatuses Stokes' law is used and presented only from a theoretical point of view. Now the possibility to experimentally investigate this law, its corrections, terminal velocities or the falling spheres viscometer concept becomes even simpler.

Specifications
Tube internal Dia. 5 cm, internal height 50 cm
Steel sphere: Dia. 25 mm, 67 g
Aluminium sphere: Dia. 25 mm, 26 g
Wooden sphere: Dia. 25 mm, 10.5 g

MAIN COMPONENTS

- Apparatus with tube
- Set of different spheres

LAWS AND PRINCIPLES INVESTIGATED

- Terminal velocity
- Density
- Dynamic viscosity
- Stokes law

Linear Air Track System

4132.10

A frictionless system to explore kinematics

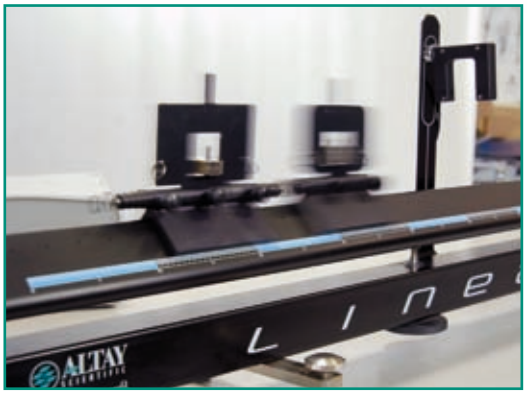
The most fundamental law of physics states that a moving object will continue forever at a constant velocity unless it is acted on by an external force.

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 dvata derived will always be accurate.

Specifications
Size: 205x18x36 cm
Weight: 16 kg

Equipment Needed:
Air Blower (code 4132.70)
Timing Set (code 4922.10)

Equipment Suggested:
RED Force Sensor (code 4840.14)
RED Photogate Sensor (code 4840.15)
Force Sensor adapter for Air Track (code 4132.90)



▲ *Used with the force sensor adapter (code 4132.90)*

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

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

▶ 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.

Force sensor adapter for Air Track

4132.90

Enhance the experiments with the Air Track using a RED Force Sensor

▼ *T-shaped force sensor adapter*

◄ *Force sensor adapter usage with the RED Force Sensor*

Specifications
Size: 4x1x5 cm
Weight: 0.1 kg

Equipment Needed:
Linear Air track (code 4132.10)
RED Force Sensor (code 4840.14)

The Force Sensor Adapter allows the use of the RED Force Sensor (code 4840.14) on the Air Track Sliders (contained in code 4132.10); with it, it's possible to acquire data on frictionless dynamics experiments.

Air Blower

4132.70

An efficient and adjustable air blower

This completely new, captivating and compact design offers very good performances, the outflow is continuously adjustable with an increased flexibility .

Also available for 110V mains (4132.70-110)

Specifications
Size: approx. 20x27x15 cm
Weight: 2.3 Kg
Supply: 230V – 50 Hz
Airflow max: 20 l/sec
External outer diameter: 3.5 cm

Compatible with:
Linear air track (code 4132.10)
Moment of inertia apparatus (code 4138.50)

The new version of Altay Air Blower is designed to provide the necessary air supply to perform experiments on dynamics.

MAIN COMPONENTS

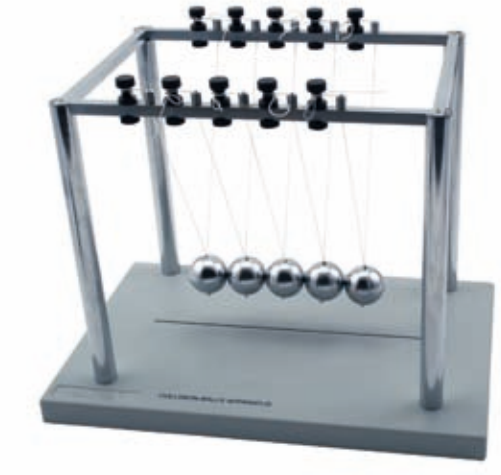
- Air blower
- Pipe 1.5 m length

▶ *Air Blower with the Moment of Inertia Apparatus*

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 17th century physicist, Abbè 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 in vacuum

▲ *Newton's Tube before air evacuation*

Specifications
Size: Dia. 5x105 cm
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.

LAWS AND PRINCIPLES INVESTIGATED

- Free fall motion in vacuum

▶ 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:

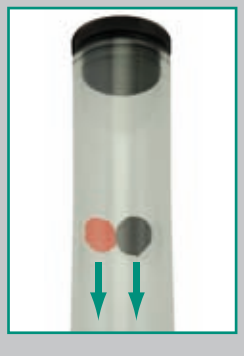
▶ *Gravity force and Newton's 2nd Law of Motion*

$$\begin{cases} F_g = mg \\ F = ma \end{cases}$$

which will make: $a = g$

◀ *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

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.

Specifications
Vertical column height: 170 cm
Scaled surface length: 150 cm
Weight: 8.4 kg

Equipment Suggested
RED Photogate Sensor (code 4840.15)

▲ *Pendulum accessories*

▲ *Free Fall Apparatus components*

◀ *Apparatus in the pendulum configuration*

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 Electronic Digital Timer is an ideal tool to study 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.

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

◀ *The Law of the Pendulum*

Remote Control Upgrade

4134.75

Enhance the experiences with the Free Fall and Pendulum Apparatus

◀ *Remote control accessories*

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.

Specifications:
Weight: 0.6 kg

Equipment Needed:
Free Fall and Pendulum Apparatus (code 4134.70)

MAIN COMPONENTS

- Receiving electromagnet cap
- Stereo cable
- Remote control

Projectile Launcher

4135.10

The ideal tool to study projectile motion

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 mechanisms 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 minimized 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 allow 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.

Specifications
Screen size: 30x20x10 cm
Weight: 2.3kg

Equipment Needed
RED Photogate Sensor (code 4840.15) or
Timing Set (code 4922.10)

▲ *Point of impact and initial velocity study*

▲ *Projectile Launcher with photogates*

▲ *Projectile Launcher components*

MAIN COMPONENTS

- Projectile Launcher
- Stainless Steel Sphere
- Landing Base

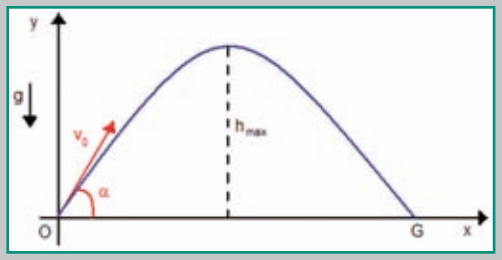
LAWS AND PRINCIPLES INVESTIGATED

- Projectile motion
- Decomposition of motions
- Acceleration of gravity

▶ 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:



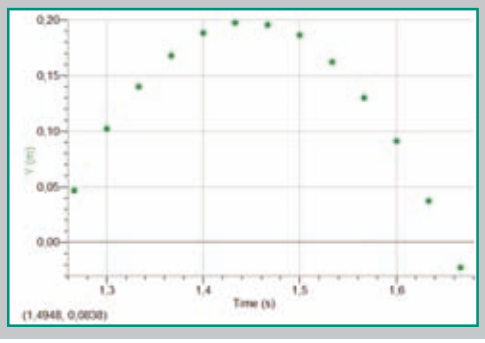
◀ *Projectile motion showing constant acceleration*

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 projectile motion*

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

Equipment Suggested
RED Photogate Sensor (code 4840.15)

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
- Amplitude's dependence

Multiple Pendulum Apparatus

4137.40

Understanding the Laws of the Pendulum

▲ *The Multiple Pendulum Apparatus*

◀ *Multiple Pendulum Apparatus components*

Specifications
Size: 104x30x35 cm
Weight: 2 kg

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.

LAWS AND PRINCIPLES INVESTIGATED

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

MAIN COMPONENTS

- Multiple Pendulum Apparatus
- Set of four Brass Spheres
- Set of four PVC Spheres
- Set of four Wood Spheres
- Amplitude's dependence

▶ 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:

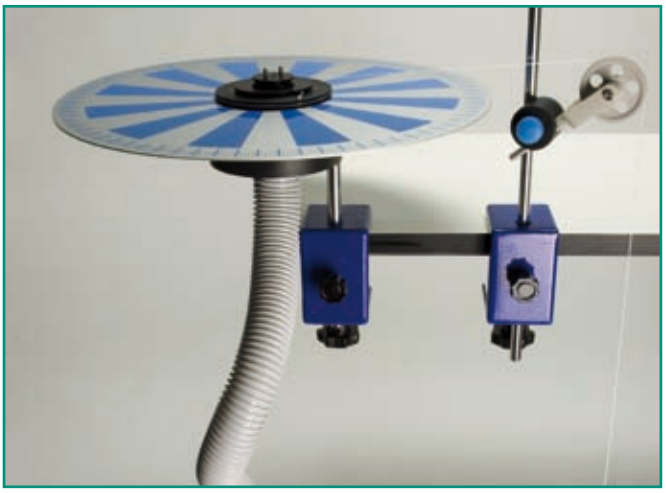
$$T = 2\pi\sqrt{\frac{l}{g}}$$

◀ *Simple Pendulum formula*

Moment of Inertia Apparatus

4138.50

An experimental approach to the moment of inertia



Specifications
Disks Dia. 60.0 cm and 20.0 cm
Rod lenght 50.0 cm
Weight: 6.4 kg

Equipment Needed
Digital Chronometer (code 2231.52)

Equipment Suggested
RED Motion Sensor (code 4840.12)

Moment of inertia of a disk experiment with a RED Motion Sensor

MAIN COMPONENTS

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

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

Disks for moment of inertia experiments

LAWS AND PRINCIPLES INVESTIGATED

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

Hardware components

Air blower

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.

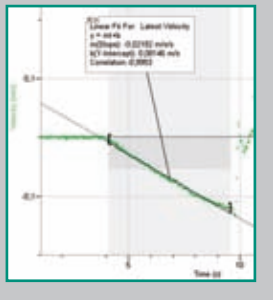
Sample assembly for the Moment of Inertia Apparatus

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

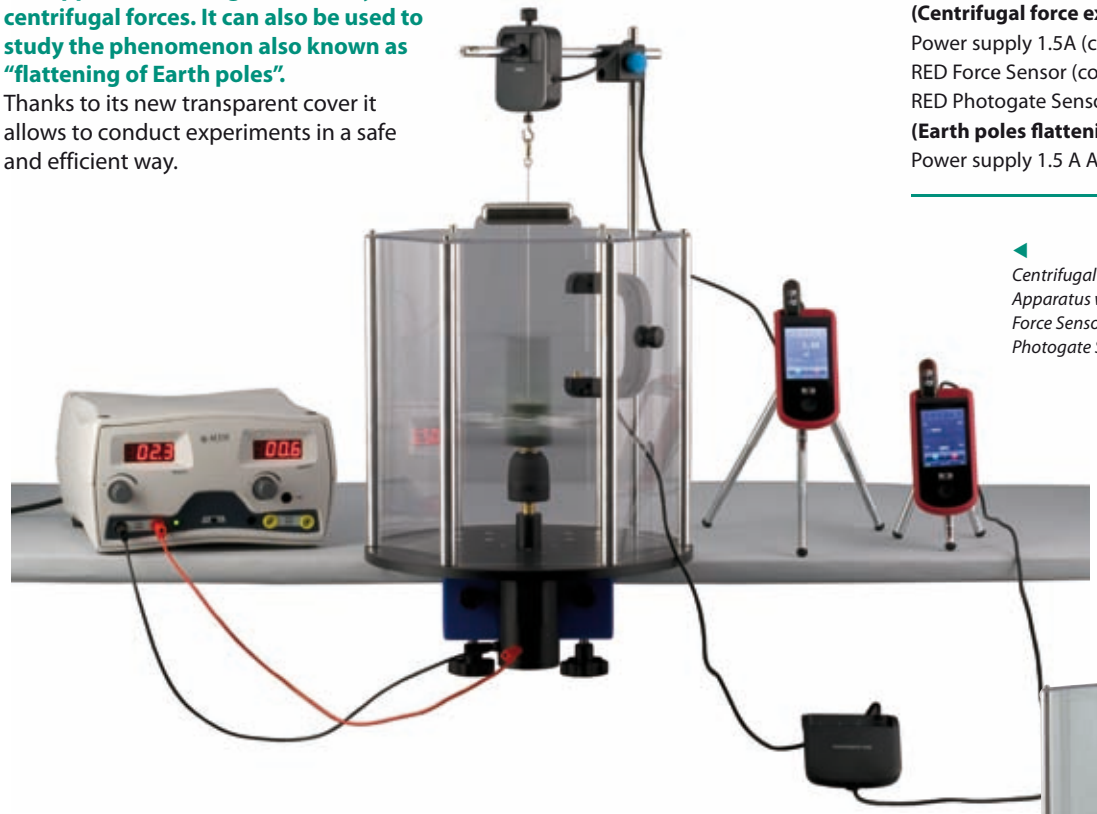
4142.80

An experimental tool to investigate the centrifugal forces and observe the phenomenon known as flattening of earth's poles

The apparatus is designed to study centrifugal forces. It can also be used to study the phenomenon also known as "flattening of Earth poles".
Thanks to its new transparent cover it allows to conduct experiments in a safe and efficient way.

Specifications
Size: Dia. approx. 32x65 cm

Equipment Needed
(Centrifugal force experiment)
Power supply 1.5A (code 2407.70)
RED Force Sensor (code 4840.14)
RED Photogate Sensor (code 4840.15)
(Earth poles flattening experiment)
Power supply 1.5 A AC/DC (code 2407.70)



Centrifugal Force Apparatus with RED Force Sensor and RED Photogate Sensor

Earth poles flattening demonstrator

MAIN COMPONENTS

- Centrifugal Force Apparatus
- Rolling wire suspension
- Centrifugal force rotator
- Earth poles flattening demonstrator
- Accessories

LAWS AND PRINCIPLES INVESTIGATED

- Centrifugal and centripedal forces
- Earth's poles flattening

EXAMPLE OF USE

Earth's poles flattening demonstrator

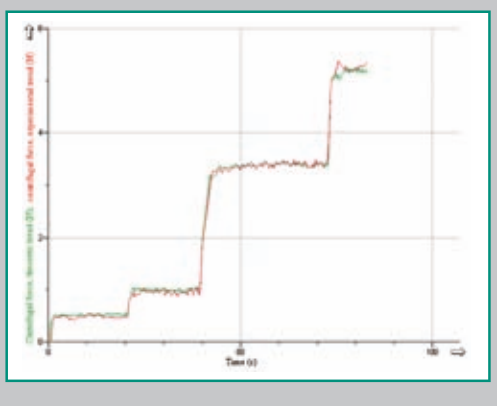
By using the Earth's poles flattening demonstrator mounted on the electric motor, it is possible to observe the effect of the centrifugal force on the shape of Earth. We can readily see that the squeezing of the poles is a balance of the centrifugal force, due to the rotation of the Earth, and a centripetal 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-leeing") 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.
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

Torsion Balance

4170.00

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

Specifications
Size: 37x35x100 cm
Weight: 5 kg approx.

Equipment Needed
Digital Chronometer (code 2231.52)

Equipment Suggested
RED Photogate Sensor (code 4840.15)

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.

Torsion Balance in a horizontal set up with balance pan

Protractor

Torsion Balance in a vertical set up with RED Photogate Sensor

▲ Balance arm with cylindrical weights housed in the wire clamp's plughole; metal wires of different diameters

▶ 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.

MAIN COMPONENTS

- Torsion balance
- Pan for weights
- Reference index
- Mass
- Balance Arm with nylon string and weights
- Metal wire Dia. 0.4mm
- Metal wire Dia. 0.6mm
- Metal wire Dia. 0.8 mm

LAWS AND PRINCIPLES INVESTIGATED

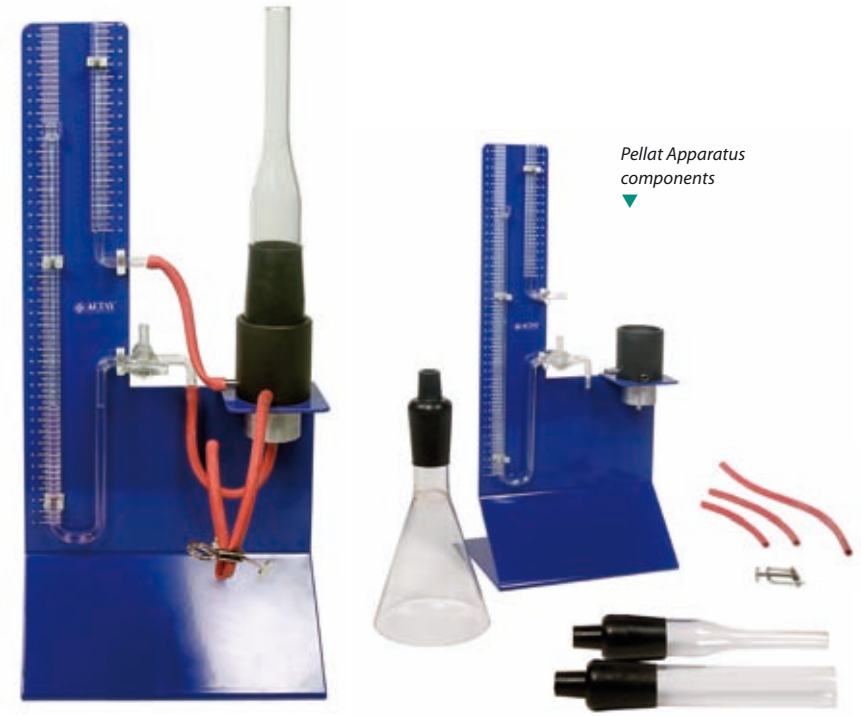
- Moment of inertia
- Torsional modulus
- Oscillation's period
- Moment of a force

Pellat Apparatus

4180.20

A simple experiment to study hydrostatic pressure

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.



Pellat Apparatus components

Specifications
Size: 24x28x55 cm
Weight: 3.0 kg

Equipment Suggested
RED Gas Pressure Sensor (code 4840.17)

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

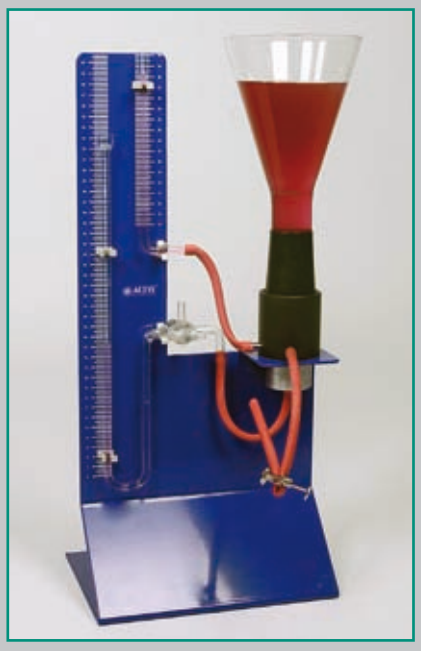
- Membranes
- Glassworks
- U-Tube Manometer

LAWS AND PRINCIPLES INVESTIGATED

- Hydrostatic pressure
- Communicating vessels principle

EXAMPLE OF USE

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



▲ *Conical shape vessel mounted on Pellat Apparatus*

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.

◀ *Balanced pressure in an empty vessel*

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

Spouting Jar

4180.44

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.

LAWS AND PRINCIPLES INVESTIGATED

- Stevino's Law

Specifications
Size: 25x28x52 cm
Weight: 1.2 kg

EXAMPLE OF USE

Mechanics of fluids • Verifying the Stevino's Law

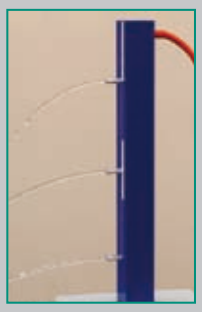
The most immediate application of this apparatus is the quantitative verification of the Stevino's Law. This law relates liquid pressure to the atmospheric pressure (P_{atm}), the density (ρ) of the fluid, the gravity acceleration (**g**) and the height (**h**) of the water column:

$$P = P_{atm} + \rho g h$$

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

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

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.



▲ *Snapshot of the Spouting Jar at work*

Communicating Vessels

4180.60

An interesting experiments with connecting vessels

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.

◀ *Communicating Vessels with coloured water*

LAWS AND PRINCIPLES INVESTIGATED

- Communicating vessels principle

Specifications
Size: 20x18x20 cm
Weight: 0.2 kg
Mounted on base

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.

Capillary Tubes

4182.20

Exploring capillarity of various fluids

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.

◀ *The Capillary Tubes apparatus with coloured water*

LAWS AND PRINCIPLES INVESTIGATED

- Capillarity
- Jurin's Law

Specifications
Size: 20x18x20 cm
Weight: 0.2kg
Mounted on base

Vacuum Bell with Plate

4315.60

The classic vacuum bell for acoustic and mechanics of fluid Experiments

Specifications
Size: Dia. 22x30 cm
Weight: 3.4 kg

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

MAIN COMPONENTS

- Glass Bell
- Plate
- Rubber cup
- Buzzer

◀ *Vacuum Bell with Buoyancy Balance inside working with a 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.

▲ *Detail of the Buoyancy Balance*

Specifications
Size: 17x17x13 cm
Weight: 0.3 kg

Equipment Needed
Vacuum Pump (code 4184.21)
Vacuum Bell with Plate (code 4315.60)
Silicon Grease (code 5424.52)

LAWS AND PRINCIPLES INVESTIGATED

- Buoyancy of air
- Air Pressure and level of vacuum

Aluminium Cuboid for Buoyancy

4184.95

Ideal for demonstrating the principles of buoyancy

LAWS AND PRINCIPLES INVESTIGATED

- Hydrostatic pressure
- Buoyancy
- Weight: force

Specifications
Size: 15x3x8 cm
Weight: 0.2 kg

Equipment Needed
Buoyancy Balance (code 4184.93)
or Tubular Spring Balance (code 4110.03)

Aluminium parallelogram ideal for the study of the buoyancy.

Boyle's Law Apparatus

4187.19

Get started with mechanics of fluids

Specifications
Size: 20x14x125 cm
Weight: 4 kg

Equipment Needed
Mercury

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.

MAIN COMPONENTS

- Graduated Burette
- Reservoir tube

LAWS AND PRINCIPLES INVESTIGATED

- Boyle's Law
- Atmospheric pressure

▶ EXAMPLE OF USE

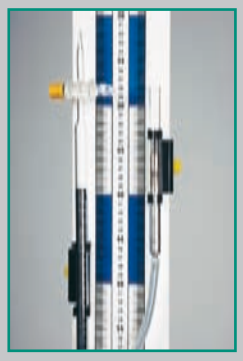
Boyle-Mariotte Law • An experimental approach to this physical phenomena

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.

Magdeburg Hemispheres

4184.48

The clearest and funniest experiment to explain the concept of pressure

Specifications
Size: Dia. approx 13 cm
Weight: 0.4 kg

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

LAWS AND PRINCIPLES INVESTIGATED

- Concept of pressure
- Air pressure

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 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).

Ripple Tank

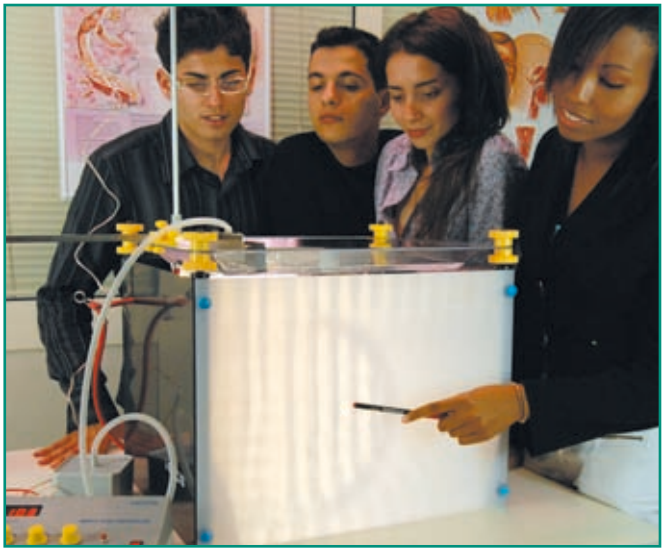
4311.80

A very effective tool that helps students understand wave mechanics

Specifications
Size: 52x44x40 cm
Weight: 13.5 kg

Plane waves

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

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.

Specifications
Size: approx. 70x45x7 cm
Weight: 7 kg

Equipment Suggested:
Food colouring (code 4207.60)

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.

LAWS AND PRINCIPLES INVESTIGATED

- Seismic waves reflection and refraction

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.

Melde's Apparatus

4315.35

A simple experiment to study standing waves on a string

◀ *Melde's Apparatus main part*

Specifications
Size: 25x18x7cm
Weight: 1.4 kg

Equipment Needed
Multitap Transformer (code 2403.70)

Equipment Suggested
Stroboscope

LAWS AND PRINCIPLES INVESTIGATED

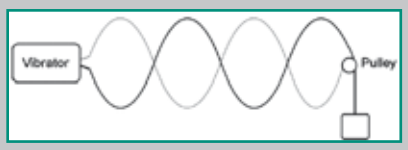
- Standing waves on a string

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 ▲

▲ *Melde's Apparatus components*

Three-Wire Sonometer

4316.05

Investigating the vibrating string

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

Specifications
Size: 67x10x10 cm
Weight: 1.9 kg

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

LAWS AND PRINCIPLES INVESTIGATED

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

▶ 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*

Pair of 440 Hz Tuning Forks

4317.40

A pair of mounted tuning forks for interference and resonance experiments

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 • A_4 note 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 (aka A_4 or LA_4 or a^1) 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.

▲ *Sound beats experiment set up with RED Microphone*

Specifications
Size: 14x7x20 cm
Weight: 1 Kg

Equipment Suggested
RED Microphone (code 4840.19)

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

Set of Tuning Forks

4317.90

Set of Tuning Forks for a wide range of experiments

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.

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

◀ *RED MIcrophone and Tuning Forks*

Specifications
Size: 25x21x7 cm
Weight: 0.9 kg
Packing: ABS carry case with foam inserts

Equipment Suggested
RED Microphone (code 4840.19)

MAIN COMPONENTS

- Tuning fork, 256 Hz
- Tuning fork, 288 Hz
- Tuning fork, 320 Hz
- Tuning fork 341.3 Hz
- Tuning fork, 384 Hz
- Tuning fork, 426.6 Hz
- Tuning fork, 480 Hz
- Tuning fork, 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

Resonance Apparatus

4331.27

Demonstrating standing waves

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.

Specifications
Size: 30x20x104 cm
Weight: 5 kg
Mounted on base

Equipment Needed
Set of Tuning forks (code 4317.90)

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*

Gravesande Ball and Ring

4200.10

Simple and effective piece of equipment for qualitative experiments

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

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

Specifications
Length of the bar 13 cm
Length of the chain 10 cm
Weight: 0.6 kg

Equipment Needed
Bunsen Burner with accessories (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

Steel bar on rod with wooden handle. U-shaped gauge, sliding fit over ends of bar, with holes 1.2 cm bore.

For demonstration of solids expansion.

Specifications
Steel bar: length 11 cm, Dia. 1.2 cm
Rod with wooden handle: length 20 cm
Weight: 0.2 kg

Equipment Needed
Bunsen Burner with accessories (code 5511.00)

LAWS AND PRINCIPLES INVESTIGATED

- Solid expansion

Thermal Expansion Bar

4200.18

Simple and effective piece of equipment to show thermal expansion

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: size approx. 12x12 cm
Weight: 0.5 kg

Equipment Needed
Bunsen Burner with accessories (code 5511.00)

LAWS AND PRINCIPLES INVESTIGATED

- Thermal expansion

Thermal Conductivity Apparatus

4210.73

Simple apparatus to show thermal expansions in introductory physics courses

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

Specifications
Total length: approx. 35 cm
Weight: 0.1 kg

Equipment Needed
Bunsen Burner with accessories (code 5511.00)

LAWS AND PRINCIPLES INVESTIGATED

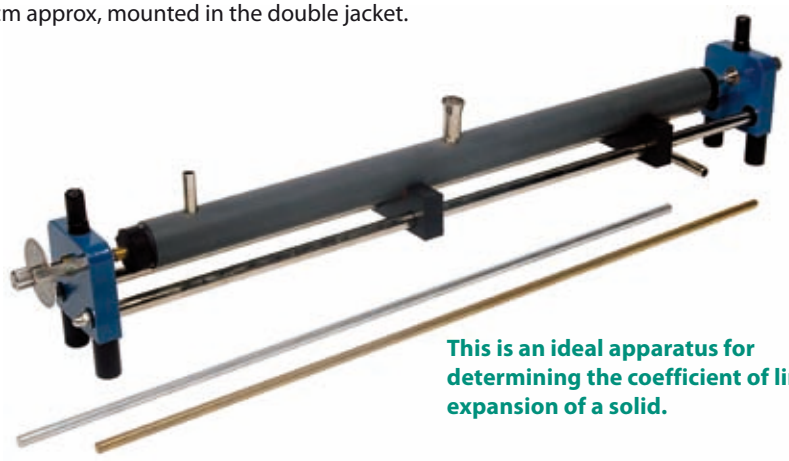
- Conductivity of different materials

Gunther Expansion Apparatus

4200.22

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

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.



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

Specifications
Size: 62x8x12 cm
Weight: approx. 2 kg

Equipment Needed
Filtering Flask
Bunsen Burner with accessories (code 5511.00)
Digital Multimeter (code 2275.10)
Altay Steam Generator (code 4200.45)

Equipment Suggested
RED Temperature Sensor (code 4840.42) or
RED Temperature Sensor Plug-In (code 4830.11)

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.

Assembly set up with RED Temperature Sensor Plug-In

Steam Generator

4200.45

The Altay Steam Generator is an efficient source of steam and hot water for the student lab. The one liter metal tank is electrically heated with a variable output of up to 400 Watts adjustable through a safety control panel. The dangers of overheating are eliminated by the thermal circuit breaker that disconnects the power if the water boils dry or electronic circuit works improperly.

COMPONENTS

- Steam generator
- Silicon tube set
- Mohr clip

Specifications
Overall dimensions: 15x19x17 cm
Weight: 3Kg
Supply voltage: 215 to 230 Volts with ground terminal, 50 - 60Hz
Power: 400 W at 220 Volts
Capacity of the tank: About 1 liter
Temperature regulation: 9 levels by setting
Preheating time: 20minutes

Compatible with:
Thermal Conductivity apparatus (4200.38)
Gunther expansion apparatus (4200.22)

Thermal Leakage System

4200.35

A simple apparatus to perform a complete study of heat losses

Specifications
Size: 25x18x14 cm
Weight: 1.9 kg

Equipment Needed
Bunsen Burner with accessories (code 5511.00)
Beaker 500 ml

Equipment Suggested
RED Temperature Sensor (code 4840.42) or
RED Temperature Sensor Plug-In (code 4830.11)

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 RED Temperature Probes (such as code 4840.42 or 4830.11)

MAIN COMPONENTS

- Aluminium cylinders
- Aluminium dissipator
- Brass cylinder
- Insulator

LAWS AND PRINCIPLES INVESTIGATED

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

EXAMPLE OF USE

Heat transfer vs surface area

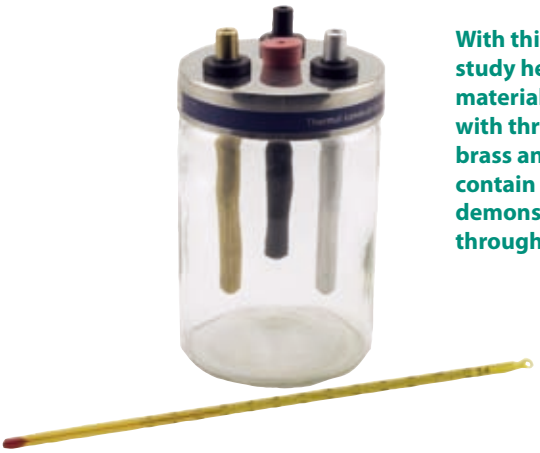
Two aluminium samples are heated up to the same temperature and let cool in air. The bodies are equal in mass and therefore in heat capacity, but they offer different surfaces to air. One sample is a cylinder and the other one is a so-called dissipater with many surfaces thus having a larger surface.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

What is the difference with or without a thermal insulator?

Thermal Conductivity Apparatus

4200.36

A simple apparatus to study heat conductivity



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.

Specifications
Size: Dia. 13x20 cm
Weight: 1.2 kg

Equipment Needed
Vernier Caliper (code 2213.10)

Equipment Suggested
RED Temperature Sensor (code 4840.42) or
RED Temperature Sensor Plug-In (code 4830.11)

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

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, 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.

Usage with RED Temperature Plug-In

Thermal Conductivity Apparatus by Steam

4200.38

Specifications
Size: approx. 19x19x22 cm
Weight: 4 Kg

Equipment Needed
Steam Generator (code 4200.45)

The Altay's thermal conductivity apparatus is ideal for measuring the thermal conductivity of several samples included with it (Masonite, Wood, Lexan, Sheet Rock, Glass).

MAIN COMPONENTS

- Material samples (Masonite, Wood, Lexan, Sheet Rock, Glass)
- Beaker 50 ml
- Petri dish Dia. 8 cm
- Rubber Tube 50 cm long
- Rubber Tube 15 cm long

LAWS AND PRINCIPLES INVESTIGATED

- Heat conductivity
- Conductivity coefficient

▶ EXAMPLE OF USE

When heat is applied to a portion of a material, that heat will move through the material. This movement of heat through a material is called the thermal current. Depending on the composition of the atoms of that material, the heat may move very slowly, or it may move very quickly. This dependance is quantified by the coefficient of thermal conductivity. Each material has a unique coefficient of thermal conductivity. A high coefficient means heat moves very quickly; a low coefficient means heat moves very slowly. Below is a chart of thermal conductivities for some common materials.

Thermal Conductivity Apparatus set up with Stem Generator ▶

Compound Bar

4200.60

Simple instrument to study thermal expansion

LAWS AND PRINCIPLES INVESTIGATED

- Expansion of solids
- Functioning of thermostats

Specifications
Length: 30 cm
Weight: 0.1 kg

Equipment Needed
Bunsen Burner with accessories (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.

Bimetal Strip with Electric Contact

4200.80

Simple demonstrator for thermal expansion

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.

Specifications
Size: 10x10x12 cm
Weight: 0.2 kg
Mounted on base, with electrical plugs for electric contacts

Equipment Suggested
RED Current & Voltage Sensor (code 4840.16)

LAWS AND PRINCIPLES INVESTIGATED

- Thermal expansion
- Demonstration model of thermostat

▶ EXAMPLE OF USE

Thermal expansion • Demonstration of a Bimetal Strip in action

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 way. Once cooled, it will revert back to its original position, closing the circuit once more.

Expansion of Liquids Apparatus

4210.32

Discover the relative coefficient of expansion of different liquids

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.

Specifications
Overall Size: 38x10x6 cm
Weight: 2.9 kg

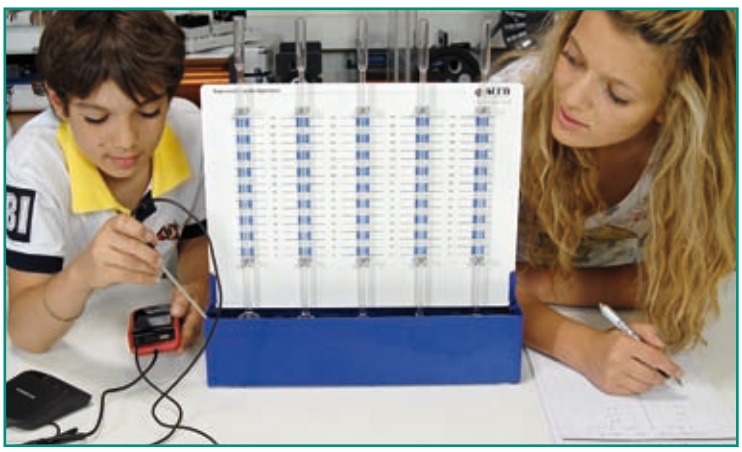
Equipment Needed
Alcohol Thermometer -10°C ÷ 110°C (code 2245.15)

Equipment Suggested
RED Temperature Sensor (code 4840.42)

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

LAWS AND PRINCIPLES INVESTIGATED

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



▲ *Measuring the liquids thermal expansion with a RED Temperature Plug-in*

Mixing Calorimeter

4230.60

Ideal apparatus for simple example of uses in thermodynamics

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.

Specifications
Size: Dia.12x30 cm
Weight: 0.6 kg

Equipment Suggested
RED Temperature Sensor (code 4830.42) or
RED Temperature Sensor Plug-In (code 4830.11)

LAWS AND PRINCIPLES INVESTIGATED

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

MAIN COMPONENTS

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

▶ 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

Joule's Law Unit for Calorimeter

4230.65

Joule's Law: electricity and thermodynamics

Add this attachment to the Altay Calorimeter to perform experiments involving electricity and thermal energy.

Joule's Law experiment with a RED Current & Voltage Sensor ▼

Specifications
Size: Dia. 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 AC/DC (code 2407.70)

Equipment Suggested
RED Current & Voltage Sensor (code 4840.16)
RED Temperature Sensor (code 4840.42) or
RED Temperature Sensor Plug-In (code 4830.11)

▶ 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.

Joule's Law ▶ $Q = I^2 Rt$

▲ *Joule's Law Unit setup with the Calorimeter*

The Joule's Law Unit for Calorimeter is used to demonstrate the thermal effect of currents and the specific heat of a fluid.

LAWS AND PRINCIPLES INVESTIGATED

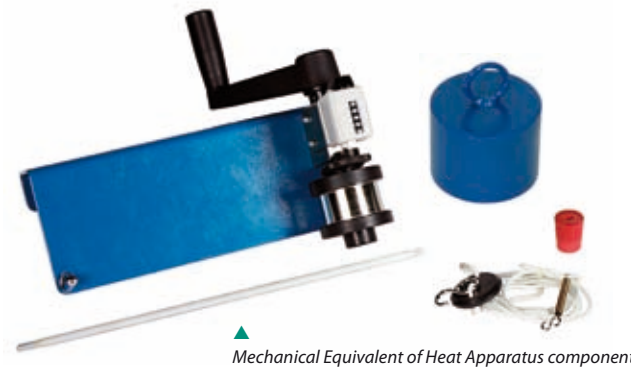
- Joule's Law
- Time dependence of the heat quantity generated in the spiral
- Resistance's value dependence of the heat quantity generated in the spiral
- Current intensity value dependence of the heat quantity generated in the spiral

Mechanical Equivalent of Heat Apparatus

4235.10

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

Specifications
Size: 26x22x20 cm
Weight: 8.5 kg
Inclusive of clamp for table mounting



Mechanical Equivalent of Heat Apparatus components

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.

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

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

Crooke's Radiometer

4215.20

Investigating the energy and impulse of an electromagnetic wave

Specifications
Size: Dia. 10x15 cm
Weight: 0.3 kg
Mounted on base

Equipment Suggested
RED Light Sensor (code 4840.18)

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 also need to remember that black painted sides get warmer than metallic ones.

Measuring the amount of light needed to keep it working

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.

Optical Bench Deluxe Edition

4417.50

A complete set for exploring geometrical optics

▲ *Optical Bench with Accessories Deluxe Edition*

Specifications
Optical Bench: length 116 cm

Equipment Suggested
RED Light Sensor (code 4840.18)

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
- Transformer 12V

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

▼ *Optical Bench with supports and holders*

◄ *Iris diaphragm, adjustable slit diaphragm and mirror*

▶ 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*

Optical Bench Standard Edition

4417.60

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

Specifications
Optical Bench: length 116 cm

Equipment Suggested
RED Light Sensor (code 4840.18)

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

Spectrum Tubes

4470.10-50

Excitation of the gas in the tube produces light

Hydrogen Spectrum Tube on Spectrum Tubes Holder with Ballast resistance

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.

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

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)

LAWS AND PRINCIPLES INVESTIGATED

- Light from excited energy levels
- Monochromatic light

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

Altay Handheld Spectrometer

4445.40

A simple and affordable way to begin studying the spectral lines

With this instrument every student can explore spectrometry on his own.

Altay's Handheld Spectrometer allows to detect the spectral lines with precision. Thanks to a cuvette support it is possible to investigate spectral Absorption properties of liquids

Specifications
Size: approx. 10x19x2.5 cm
Weight: 0.2Kg

Equipment Suggested
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 types of spectral 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 analyzing the spectral lines of a light source. In order to perform the experiment, set the position of the spectral lamp so that the collimator is properly aligned. The diffraction grating allows to observe the spectral lines of the gas. By knowing the diffraction angle, we can then work out the wavelength of the light.

Details of the Handheld Spectrometer Eyepiece ▶

Newton's Disk

4453.22

The human perception of colours

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

▶ 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 hite ▲
at a higher rotation

Specifications
Size: 18x25x12 cm
Weight: 0.7 kg
Mounted on base

The colours represent the fundamental 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".

LAWS AND PRINCIPLES INVESTIGATED

- Colour mixing
- Human perception of colours

Newton's Disk with Motor

4453.30

The human perception of colours

The colours red, orange, yellow, green, blue, indigo and violet represent the fundamental colours of the spectrum.

▲ *Colours' angle division when the disk is stopped*

When the disk is put in motion, they blur and the eye is not able to respond rapidly enough: the colours look like mixed together to form white. Since the eye is more sensitive to colours in the middle of the visible spectrum, the colours' angle is different. When the disk is rotated, the colours fuse together resulting in the effect of "white light".

Specifications
Size: approx. 32x20x5 cm
Weight: 0.5 Kg

Equipment Needed
Power supply 1.5 A AC/DC (code 2407.70) or 1.5 A DC (code 2407.80)
Connecting leads (code 2522.02-14)

LAWS AND PRINCIPLES INVESTIGATED

- Colour Mixing
- Human Perception of Colours

▶ EXAMPLE OF USE

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

The spectrometer is an ideal instrument for analyzing the spectral lines of a light source. In order to perform the experiment, set the position of the spectral lamp so that the collimator is properly aligned. The diffraction grating allows to observe the spectral lines of the gas. By knowing the diffraction angle, we can then work out the wavelength of the light.

▲ *The Newton's Disk consists in a disk with coloured segments printed on it, mounted on a base equipped by two safety sockets for connecting the power supply*

Wimshurst Machine

4622.20

One of the classic electrostatic generator experiment

The Wimshurst Machine ready to run

Specifications
Size: 40x24x43 cm
Weight: 3.8 kg

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.

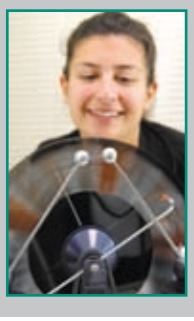
LAWS AND PRINCIPLES INVESTIGATED

- Electrostatic charge
- Electrical sparks

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

Pith Ball Electroscope in detail

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.

Specifications
Size: Dia. 13x26 cm
Weight: 0.2 kg

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

Van de Graaff Generator

4623.20

High Energy Physics with the Van de Graaff Generator

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.

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

▼ *Detail of the spark of several thousands volts*

Specifications
Size: 20x20x77 cm
Weight: 6.1 kg

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

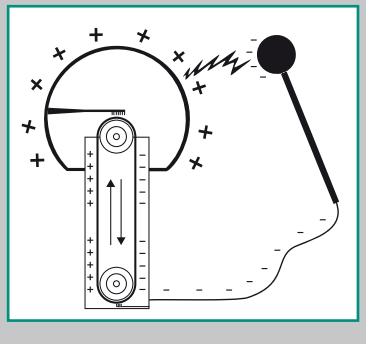
▼ *Van de Graaff components*

▶ 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.

▶ *Functioning scheme*



Leaf Electroscope

4625.50

A classical instrument to measure static charges

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.

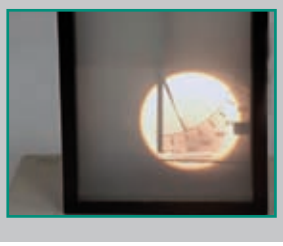
LAWS AND PRINCIPLES INVESTIGATED

- Electrostatic charge measure

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.

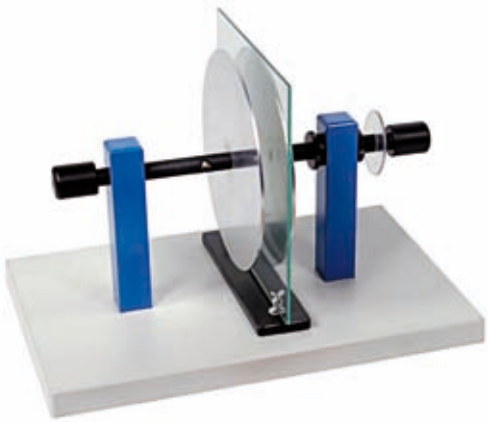


Leaf detail with back lighting

Aepinus Air Condenser

4628.32

A demonstration model of a condenser



Specifications
Size: 34x20x25 cm
Weight: 3.3 kg

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.

LAWS AND PRINCIPLES INVESTIGATED

- Plane face condenser
- Dielectric effect

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*

Various Magnets

** Minimum Order Quantity 5 pcs*

Different shape magnets for a wide number of magnetism experiments

Specifications
All items can be bought separately

LAWS AND PRINCIPLES INVESTIGATED

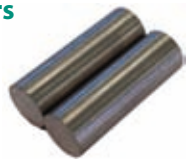
- Magnetic poles
- Magnetic field
- Lines of force

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.

Cylindrical Magnets

4611.18*

Cylindrical magnets, supplied in pairs



Specifications
Material: ALNICO
Size: Dia. 0.8x2.5 cm
Weight: 0.1 kg

Chrome Steel Bar Magnets

4611.50*

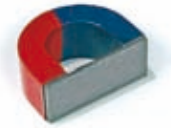
Painted in two colours for North and South, with keeper. Supplied by pair, in plastic case.

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: Dia. 2.5x0.5 cm - Weight: 0.1 kg

Plastic Cased Bar Magnets

4611.40*

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

Specifications
Size: 8x2x2x1 cm
Weight: 0.4 kg

Bar Magnets

4611.65*

Red in colour, with north pole marked with dimple.
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: Dia. 2.4x0.7
Weight: 0.1 kg

Ferrite Magnet

4612.09*

Magnetised through thickness.

Specifications
Size: 5x2x0.6 cm
Weight: 0.1 kg

Magnetic Needle on Stand

4613.80

A simple magnetic needle compass

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.

◀ *Magnetic Needle components*

Specifications
Needle: 10 cm length
Support rod: 11 cm length
Mounted on base: 6 cm dia.
Weight: 0.1 kg

LAWS AND PRINCIPLES INVESTIGATED

- Earth magnetic field
- North and cardinal points

Demonstration Compass

4614.50

Study the cardinal points with a compass

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.

LAWS AND PRINCIPLES INVESTIGATED

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

Specifications
Size: Dia. 16x5 cm
Weight: 0.1 kg
Magnetic needle: 10 cm length

▶ *Compass rose example*

Linear Oersted Apparatus

4614.60

Experimental study of the Biot-Savart Law for an electric wire

The Linear Oersted apparatus shows that an electric current flowing through a linear conductor produces a magnetic field able to divert the equilibrium position of a magnetic needle.

LAWS AND PRINCIPLES INVESTIGATED

- Biot-Savart Law
- Magnetic field produced by a straight wire conductor

Specifications
Size: Dia. 16x5 cm
Weight: 0.1 kg
Copper wire Dia. 0.2 cm
Safety socket: 0.4 cm
Max current: 5 A

Equipment Suggested
Power supply 10A AC/DC (code: 2407.75)

A Power Supply with current limitation is needed.

Rotating Coil

4640.60

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

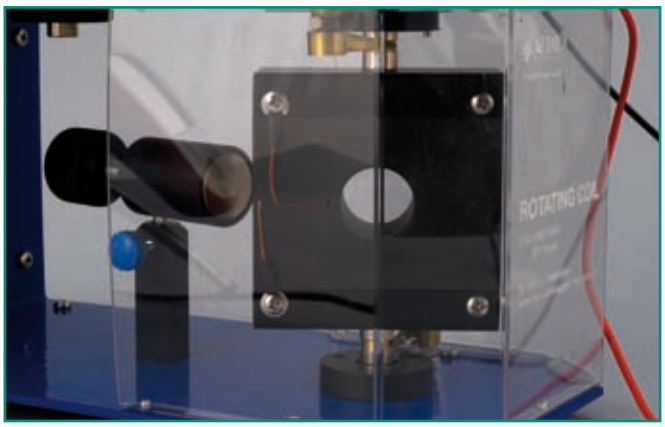
Specifications
Size: 20x20x25 cm
Weight: 2.7 kg

Equipment Suggested
RED Voltage & Current Sensor (code 4840.16)

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.

LAWS AND PRINCIPLES INVESTIGATED

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



▲ *Detail of the Coil in front of magnets*

◀ *The Rotating Coil in standing position*

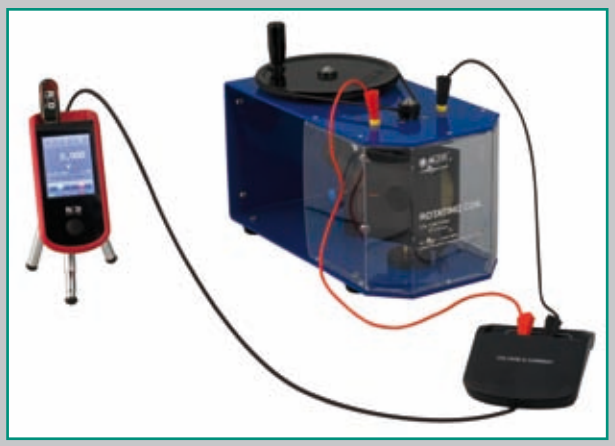
▶ EXAMPLE OF USE

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

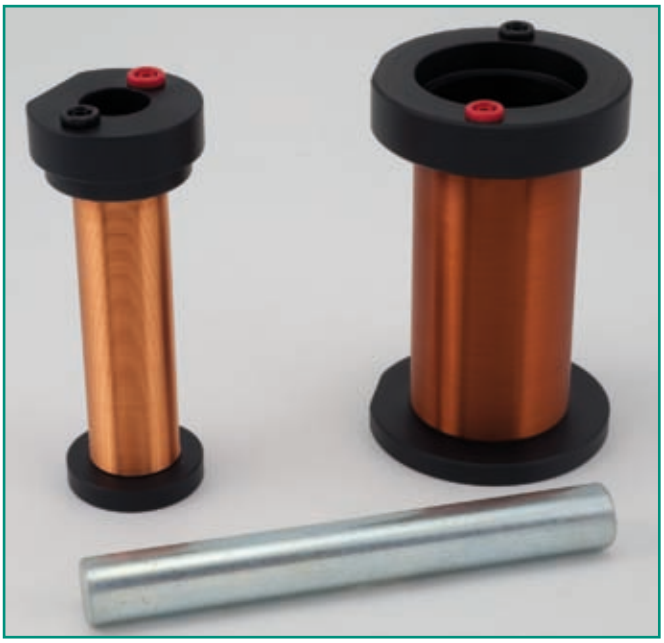


▲ *Rotating Coil used with RED Voltage & Current Sensor*

Induction Coils

4640.75

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



◄ *Induction Coil and Iron Core*

Specifications
Size: Dia. 10x17 cm
Weight: 4 kg

Equipment Suggested
RED Voltage & Current Sensor (code 4840.16)
RED Magnetic Field Sensor (code 4840.25)
Chrome Steel Bar Magnets (code 4611.50)
Power Supply 10 A (code 2407.75)

MAIN COMPONENTS

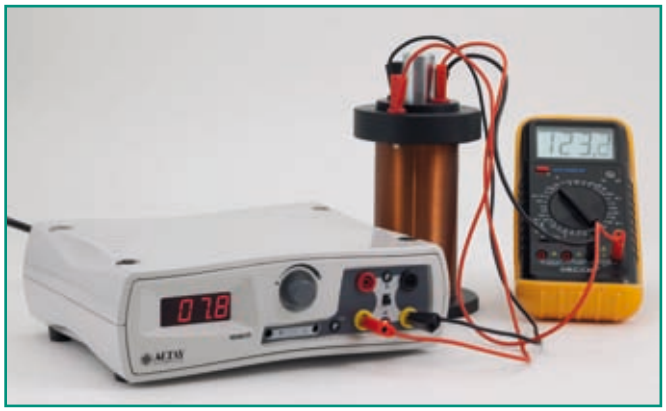
- Coil 250 Turns
- Coil 2000 Turns
- Iron Core

LAWS AND PRINCIPLES INVESTIGATED

- Magnetic induction
- Inductance

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.

▼ *Measuring Coil's electric resistance*



Induction Coil 600 turns

4640.76

A powerful and sturdy coil for electromagnetism experiments

◄ *Three sockets for 300 or 600 turns configuration*

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. Dia. 19 cm
Weight: 2 Kg
600 Turns
Max inductance: 80 mH approx
Wire Dia. 1 mm
Two function modes: 300 - 600 turns
Maximum current: 3A

Equipment Needed
2x Connecting Lead (code 2522.14)

Equipment Suggested
RED Voltage & Current Sensor (code 4840.16)
RED Magnetic Field Sensor (code 4840.25)
Power Supply 10A (code 2407.75)
Laboratory jack (code 5406.30 – 34)
Tape measure (code 2211.10)

LAWS AND PRINCIPLES INVESTIGATED

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

Induction Coil 1100 turns

4640.77

Explore magnetic fields easily

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.

Specifications
Size: approx.
Dia. 12 cm, length 31 cm
Weight: 2 Kg
1100 Turns
Max inductance: approx .20 mH
Wire Dia.: 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)
RED Voltage & Current Sensor (code 4840.16)
RED Magnetic Field Sensor (code 4840.25)
Laboratory jack (code 5406.30 – 34)
Tape measure (code 2211.10)

◄ *Three sockets for 550 or 1100 turns configuration*

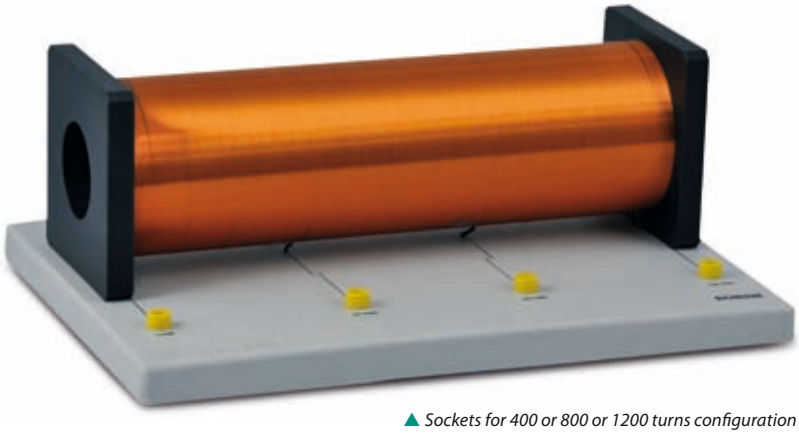
LAWS AND PRINCIPLES INVESTIGATED

- 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.



▲ *Sockets for 400 or 800 or 1200 turns configuration*

Specifications
Size: 42x30x16 cm
Weight: 4.2 kg
Single layer solenoid
Three safety sockets (400 – 800 - 1200 turns)
Copper wire Dia. 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
RED Magnetic Field Sensor (code 4840.25)

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

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 Dia. 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.

▲ *Assembly view of the Double Winding Coil*

Specifications
Size: 70x18x12 cm
Weight: 2.8 kg

Equipment Needed
Power supply 1.5 A AC/DC (code 2407.70)
Connecting leads (code 2522.02 - 14)

Equipment Suggested
Digital Multimeter (code 2275.10)
Inductance meter

MAIN COMPONENTS

- Coil
- Digital Teslameter

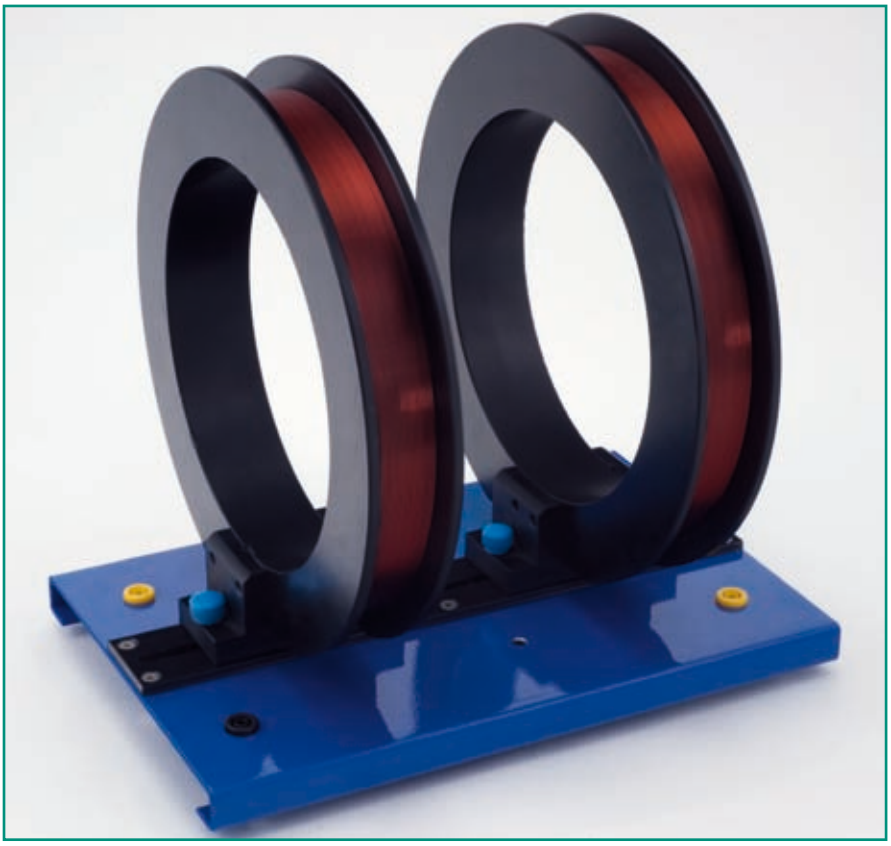
LAWS AND PRINCIPLES INVESTIGATED

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

Helmholtz Coils

4851.04

Generate a nearly uniform magnetic field using Helmholtz Coils



▲ *Assembly view of the Helmholtz Coils*

Specifications
Size: approx. 30x20x28 cm
Weight: 5 Kg
1100 Turns

Equipment Suggested
Power supply 1.5 A AC/DC (code 2407.70)
RED Magnetic Field Sensor (code 4840.25)

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 generation

Max Flux Coil

4640.73

Perform the most famous experiment on magnetic induction actions

The large diameter coil (internal coil dia. 45mm, external coil dia. 60 mm) is made up of 200 copper turns 5/10th mm; It is suspended by a 45 cm long coaxial cable with great flexibility so as not to disrupt the mobility of this coil; The maximum current allowed is 1A. This item enables to show evidence of magnetic induction actions, to investigate fundamental principles of physics as the Faraday's law of induction and Lenz's law, to study the dipole approximation rule, and the earth's magnetic field. Ideal for use in many experiments such as plotting a hysteresis of a ferro-magnet.

LAWS AND PRINCIPLES INVESTIGATED

- Magnetic field produced by a current-carrying loop
- Magnetic flux cutting a loop
- Magnetic induction
- Faraday's law
- Lenz's laws

Specifications
Internal coil Dia. 0.45 cm, external coil Dia. 0.6 cm
200 copper turns 0.5 mm Dia.

It is suspended by a 45 cm long coaxial cable with great flexibility so as not to disrupt the mobility of this coil.

The maximum current allowed is 1A.

Equipment Needed
Power supply 1.5 A AC/DC (code 2407.70)

Equipment Suggested
RED Magnetic Field Sensor (code 4840.25)
Neodymium-Iron-Boron Magnet (code 4611.86)

With this apparatus, it is possible to show evidence of magnetic induction actions.

Laplace Apparatus

4646.10

Laplace Apparatus works without mercury

Altay's 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.

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

Laplace Rail

4646.15

Discover the concepts of electromagnetism

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.

MAIN COMPONENTS

- Laplace Rail
- C shape magnet
- Rod

LAWS AND PRINCIPLES INVESTIGATED

- Laplace's Law
- Lorentz's Force

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.

Electrical Safety Simulator

4715.00

Simulate easily the typical technical problems of an electrical system: short circuit, current leakage, overload.

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
Size: approx. 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)
RED Voltage & Current Sensor (code 4840.16)

The Simulator enables students to understand how dealing with electrical systems in a safe way.

▼ *Current leakage experiment with a RED Voltage & Current Sensor*

▶ EXAMPLE OF USE

Electrical overload

Purpose of this experiment is to simulate a typical occurrence characterizing the electrical systems when an excessive number of electrical devices is connected to the power supply.

LAWS AND PRINCIPLES INVESTIGATED

- Short circuit
- Current leakage
- Overload
- Circuit breaker

Sliding Contact Rheostat

4694.11-61

Changing the resistance value with a Sliding Contact Rheostat

Specifications
Size: 35x10x15 cm
Weight: 2.5 kg
2.9 Ω, max 9 A (code 4694.11)
10 Ω, max 5 A (code 4694.21)
50 Ω, max 2.2 A (code 4694.31)
120 Ω, max 1.4 A (code 4694.41)
300 Ω, max 0.9 A (code 4694.51)
1400 Ω, max 0.4 A (code 4694.61)

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.

LAWS AND PRINCIPLES INVESTIGATED

- Variable resistance

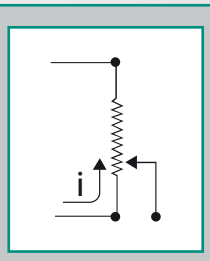
▶ EXAMPLE OF USE

Variable resistance • **Suitable for use in many electricity experiments**

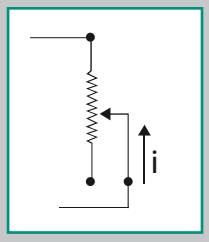
Each rheostat is fitted with three terminals that allow it to be used as a fixed or a variable resistance or a potentiometer.

◀ *Resistance measurement*

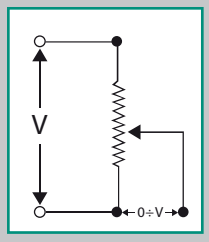
Connecting the two black plugs to the circuit, the rheostat works as a fixed resistance.
Connecting the black and red plugs to the circuit, the rheostat works as a variable resistance.
With a more complex circuit schema is possible to realise a potentiometer.



▲ *Rheostat used as a fixed resistance*



▲ *Rheostat used as a variable resistance*

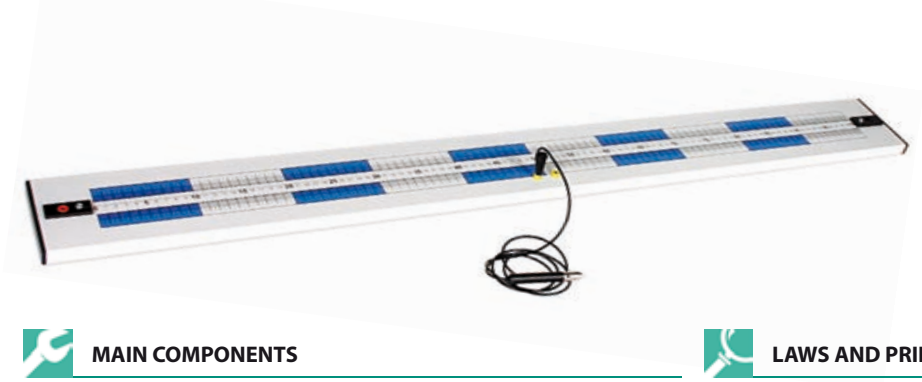


▲ *Rheostat used as a potentiometer*

Potentiometer Bridge

4697.00

The most effective way to introduce the concept of resistance



Specifications
Size: 110x12x3 cm
Weight: 2.7 kg

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

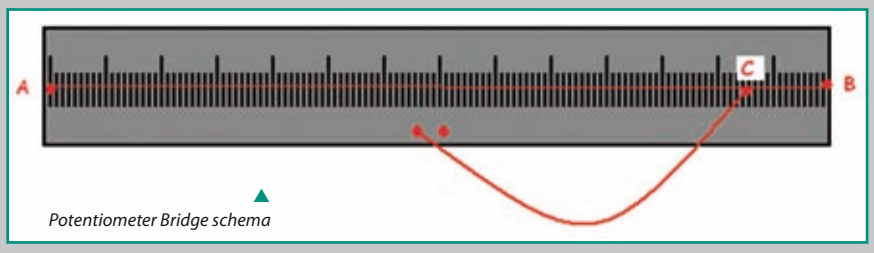
LAWS AND PRINCIPLES INVESTIGATED

- 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*

Generator Model

4739.20

Demonstration model of dynamo for easy understanding of the functioning

Specifications
Size: 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 0.4 cm 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

Demonstration Transformer

4729.00

Demonstration of the voltage transformation in an alternate current

Demonstration Transformer components

Specifications
Size: 20x15x20 cm
Weight: 6.2 kg
Power output: 2 A max.

Equipment Needed
Digital Multimeter (code 2275.10)

Equipment Suggested
RED Current & Voltage Sensor (code 4840.16)

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

Voltage transformation measurement

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

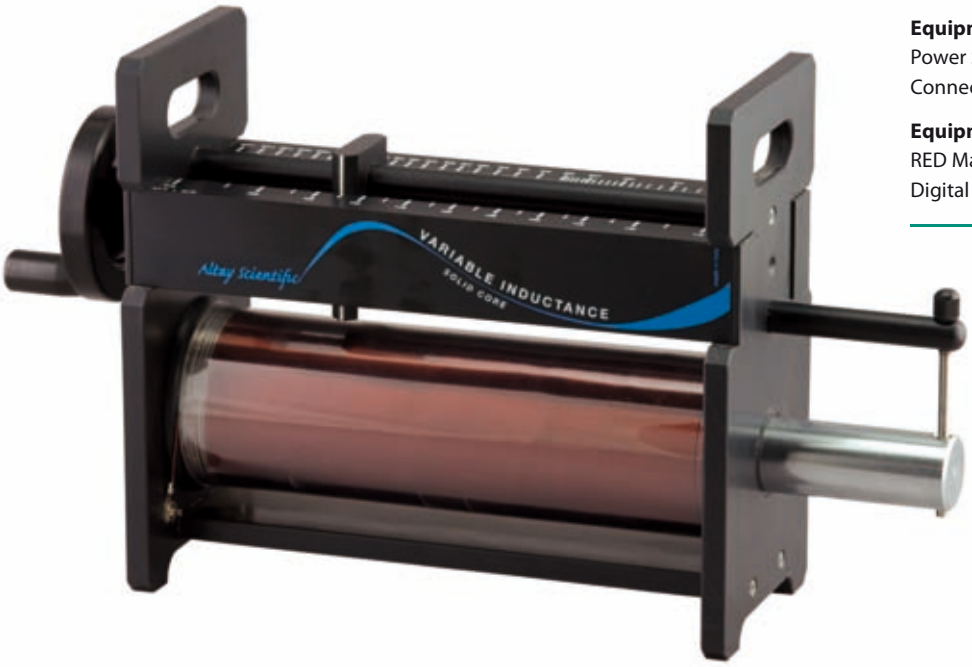
Voltage transformation • **How to obtain 12 V power supply from 220 V line power**

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.

Variable Inductance

4731.00

A unique apparatus to discover inductance



Specifications
Size: 25x11x22 cm
Weight: 8 kg

Equipment Needed
Power Supply 10 A (code 2407.75)
Connecting leads (code 2522.00) (2x)

Equipment Suggested
RED Magnetic Field Sensor (code 4840.25)
Digital Multimeter (code 2275.10)

MAIN COMPONENTS

- Variable Inductance
- Solid Iron Core
- Laminated Iron Core

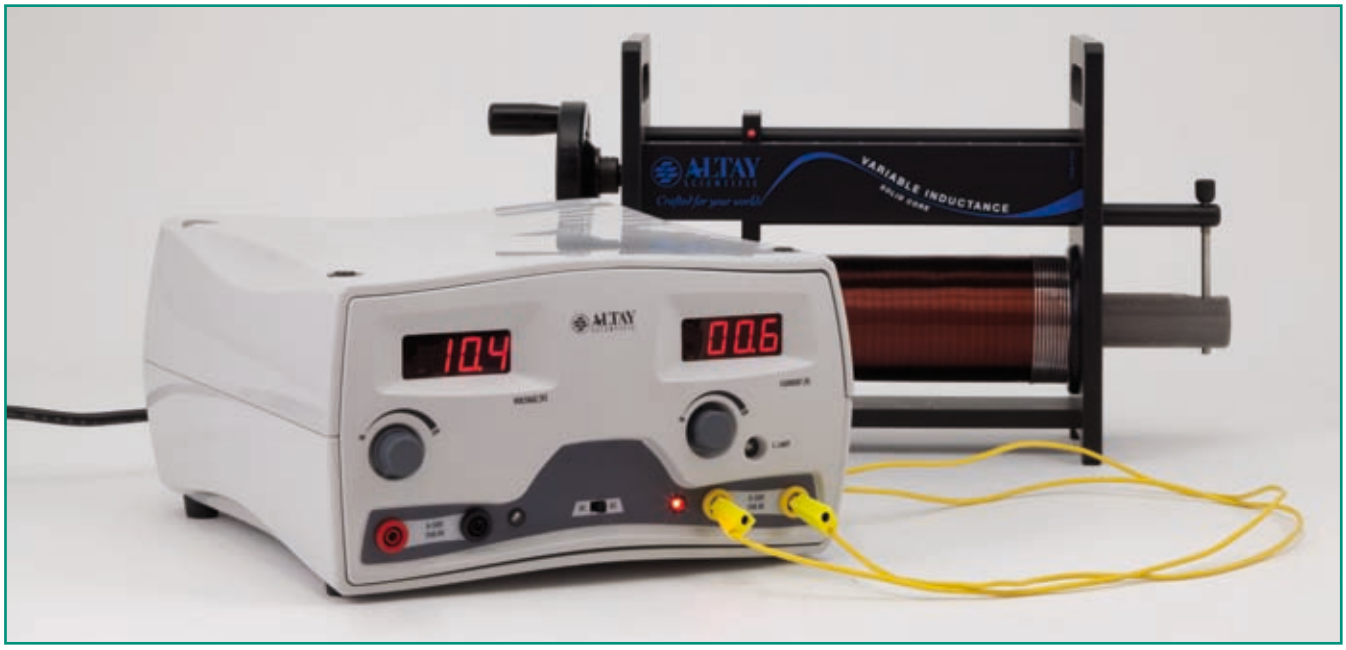
LAWS AND PRINCIPLES INVESTIGATED

- Generation of magnetic fields by flowing currents
- Study of a variable inductance
- Role of iron cores
- Study of RL, RLC circuits

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.

▼ *Power Supply and Variable Inductance*



Demonstration Dynamo

4739.45

Shows the conversion of mechanical energy into electrical energy and principle of working of simple AC and DC dynamos

Altay's Demonstration Dynamo side view.

Specifications
Size: 24x13x16 cm
Weight 1.2 kg

Equipment Needed
RED Voltage & Current Sensor (code 4840.16)

LAWS AND PRINCIPLES INVESTIGATED

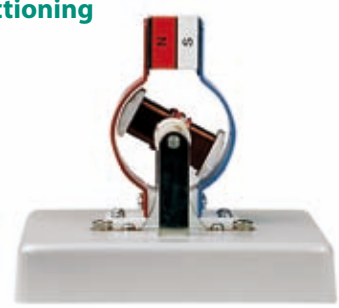
- Motor spinning
- Dynamo
- Current generation
- Interaction between currents and magnetic fields

Complete assembly mounted on a base and capable of generating both AC and DC simultaneously as indicated by the glowing of the led on the base.

Motor Unit

4743.05

Open demonstration model of motor for easy understanding of the functioning



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.

Specifications
Size: 12x12x10 cm
Weight: 0.7 kg
Electrical supply: 4-6 V DC or AC

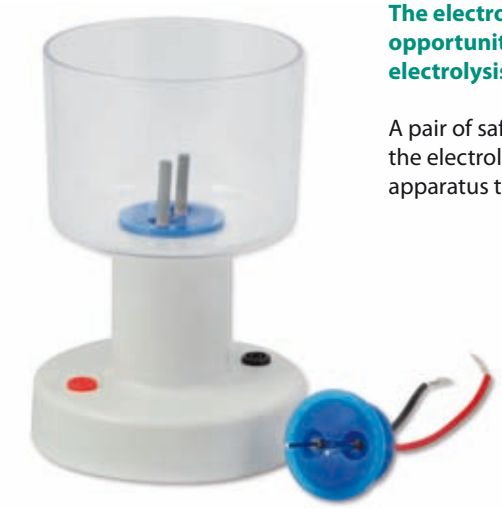
LAWS AND PRINCIPLES INVESTIGATED

- Motor spinning
- Dynamo
- Interaction between currents and magnetic fields

Electrolyzer

4870.00

An easy to use equipment to realize the electrolysis of water, salt water and aqueous solutions .



The electrolyzer gives the students the opportunity to study the process of electrolysis.

A pair of safety sockets located on the base of the electrolyzer enables the user to connect the apparatus to an external DC power supply.

LAWS AND PRINCIPLES INVESTIGATED

- Electrolysis in basic environment
- Electrolysis in acid environment
- Electrolysis of aqueous solutions of some salts

Specifications
Size: Dia.:12x19 cm
Weight: 0.3 kg
Electrolyzer with interchangeable carbon electrodes Capacity Plastic transparent basin 500 ml
Spare electrodes mounted on caoutchouc base
2 Nickel Electrodes (code 4870.03*)
2 Carbon Electrodes (code 4870.01*)
2 Graduated glass Test tubes

Equipment Needed
DC power supply
(codes 2407.75-2407.70- 2407.80)
Connecting leads (code 2522.02)

Equipment Suggested
Digital Multimeter (code 2275.10)

MAIN COMPONENTS

- Electrolyzer
- 2 Nickel Electrodes
- 2 Carbon Electrodes
- 2 Graduate made of glass Test tubes

** Minimum Order Quantity 5 pcs*

Radioactivity Bench

4832.00

An easy to set up apparatus for radioactivity

Altay's Radioactivity Bench

Metallic screens

Specifications
Radioactivity Bench: length 35 cm
Geiger Müller Counter: size 45x15 cm

Equipment Needed
Alpha Source (code 4822.53)
Beta Source (code 4822.52)
Beta/Gamma Source (code 4822.51)

With our Radioactivity Bench it is easy to measure the number of radioactive particles emitted by alfa, beta and gamma sources. It is also possible to verify the principle of radioactive decay that is the set of various processes by which unstable atomic nuclei emit subatomic particles.

Radioactivity Bench can be mounted on Altay Magnetic Board (code 4114.30)

Radioactivity Bench with holders for sources and screens

MAIN COMPONENTS

- Radioactivity Bench
- Support for Radioactivity Sources
- Container for Absorbers
- Geiger Müller Rate Counter
- Geiger Müller Probe
- Lead Metal Screens
- Brass Metal Screen
- Iron Metal Screen
- Aluminium Metal Screen

LAWS AND PRINCIPLES INVESTIGATED

- Radioactive decay
- Alfa, beta and gamma sources
- Radiation absorption from metallic screens
- Geiger Müller detection

EXAMPLE OF USE

Radioactive sources and effect of metal screens

Determination of Radioactive alfa, beta and gamma decay and study of shielding effect of metal screens

Altay Radioactivity bench is suited for an easy measure of the radioactive decay of the different sources supplied.
Setting up the time interval to a specified value, the radioactive activity in becqerel (Bq) can be quickly measured applying the known physics laws. If a quantity of radioactive material produces one decay event per second, it has an activity of one Bq. Since any reasonably – sized sample of radioactive material contains many atoms, one becquerel is a tiny level of activity, numbers on the order of gigabecquerels are commonly seen. With the different metal screens supplied is also possible to study the shielding due to different materials, for example lead, interposed between the radioactive source and the detector. In this way it is possible to verify the behaviour of various radioactive source in presence of different metal screening and understand, for examples, the principles behind the construction of bunkers.

Effect of lead screen

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Data
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SENSORS

124 RED FORCE SENSOR

130 RED STORAGE CASE

RED Motion Sensor

4840.12

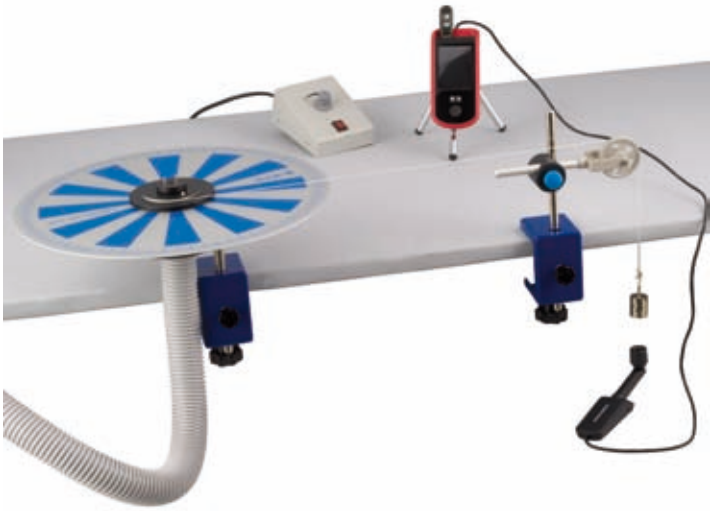
Using ultrasound technology, this sensor takes highly accurate distance measurements in real time. Ultrasonic pulses are emitted by the motion sensor, reflected from a target, and then detected by the device. The time it takes for the reflected pulses to return is used to calculate the target's position. 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, among other physics and physical science experiments.

Protection Cage
A Protective Cage is available as an accessory to offer enhanced protection for the motion sensor while dropping objects from above or over the top of the unit. The cage is designed not to interfere with data collection.

Specifications
Range: 0.15–6 m
Resolution: 0.001 m
Sample Rate: maximum 50 samples/second

Motion sensor comes with brick battery, quick reference guide, and a USB flash drive for storing data.

Moment of Inertia experiment with a RED Motion Sensor ▼



RED pH Meter

4840.13

Specifications
Range: 0–14 pH
Accuracy: ±0.2 pH
Resolution: 0.01 pH
Sample Rate: maximum 10 samples/second.

Includes brick battery, quick reference guide, USB flash drive for storing data, and electrode storage solution.

Whether you're monitoring pH for a chemistry, physical science, life science, or earth science activity, this pH meter offers accurate readings in a convenient format. Use it to collect data for pH of solutions, general solution preparation, study of biological buffers, soil analysis, water analysis, and more.

RED Force Sensor

4840.14

Conduct a wide range of physical science and physics activities with accurate data collected with this force sensor. Use it for studies of friction, simple harmonic motion, collision studies, weight determination with a spring scale, buoyancy, the usefulness of levers and pulleys, and more. The force sensor can be easily mounted in a variety of experimental configurations using metal support rods that screw into the sensor head. Rods available separately.

Force Accessory Pack
The Force Sensor Accessory Pack includes an additional bumper and hook that are designed to individually connect directly to the force sensor. The hook accessory is useful for connecting to a string and measuring pulling forces; the bumper is helpful for measuring collision forces or pushing forces.

▲ *Third Newton's law hands on experiment*

Inclined plane and RED Force Sensor ▶

Support Rod
The Metal Support Rod accessory with one threaded end may be connected to any sensor in order to place them in a variety of experimental configurations. Recommended for use with the force sensor.

Specifications
Range: ±50 N
Accuracy: ±1%
Resolution: 0.02 N
Sample Rate: max 1,000 samples/second

Force sensor comes with brick battery, quick reference guide, a USB flash drive for collecting data, rubber bumper attachment, and metal hook attachment
Replacement hook and bumper also available separately in the Force Accessory Pack

RED Photogate Sensor

4840.15

Accommodate up to four photogate heads with this sensor, and use it to study free fall, periods, collisions, pendulum motion, and more. Operating modes include gate to gate, shadow, period, and pendulum. The sensor includes brick battery, quick reference guide, USB flash drive for storing data, and two photogate heads. Additional heads are available separately. Support rods that screw directly into the photogate head for easy mounting to an experimental setup are also available separately.

◀ *Pendulum period measurement with a RED Photogate Sensor*

Specifications
Resolution: 0.1 ms

Photogate Heads
Set of two photogate heads are designed for use with photogate sensor hub, which accommodates up to four heads.

Picket Fence
When used with the photogate heads you can study free fall motion with this device featuring eight opaque bars spaced every 5 cm, and silk-screened directly onto clear plastic.

Super Pulley
This low friction plastic pulley can be mounted directly with the photogate heads to monitor motion as an object passes over the pulley or as the pulley rolls along a table.

Support Rod
This support rod with one threaded end may be connected to any sensor in order to place them in a variety of experimental configurations. Recommended accessory for the photogate heads.

RED Voltage & Current Sensor

4840.16

This probe works seamlessly with a wide variety of configurations of battery electronics and circuits, making it perfect for your physical science, physics, and chemistry activities. Use the voltage and current sensor like a multimeter to measure voltages and currents in low-voltage AC and DC circuits, or explore the effectiveness of homemade battery cells and different battery con- figurations. Voltage measured represents differential voltage. Probe includes brick battery, quick reference guide, a USB flash drive for storing data, and a set of two connecting leads with alligator clips. Additional sets of leads with banana plugs or alligator clips are available separately.

Specifications
Range: ±12 V, ±1 A
Resolution: 6 mV, 0.5 mA
Sample Rate: max 50,000 samples/second

Alligator Clips
These 50 cm long leads offer low contact resistance between laboratory equipment and the Voltage & Current Sensor. Set of two.

Banana Plugs
With dual banana plug ends, the leads connect to the sensor ports as well as circuit boards and other physics apparatus in your classroom or laboratory. The 50 cm long leads offer low contact resistance between laboratory equipment and the Voltage & Current Sensor. Set of two.

Experimental verification of the Joule's law with a RED Voltage & Current

RED Gas Pressure Sensor

4840.17

An ideal sensor for experiments in physics, physical science, life science, and chemistry, this sensor provides accurate readings for activities investigating fermentation, respiration of cells and microorganisms, the ideal gas law, and more. Measurements are recorded in Pascals (Pa) and Atmosphere (atm).

Specifications
Range: 0–200 kPa
Resolution: 50 Pa
Sample Rate: max 100 samples/second

Gas Pressure sensor includes brick battery, quick reference guide, USB flash drive for storing data, and an Accessory Pack featuring a syringe, two lure locks, and silicone tubing.

Replacement Accessory Packs can also be purchased separately

Gas Pressure Accessory Pack
A 20 mL syringe, 2 luer-lock connectors, and a piece of silicon tubing are included, allowing you to perform a variety of gas pressure and gas law experiments in your lab or classroom.

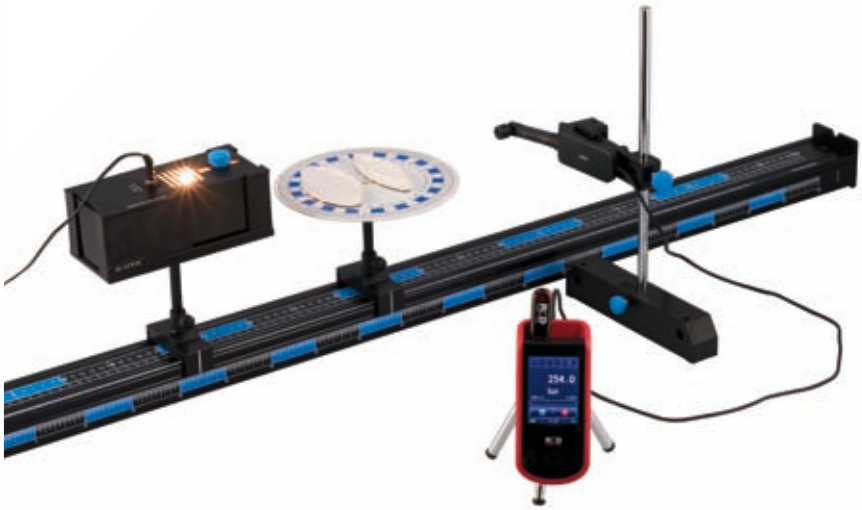
RED Light Sensor

4840.18

Detecting movement in the visible light range, this light sensor emulates the human eye in spectral response. Choose from two different illumination ranges, which are easily selected on the unit's setup menu. Chemistry, physical science, life science, and environmental science experiments involving light intensity, inverse-square law experiments, reflectivity, solar energy, and polarization are all possible to support with easy, accurate data. Includes brick battery, quick reference guide, USB flash drive for collecting data.

Specifications
Range: 0–30,000 lx; 0-2,000 lx
Resolution: 10 lx; 0.5 lx
Sample Rate: max 1,000 samples/second

▼ *Focal length of a system of lenses with the Hartl disk and a RED Light sensor*



RED Microphone

4840.19

This high-quality microphone can be used to display and study the waveforms of sound from a human voice and musical instruments. It is also ideal for speed of sound experiments.

Specifications
Range: 0–100 (normalized values)
Sampling rate: up to 50,000 samples/second

Microphone sensor includes brick battery, quick reference guide, USB flash drive for storing data

▼ *Studying beats phenomenon with the RED Microphone*

RED Temperature Sensor

4840.42

Collect fast and simple measurement of static or changing temperatures during your life science, physical science, chemistry, earth science, or environmental science activities with this easy-to-use temperature probe. Investigate phase of matter, exothermic and endothermic reactions, effects of environmental conditions on temperature, insulation experiments, lessons related to weather and seasons, and solar energy with accurate data. The sensing element in this sensor is a Pt-100 contained in a stainless steel shaft. Its long probe length and rubberized lip grip also allow a comfortable and secure fit on a variety of glassware commonly used in the classroom and lab. Collect measurements in Celsius, Fahrenheit, or Kelvin. Sensor comes with brick battery, quick reference guide, USB flash drive for storing data.

Specifications
Range: -200 / +800°C
Accuracy: ±3°C or 3%, whichever is greater
Resolution: 0.1°C
Sample Rate: max 10 samples/second

RED Temperature Sensor Plug-In

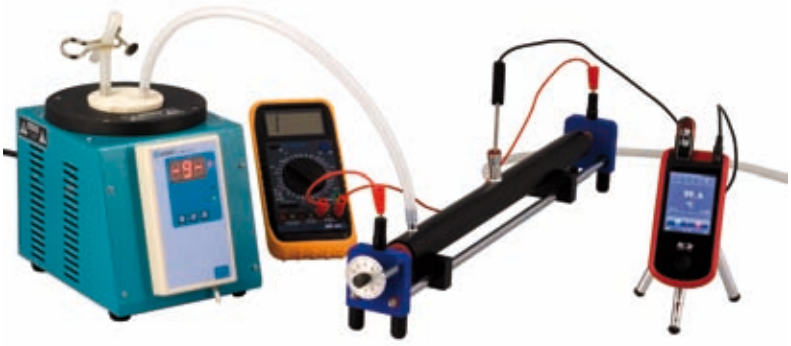
4830.11

Plug this sensor into any RED Data Collector unit to instantly transform it into a temperature-collecting device. Collect up to ten temperature readings per second in Celsius, Fahrenheit, or Kelvin. Because the sensor is safe for use in organic liquids, salt solutions, acids and bases, you can use it for a wide variety of experiments in chemistry, physical science, life science, earth science, and environmental science. Easily collect accurate data for activities involving phase of matter, exothermic and endothermic reactions, effects of environmental conditions on temperature, insulation, weather, the seasons, solar energy, and more.

Specifications
Temperature Range: -30 / +135°C
Accuracy: ±0.5°C
Resolution: 0.1°C
Sample Rate: max 10 samples/second

RED Temperature Sensor Plug-In to be connected to any DAQ ▶

Temperature has influence on solid thermal expansion. Investigation with a RED Temperature sensor ▼



RED EKG Probe

4840.22

Measure the electrical activity of the heart over a period of time, using electrodes attached to the outer surface of the skin. This probe detects and records heartbeat using three leads and patches, included, and a quick one–button operation. Lab activities in biology, life science, and health science are made simpler with faster and more accurate results. Includes a long-lasting rechargeable brick battery with charger, quick reference guide, and USB flash drive for data storage.

Specifications
Range: 30 - 200 beats/minute

RED Dissolved Oxygen Probe

4840.23

The Dissolved Oxygen Sensor can be used to monitor and explore factors that affect the concentrations of dissolved oxygen molecules in aqueous solutions. By using it, students can explore the effects of temperature, pressure, water movement, inorganic chemicals, organic matter, and living organisms on levels of dissolved oxygen.
This sensor is also containing an internal probe tip thermistor for temperature compensation when reading the concentration.
Includes a long-lasting rechargeable brick battery with charger, quick reference guide, and USB flash drive for data storage.

Specifications
Range: 0 - 20 mg/l
Accuracy: ±10% of reading
Resolution: 0.01 mg/l
Sampling Rate: from 1/300 up to 10 samples/second

RED CO_2 Gas Sensor

4840.24

Quickly and easily measure gaseous carbon dioxide in the surrounding air with this high quality sensor. This sensor can be used to monitor changes in CO_2 levels with a sampling rate of ten samples per second, providing fast and accurate data collection for a variety of activities in your life science, earth science, physical science, or chemistry classroom. Includes a long–lasting brick battery with charger, quick reference guide, and USB flash drive for storing data. A CO_2 /O_2 Adapter and plastic sample collection bottle are also available.

Specifications
Range: 350 to 10,000 ppm
Accuracy: ±20% at 1,000 ppm
Resolution: 1 ppm
Sampling Rate: max 10 samples/second

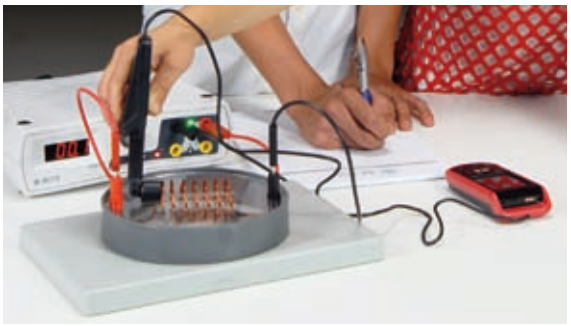
RED Magnetic Field Sensor

4840.25

This probe features a rotating sensor head to investigate the field around magnets, coils, and electrical devices. Ideal for gauging the level of intensity of a magnetic force during physical science, physics, and engineering lab activities. Includes a long–lasting rechargeable brick battery and charger, USB flash drive for data storage, and quick reference guide.

Specifications
Range: ±1,000 Gauss
Accuracy: ±10% of reading
Resolution: 1 Gauss
Sampling Rate:
max 1,000 samples/second

RED Magnetic Field Sensor for the study of the magnetic dipole approximation



… and the magnetic field produced by a solenoid

RED Blood Pressure Sensor

4840.36

Designed to measure human blood pressure and pulse rate with rapid accuracy, this probe makes experimentation in biology, health science, and life science labs easier than ever. Get clear and easy readings of both systolic and diastolic blood pressure rates, displayed boldly on the unit's digital screen. One–button operation and easy out–of–box setup ensure a user–friendly experience in the classroom. Includes a long-lasting rechargeable brick battery with charger, USB flash drive for data storage, and quick reference guide. A sphygmomanometer is also available.

Specifications
Range: 0 - 250 mm Hg
Accuracy: ±10% of reading
Resolution: ±1 mm Hg.

Accessories

RED Lanyard

4830.87

Comfortably wear a RED Data Collector around your neck for mobile experimentation and field trip activities using this durable cotton/polyester lanyard, featuring detachable connector and quick release.

RED USB Flash Drive

4830.82

Specifically designed for the RED Data Collector sensors, USB flash drives include an instruction manual, Microsoft Excel plug-in for data analysis, and help files. The 1 GB capacity is capable of storing a multitude of data files from repeated activities.

RED Picket Fence

4830.86

When used with the photogate sensor, this picket fence allows you to study free fall motion. It features eight opaque bars spaced every 5 cm, and silk-screened directly onto clear plastic.

RED Wall Charger Power Supply with international Plugs

4840.83

Recharge your RED Data Collector with ease using this station that conveniently plugs into a wall or floor socket. Included micro USB to USB cord allows sensors to recharge while connected to a laptop. Collectors can be used while recharging.
Input: 100-240 V ~, 50/60 Hz 0.20 A
Output: 5.0 V ⎓, 1.0 A

Rechargeable Brick Battery

2401.30

Use this Lithium-ion rechargeable battery in place of the three AA batteries included with each RED Data Collector for a convenient, environmentally friendly power source. The battery capacity is 2100 mAh with a voltage of 3.7V.

RED Storage Case

4830.95

This sturdy storage solution will accommodate sets of RED Data Collector sensors and their accessories. The hard outer shell and foam lined interior protects your sensors and keeps your accessories organized. Each case is designed to store up to six sensors.

RED Force Sensor Accessory Pack

4830.88

The Force Sensor Accessory Pack, available separately, includes an additional bumper and hook that are designed to individually connect directly to the force sensor. The hook accessory is useful for connecting to a string and measuring pulling forces; the bumper is helpful for measuring collision forces or pushing forces.

Accessories

RED Connecting Leads, Alligator Clips

4830.94

These 50 cm long leads offer low contact resistance between laboratory equipment and thevoltage/current sensor. A banana plug end connects to the sensor ports while the alligator clip ends allow you to perform a variety of experiments in your classroom or laboratory. Set of two.

RED Connecting Leads, Banana Clips

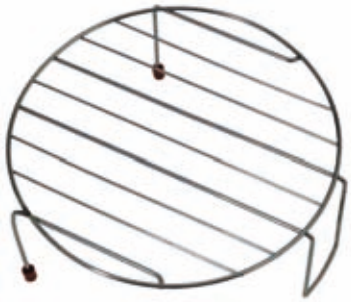
4830.99

With dual banana plug ends, the leads connect to the sensor ports as well as circuit boards and other physics apparatus in your classroom or laboratory. The 50 cm long leads offer low contact resistance between laboratory equipment and the voltage/current sensor. Set of two.

RED Motion Sensor Protection Cage

4830.90

Add this accessory to your RED Data Collector Motion Sensor to offer enhanced protection while dropping objects from above or over the top of the unit. The cage is designed not to interfere with data collection.



RED Data Collector Photogates, Set of 2

4830.43.001

Set of two photogate heads for use with the photogate sensor hub, which accommodates up to four heads.

RED Support Rod

4830.91

This support rod with one threaded end (1/4") may be connected to any RED sensor in order to place them in a variety of experimental configurations. Recommended accessory for the photogate heads, motion, and force sensors.

RED Tripod Stand

4830.46

Mini Tripod Stand with Ball Tilt Head, silver color. Easy to mount on every RED Sensor in order to place them in a variety of configuration through the tilting head. It's a 3-parts tripod legs with thread: 1/4". The height when closed: 140 mm, fully open: 280 mm. Useful also for photo and video cameras, LCD monitors, microphones and mini speakers. Weight approx. 88g

RED Gas Pressure Accessory Pack

4830.89

A 20 mL syringe, 2 luer-lock connectors, and a piece of silicon tubing are included, allowing you to perform a variety of gas pressure and gas law experiments in your lab or classroom.

RED Super Pulley

4112.50

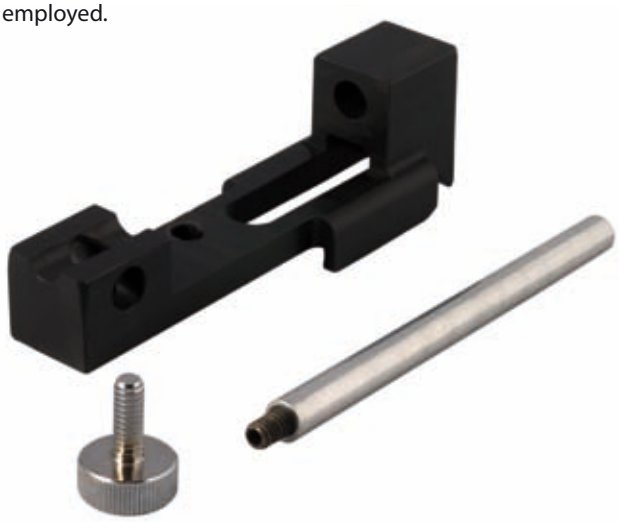
This low friction plastic pulley can be mounted directly (1/4") with the photogate heads to monitor motion as an object passes over the pulley or as the pulley rolls along a table.

RED Sensor Universal Adapter

4831.00

This adapter has been conceived for using the RED sensors together with Altay's products as suggested in the list of compatible products.

This universal adapter when used together with RED sensors assures better performances compared to experiments for which data logging systems are not employed.



▲ *4831.00*

Specifications
Size: approx. 13x4x4 cm
Weight: 0.1 kg

Items to be used with
RED Light Sensor (code 4840.18)
RED Motion Sensor (code 4840.12)
Red Microphone (code 4840.19)

Equipment Suggested
Mechanics kit 2 (RED Motion)
Mechanics upgrade 1(RED Motion)
Optics kit 1-2-3
Optics upgrade 1-2-3
Optical bench deluxe edition (RED Light)

RED Motion Sensor Adapter for Mechanics Multiuse

4831.01

This adapter has been conceived to mount the motion sensor on the linear track to perform experiments on mechanics.

This simple adapter has been developed in order to provide a proper alignment between RED motion sensor and components.

◀ *4831.01*

Specifications
Size: approx. Dia. 3x5 cm
Weight: approx. 0.1 kg

Items to be used with
RED Motion Sensor (code 4840.12)
Altay track set (code 4954.11)

Equipment Suggested
Mechanics upgrade 1(code 4941.14)
Eddy Current set (code 4941.51)

Adapters

RED Force Sensor Adapter for Cart

4831.02

A new way to use the RED force sensor for studying collisions

▲ *4831.02*

Specifications
Size: approx. 11x6x4 cm
Weight: approx. 0.2 Kg

Items to be used with
RED Force Sensor (code 4840.14)
Altay cart without plunger (code 4941.12)
Altay cart with plunger (code 4941.13)

Compatible Altay's items
Mechanics upgrade 1 (code 4941.14)

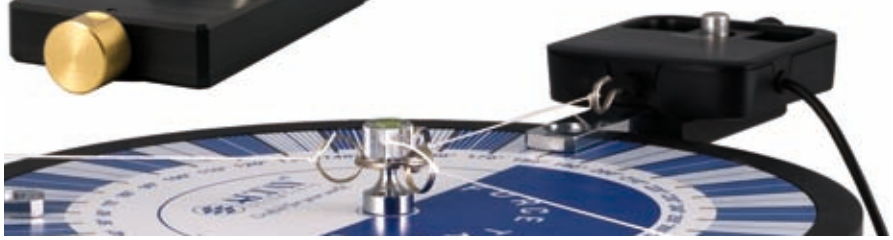
This adapter has been conceived to mount the force sensor on the Altay's cart in order to perform experiments on elastic and inelastic collisions

RED Force Sensor Adapter for Force Table

4831.03

A unique solution to employ the RED force sensor together with the Varignon's table

◀ *4831.03*



Specifications
Size: approx. 9x4x4 cm
Weight: approx. 0.1 kg

Items to be used with
RED Force Sensor (code 4840.14)
Force table (code 4114.11)

The use of RED force sensor together with the Altay's force table allows us to verify the parallelogram rule on composition of forces

RED Light Adapter for Optics Multiuse

4831.04

A versatile solution to use the light sensor to perform experiments on the linear track

◀ *4831.04*

Specifications
Size: approx. Dia. 3 x10 cm
Weight: 0.1 Kg

Items to be used with
RED Light Sensor (code 4840.18)
Track set (code 4954.12)

Equipment Suggested
Optics upgrade1 (code 4944.11)
Optics upgrade2 (code 4944.20)
Optics upgrade3 (code 4944.30)

This adapter has been conceived to mount the light sensor on the linear track to perform experiments on optics.
This simple adapter has been developed in order to provide a proper alignment between RED light sensor and optics components.

RED Force Sensor Adapter for Inclined Plane

4831.05

A unique and easy way to mount the force sensor on inclined plane

◀ *4831.05*

Specifications
Size: approx. Dia. 1x5 cm
Weight: 0.1 kg

Items to be used with
RED Force Sensor (code 4840.14)
Inclined plane (code 4115.10)

This adapter has been conceived to mount the force sensor on the inclined plane to perform experiments on composition of forces and gravity.

RED Universal Magnet Support

4831.06

Universal magnetic adapter for all RED sensors

◀ *4831.06*

▶ *All the RED sensors can be magnetically attached with this support*

Specifications
Size: approx. Dia. 2x2 cm
Weight: 0.1 kg

Items to be used with
RED all series

A unique way to employ the RED photogate for experiments performed on linear track and magnetic board.

Thanks to this support it is also possible to fix DAQ and all sensor heads to magnetic board or any other metallic surface.

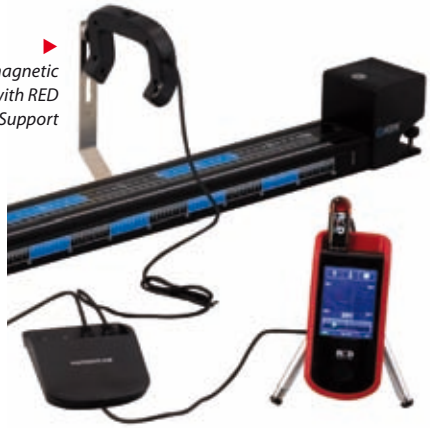
RED Photogate Support for Track Set

4831.07

The necessary support to mount the RED photogate on the linear track to perform experiments on dynamics

▶ *Special support for Photogate magnetic attachment to be used in combination with RED Universal Magnet Support*

4831.07 ▼



Specifications
Size: approx. 18x2x4 cm
Weight: 0.1 kg

Items to be used with
RED Photogate (code 4840.15)
RED Universal Magnet Support (code 4831.06)
Track set (code 4954.12)

Equipment Suggested
Mechanics upgrade 1 (code 4941.14)

This adapter has been conceived to mount the RED Photogate on the linear track in order to perform experiments on dynamics and mechanics of the collisions.

Sets

Elementary School RED Set 1

4841.01

This set features RED Data Collectors suitable for an introductory course for Elementary schools. Additional contents include 2 USB drives for storing data, 2 lanyards, 1 support rod, and a protection cage for the motion sensor.

The set includes
RED Motion Sensor (code 4840.12)
RED Light Sensor (code 4840.18)
RED Temperature Sensor Plug-In (code 4830.11)

A set of activities is outlined on the included electronic guide - you'll find three activities per type of sensor provided.

Elementary School RED Set 2

4841.02

This set features RED Data Collectors suitable for an advanced course for Elementary schools. Additional contents include 5 USB drives for storing data, 5 lanyards, 2 support rods, a protection cage for the motion sensor, a set of two alligator clip connecting leads, force hook and bumper accessory, and gas pressure accessories. A set of activities is outlined on the included electronic guide - you'll find three activities per type of sensor provided.

The set includes
RED Motion Sensor (code 4840.12)
RED Light Sensor (code 4840.18)
RED Temperature Sensor Plug-In (code 4830.11)
RED Voltage & Current Sensor (code 4840.16)
RED Gas Pressure Sensor (code 4840.17)
RED Force Sensor (code 4840.14)

Middle School RED Set 1

4841.03

This set features RED Data Collectors suitable for an introductory course for Middle schools. Additional contents include 4 USB drives for storing data, 4 lanyards, 2 support rods, a protection cage for the motion sensor, a set of two alligator clip connecting leads, a force hook, and bumper accessory. A set of activities is outlined on the included electronic guide - you'll find three activities per type of sensor provided.

The set includes
RED Motion Sensor (code 4840.12)
RED Light Sensor (code 4840.18)
RED Temperature Sensor Plug-In (code 4830.11)
RED Voltage & Current Sensor (code 4840.16)
RED Force Sensor (code 4840.14)

Middle School RED Set 2

4841.04

This set features RED Data Collectors suitable for an advanced course for Middle schools. Additional contents include 6 USB drives for storing data, 6 lanyards, 2 support rods, protection cage for motion sensor, alligator clip connecting leads, force hook, bumper accessory, and gas pressure accessories. A set of activities is outlined on the included electronic guide - you'll find three activities per type of sensor provided.

The set includes
RED Motion Sensor (code 4840.12)
RED Light Sensor (code 4840.18)
RED Voltage & Current Sensor (code 4840.16)
2 x RED Temperature Sensor Plug-In (code 4830.11)
RED pH Meter (code 4840.13)
RED Gas Pressure Sensor (code 4840.17)
RED Force Sensor (code 4840.14)

Physical Science RED Set 1

4841.05

This set features RED Data Collectors suitable for an introductory course for Physical sciences. Additional contents include 4 USB drives for storing data, 4 lanyards, 2 support rods, a protection cage for the motion sensor, a set of two alligator clip connecting leads, and force hook and bumper accessories. A set of activities is outlined on the included electronic guide - you'll find three activities per type of sensor provided.

The set includes
RED Motion Sensor (code 4840.12)
RED Temperature Sensor Plug-In (code 4830.11)
RED Voltage & Current Sensor (code 4840.16)
RED pH Meter (code 4840.13)
RED Force Sensor (code 4840.14)

Physical Science RED Set 2

4841.06

This set features RED Data Collectors suitable for an advanced level course for Physical sciences. Additional contents include 6 USB drives for storing data, 6 lanyards, 4 support rods, a protection cage for the motion sensor, picket fence, force hook and bumper accessories, gas pressure accessories, and a set of two alligator clip connecting leads. A set of activities is outlined on the included electronic guide - you'll find three activities per type of sensor provided.

The set includes
RED Light Sensor (code 4840.18)
2 x RED Temperature Sensor Plug-In (code 4830.11)
RED Voltage & Current Sensor (code 4840.16)
RED pH Meter (code 4840.13)
RED Gas Pressure Sensor (code 4840.17)
RED Force Sensor (code 4840.14)
RED Photogate Sensor (code 4840.15)

Sets

Physics RED Set 1

4841.07

This set features RED Data Collectors suitable for an introductory course for Physics. Additional contents include 4 USB drives for storing data, 4 lanyards, 4 support rods, a protection cage for the motion sensor, picket fence, gas pressure accessories, and a set of two alligator clip connecting leads.

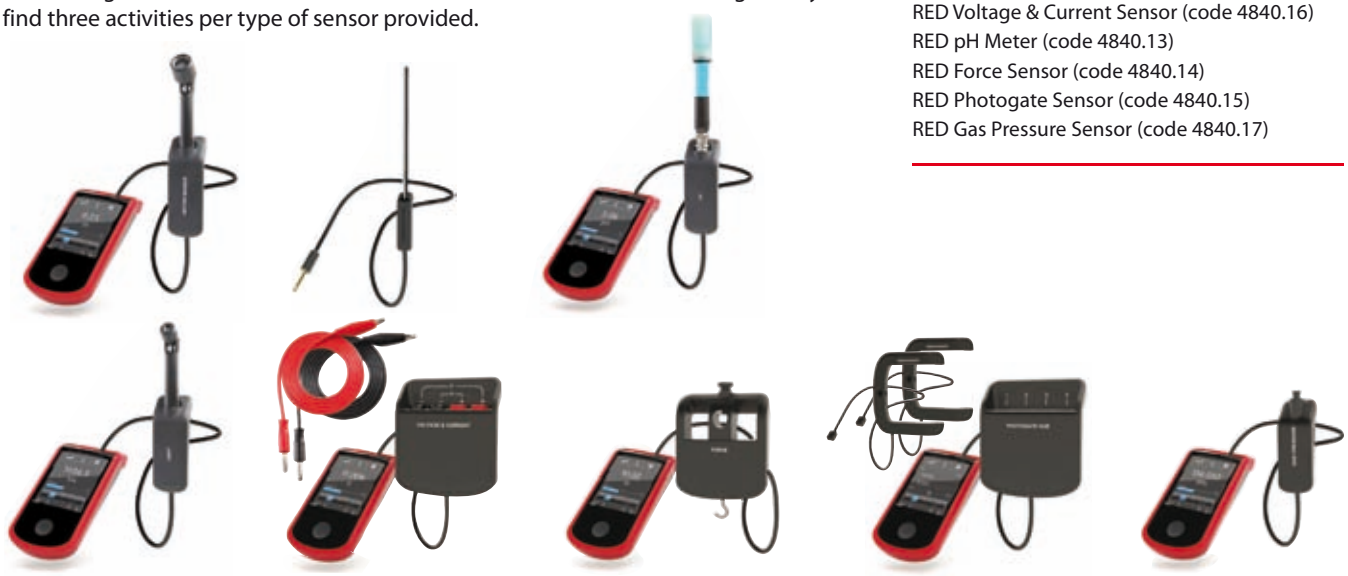
The set includes
RED Voltage & Current Sensor (code 4840.16)
RED Force Sensor (code 4840.14)
RED Photogate Sensor (code 4840.15)
RED Motion Sensor (code 4840.12)

A set of activities is outlined on the included electronic guide - you'll find three activities per type of sensor provided.

Physics RED Set 2

4841.08

This set features RED Data Collectors suitable for an intermediate level course for Physics. Additional contents include 7 USB drives for storing data, 7 lanyards, a protection cage for the motion sensor, picket fence, gas pressure accessories, and set of two alligator clip connecting leads. A set of activities is outlined on the included electronic guide - you'll find three activities per type of sensor provided.



The set includes
RED Motion Sensor (code 4840.12)
RED Light Sensor (code 4840.18)
RED Temperature Sensor Plug-In (code 4830.11)
RED Voltage & Current Sensor (code 4840.16)
RED pH Meter (code 4840.13)
RED Force Sensor (code 4840.14)
RED Photogate Sensor (code 4840.15)
RED Gas Pressure Sensor (code 4840.17)

Physics RED set 3

4841.13

This set features RED Data Collectors suitable for an advanced level course for Physics. Additional contents include 9 USB drives for storing data, 9 lanyards, 4 support rods, a protection cage for the motion sensor and gas pressure sensor accessories. A set of activities is outlined on the included electronic guide - you'll find three activities per type of sensor provided.

The set includes
RED Voltage & Current Sensor, (code 4840.16)
RED Motion Sensor, (code 4840.12)
RED Light Sensor, (code 4840.18)
RED Microphone, (code 4840.19)
RED Magnetic Field Sensor (code 4840.25)
RED Photogate Sensor, (code 4840.15)
RED Temperature Sensor, (code 4840.42)
RED Force Sensor, (code 4840.14)
RED Gas Pressure Sensor, (code 4840.17)

Sets

Physics RED set 3

Life Science RED Set 1

4841.10

This set features RED Data Collectors suitable for an introductory level course for Life sciences.

The set includes
2 x RED Temperature Sensor Plug-In (code 4830.11)
RED Gas Pressure Sensor, (code 4840.17)
RED pH Meter (code 4840.13)

Additional contents include 2 USB drives for storing data, 2 lanyards, and gas pressure accessories. A set of activities is outlined on the included electronic guide - you'll find three activities per type of sensor provided.

Life Science RED Set 2

4841.14

This set features RED Data Collectors suitable for an advanced level course for Life sciences. Additional contents include 6 USB drives for storing data, 6 lanyards, 3 support rods and gas pressure sensor and dissolved oxygen accessories. A set of activities is outlined on the included electronic guide - you'll find three activities per type of sensor provided.

The set includes
RED Gas Pressure Sensor, (code 4840.17)
RED CO_2 Gas Probe (code 4840.24)
RED Dissolved Oxygen Probe (code 4840.23)
RED pH Meter (code 4840.13)
RED Blood Pressure Sensor (code 4840.36)
RED Temperature Sensor Plug-In (code 4830.11)
RED EKG Probe (code 4840.22)

Sets

Chemistry RED Set 1

4841.09

This set features RED Data Collectors suitable for an introductory level course for Chemistry.

The set includes
RED Temperature Sensor Plug-In (code 4830.11)
RED Voltage & Current Sensor (code 4840.16)
RED Gas Pressure Sensor (code 4840.17)
RED pH Meter (code 4840.13)

Additional contents include 3 USB drives for storing data, 3 lanyards, gas pressure accessories, and a set of two alligator clip connecting leads. A set of activities is outlined on the included electronic guide - you'll find three activities per type of sensor provided.

Environmental RED set 1

4841.11

The set includes
RED pH Meter (code 4840.13)
RED Temperature Sensor (code 4840.42)
RED CO_2 Gas Probe (code 4840.24)
RED Dissolved Oxygen Probe (code 4840.23)
RED Voltage & Current Sensor (code 4840.16)
RED Light Sensor (code 4840.18)

This set features RED Data Collectors suitable for an introductory level course for Environmental sciences. Additional contents include 6 USB drives for storing data, 6 lanyards, 2 support rods and dissolved oxygen sensor accessories. A set of activities is outlined on the included electronic guide - you'll find three activities per type of sensor provided.

Physiology RED set 1

4841.12

This set features RED Data Collectors suitable for an introductory level course for Physiology. Additional contents include 3 USB drives for storing data, 3 lanyards, 2 support rods and EKG sensor accessories. A set of activities is outlined on the included electronic guide - you'll find three activities per type of sensor provided.

The set includes
RED EKG Probe (code 4840.22)
RED Blood Pressure Sensor (code 4840.36)
RED Temperature Sensor Plug-In (code 4830.11)

POWER SUPPLY

A switching-mode power supply (also SMPS) is an electronic power supply unit (PSU) that incorporates a switching regulator: while a linear regulator maintains the desired output voltage by dissipating excess power in a pass power transistor, the SMPS rapidly switches a power transistor between saturation (full on) and cutoff (completely off) with a variable duty cycle whose average is the desired output voltage.

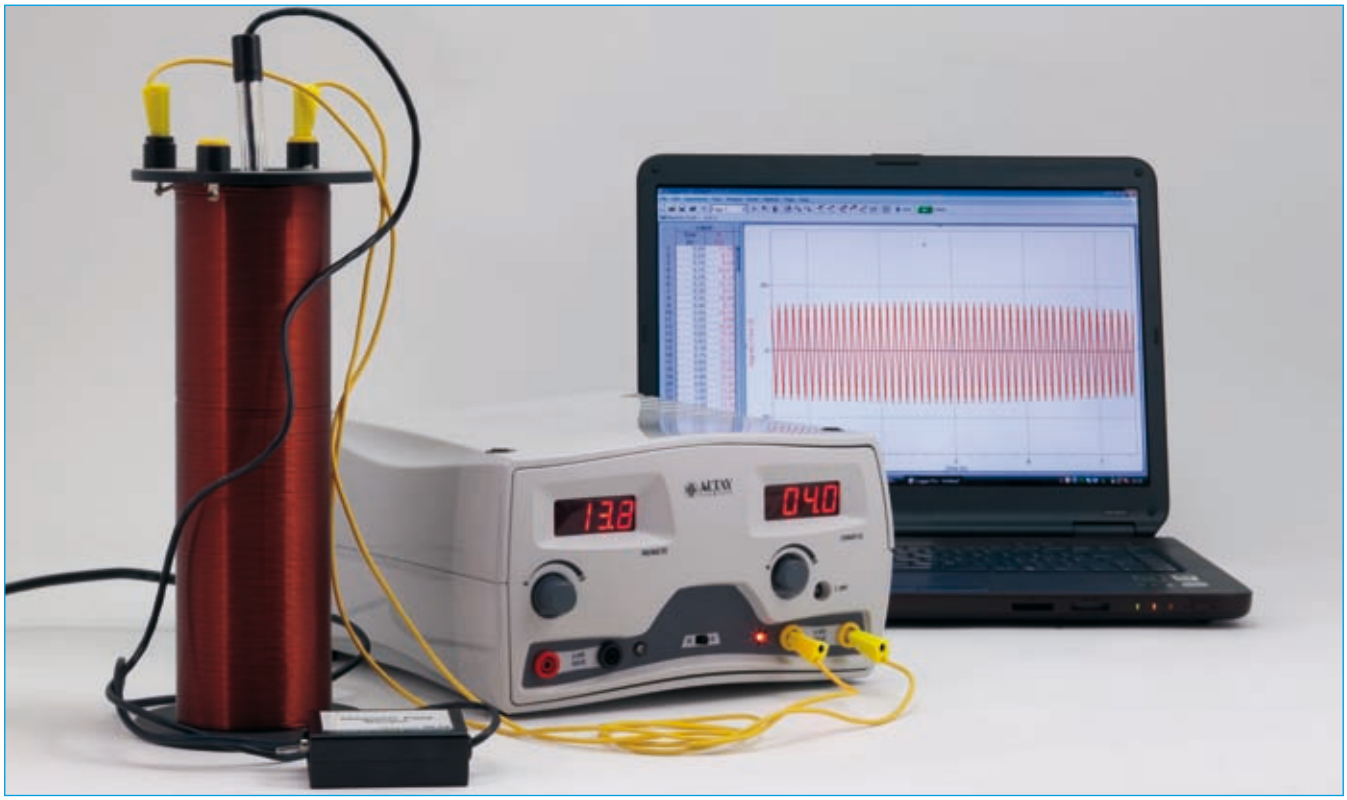
The main advantage of this method is the greater efficiency: compared to the semiconducting state, the switching transistor dissipates less power while working in the saturated and in the off states.
Eliminating the low frequency transformers, a SMPS is smaller size and lighter than a standard Power Supply Unit, generating at the same time less heat due to higher efficiency.

142 POWER SUPPLY 10A AC/DC

143 POWER SUPPLY 30A DC

143 POWER SUPPLY 5KV DC

144 POWER SUPPLY 1.5A DC



Altay's Power Supplies are a must in any laboratory, providing reliability in any condition ▲

- **UNIQUE SWITCHING-MODE POWER SUPPLY**
- **HIGHLY STABLE VOLTAGE**
- **UNIVERSAL INPUT**
- **STACKABLE**
- **DIGITAL**
- **ABS SHOCK-RESISTANT MATERIAL**

◀ *It is easy to stack the power supplies to save space* ▶

The Power Supplies are designed to work with all the Altay apparatus ▼

Power supply 1.5A AC/DC

2407.70

0-30V AC/DC, 1.5A

The Power Supply 1.5 A is a useful equipment for every laboratory: it can be used to perform a large variety of experiments and to supply power to a wide range of equipment. It is provided with separated AC/DC outputs and with a current limitator.
Specify in your order the cable that fits the requirement of your electrical standard.

Specification

AC INPUT	Universal mains from 90V to 240V AC, 50/60Hz
OUTPUT	Continuously variable from 0V to 30V AC/DC – 1.5A max (AC output synchronized with the mains frequency)
DISPLAY	Single display "4 digit meters"
GENERAL	Safety sockets output
	DC/0/AC switch
	Ripple noise 1% at 1.5A max
	CE Compliant with EN61010-1 and EN61326
DIMENSIONS	approx. 25x20x9 cm

Power supply 10A AC/DC

2407.75

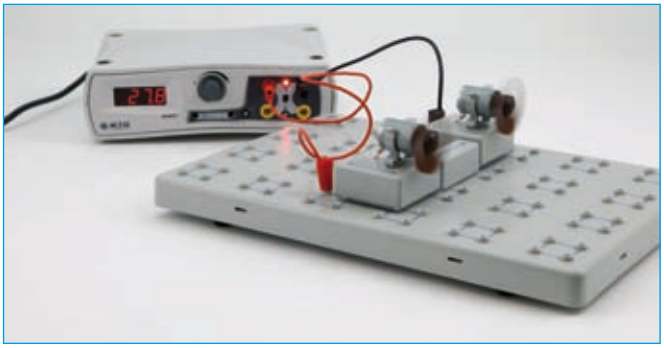
0-30V AC/DC, 10A

With the Power Supply 10 A it is possible to supply power to every equipment needing high currents. It is provided with two displays (one for voltage and one for current) and separated AC/DC outputs.
Specify in your order the cable that fits the requirement of your electrical standard.

Specification

AC INPUT	Universal mains from 90V to 240V AC, 50/60Hz
OUTPUT	Continuously variable from 0V to 30V AC/DC and from 0A to 10A (AC output synchronized with the mains frequency)
DISPLAY 1	4 digit meters for voltage monitoring
DISPLAY 2	4 digit meters for current monitoring with presetting limitation
GENERAL	Safety sockets output
	Switch for AC/DC output selection
	Current limitation
	Ripple noise 1% at 10A max.
	CE Compliant with EN61010-1 and EN61326
DIMENSIONS	approx. 25x27x15 cm

Power Supply 1.5 A working with the Electricity System 2 ▼



Power Supply 10 A powering the Barlow's Wheel ▼

Power supply 30A DC

2407.65

0-12V DC, 30A

This Power Supply is the best solution for all the equipment needing very strong DC currents.
Specify in your order the cable that fits the requirement of your electrical standard.

Specification

AC INPUT	Universal mains from 90V to 240V AC, 50/60Hz
OUTPUT	Continuously variable from 0V to 12V DC – 30A max
DISPLAY 1	4 digit meters for voltage monitoring
DISPLAY 2	4 digit meters for current monitoring with presetting limitation
GENERAL	Safety sockets output
	Ripple noise 1% at 30A max
	CE Compliant with EN61010-1 and EN61326
DIMENSIONS	approx. 20x27x15 cm

Try this power supply with the Circular Coil ▼

Power supply 5kV DC

2407.05

5 kV, 5 mA

Providing multiple outputs, this power supply is useful in many experiments: spectrum tubes, e/m apparatus.
Specify in your order the cable that fits the requirement of your electrical standard.

Specification

AC INPUT	Mains 115/230V AC, 50/60Hz
OUTPUT 1	Continuously variable from 0V to 5kV DC – 5mA max
OUTPUT 2	Output fixed 6.3V AC – 3A max
OUTPUT 3	Output fixed 9V DC – 2A max
OUTPUT 4	Continuously variable from 0V to 300V DC – 50mA max
DISPLAY	4 digit meters for voltage monitoring for output 1 & 4
GENERAL	Safety sockets output
	Led for current limitation
	Ripple noise 1% for all output
	CE Compliant with EN61010-1 and EN61326
DIMENSIONS	approx. 20x27x15 cm

The 5 kV Power Supply powering the Spectrum Tube ▼

Multitap Transformer

2403.70

A general purpose laboratory transformer

This transformer is very useful in physics, electricity and electronics laboratories for multiple outputs at different voltages.
Specify in your order the cable that fits the requirement of your electrical standard.

Specification

AC INPUT	Mains 115/230V AC , 50/60Hz
OUTPUT	3V - 6V - 9V - 12V AC – 1A max
DISPLAY:	4 digit meters for current monitoring
GENERAL	Safety sockets output
	CE Compliant with EN61010-1 and EN61326
DIMENSIONS	approx. 25x20x9 cm

Power supply 1.5A DC

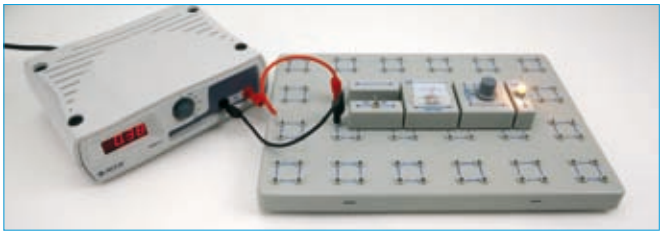
2407.80

3- 4.5 - 6 - 7.5 - 9 - 12V DC - 1.5A

Sturdy and reliable, the transformer allows output selection in an easy way. Specify in your order the cable that fits the requirement of your electrical standard.

Specification

AC INPUT	Mains 115/230V AC, 50/60Hz
OUTPUT	Fixed outputs 3V – 4.5V – 6V – 7.5 – 9V – 12V DC – 1.5A max
DISPLAY	4 digit meters for current monitoring
GENERAL	Safety sockets output
	CE Compliant with EN61010-1 and EN61326
DIMENSIONS	approx. 25x20x9 cm



Cables for Power Supply

Provide the power to your own circuits with this transformers and Altay's Electricity and Electronics Systems.

CODE	Descriptioni
ECAV0010	Cable, UK to IEC/VDE
ECAV0011	Cable, USA to IEC/VDE
ECAV0012	Cable, UE to IEC/VDE
ECAV0034	Cable, PRC to IEC/VDE

The Multitap Transformer used with Electricity System 2 ▲

DATALOGGERS & SENSORS

Our comprehensive range of dataloggers and sensors can work with a variety of Altay Physics apparatus providing accurate acquisition and manipulation of data.
Our sensors are portable, versatile and easy to use guaranteeing consistent accuracy in all circumstances – whether in the classroom or on a field trip, learning physics becomes meaningful and fun.

146 WIRELESS DYNAMICS SENSOR SYSTEM

146 LABQUEST 2

148 LOGGERPRO 3

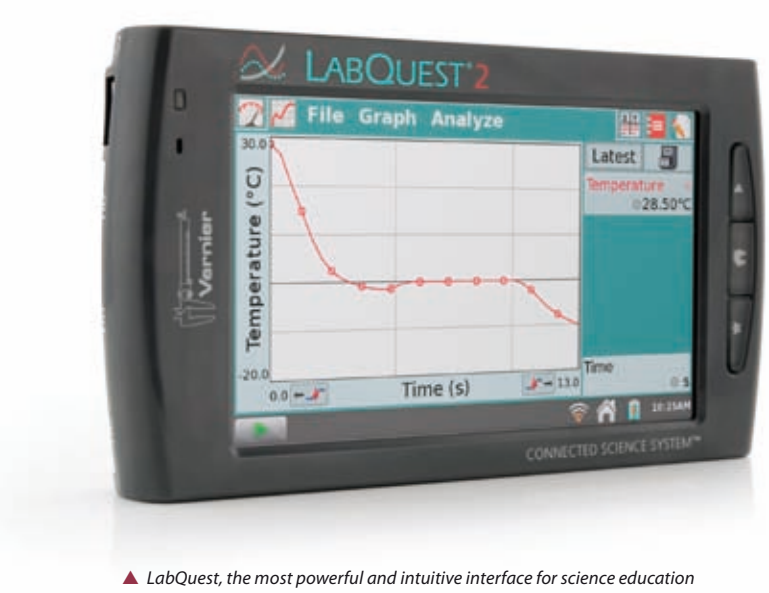
149 ROTARY MOTION SENSOR

LabQuest 2

2300.35

The freedom to inquire. The technology to excel

LabQuest 2 is the most powerful and intuitive interface for science education. Engage your students with hands-on science in your classroom or in the field.



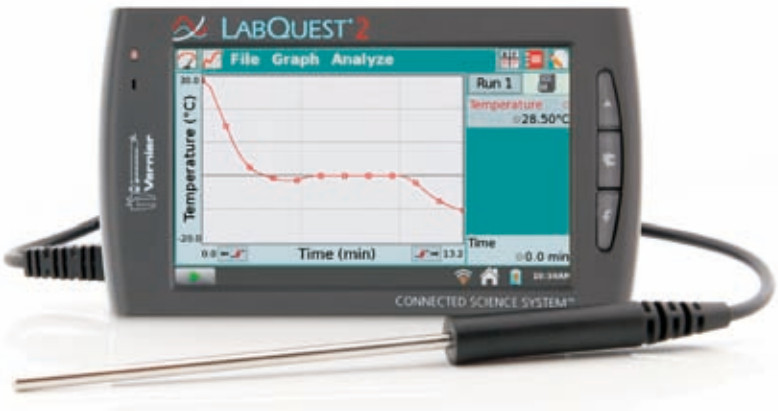
▲ *LabQuest, the most powerful and intuitive interface for science education*

Vernier LabQuest 2 is a standalone interface used to collect sensor data with its built-in graphing and analysis application. The large, high-resolution touch screen makes it easy and intuitive to collect, analyze, and share data from experiments. Its wireless connectivity encourages collaboration and personalized learning.
You can also use LabQuest 2 as a computer interface using Logger Pro software for advanced analysis and video features.

Features of LabQuest
- Standalone and computer interface with a touch screen
- Compatible with all Vernier sensors
- Fast data collection
- Rechargeable, high-capacity battery
- Compatible with Windows and Macintosh computers
- Free software updates

New for LabQuest 2
- Collect, analyze, and share sensor data wirelessly on any device with a web browser
- Larger and higher resolution screen with portrait and landscape orientations
- Additional built-in sensors such as GPS and accelerometers
- Faster processor for fast analysis and graphing

Hardware
- Large, high-resolution touch screen
- Built-in sensors such as GPS and accelerometers
- Wireless connectivity with Wi-Fi and Bluetooth
- Fast data collection with 100,000 samples per second



Technical Specifications

Display
- 11.2 cm x 6.7 cm (13.1 cm diagonal) screen
- 800 x 480 pixel color display at 188 dpi
- LED backlight
- Portrait or landscape screen orientation
- High-contrast mode for outdoor visibility

Processor
- 800 MHz Application Processor
- Connectivity
- Wi-Fi 802.11 b/g/n
- Bluetooth for WDSS

User Interface
- Resistive touch screen
- Touch and stylus navigation for efficiency and precision

Data Acquisition
- 100,000 samples per second
- 12-bit resolution
- Built-in GPS, 3-axis accelerometer, ambient temperature, light, and microphone

Environmental Durability
- Operating Temperature: 0 – 45°C
- Storage Temperature: -30 – 60°C
- Splash resistant
- Rugged enclosure designed to withstand a fall from lab bench

Size and Weight
- Size: 8.8 cm x 15.4 cm x 2.5 cm
- Weight: 350 g

Ports
- 5 sensor channels
- USB port for sensors, flash drives, and peripherals
- USB mini port
- DC power jack
- MicroSD/MMC slot
- Audio in and out

Interfaces

Connected Science System
- The Connected Science System is a networked collection of probeware technology that supports hands-on, collaborative learning with individualized accountability. Students can collect, view, analyze, and annotate data on an iPad or any device with a compatible web browser.

Curriculum
- Student instructions for over 100 of Vernier's most popular experiments included
- Customizable library of Vernier experiments
- Import your own experiments into LabQuest 2

Storage
- 200 MB
- Expandable with MicroSD and USB flash drive

Power
- Rechargeable, high-capacity battery
- DC charging/powering through external adapter (included)

Software
- Real-time graphing and live sensor data display
- Powerful analysis with linear and curve fits
- Built-in periodic table, stopwatch, scientific calculator, and more
- Touch and stylus navigation for efficiency and precision

Wireless Dynamics Sensor System

2300.20

Force, acceleration, altitude. All in one, all wireless

◀ *Wireless Dynamics Sensor System, the wireless solution for datalogging*

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

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.

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/s^2 (±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 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

LoggerPro 3

2300.50

Real-time graphing and powerful analytical tools

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.

LoggerPro 3 Software

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 PoweredTM 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

Specifications
Designed for Windows XP
Mac OS X Native
Software of choice for Apple® Mobile Science Labs
Available in multiple languages

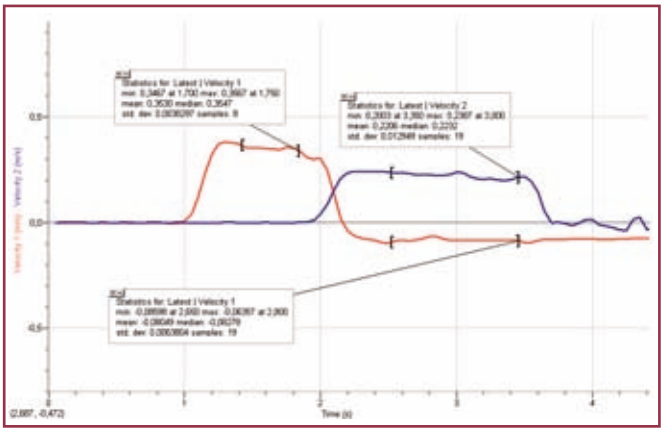
Analysis tools
Draw predictions on graphs prior to collecting data
Determine statistical information about data
Perform a linear regression
Fit a curve to data
Model data with an equation

Compatibility
LabPro
Go!Temp
Go!Link
Go!Motion
Vernier Spectrometer
Garmin GPS
Wireless Dynamics Sensor System
Ohaus Balances

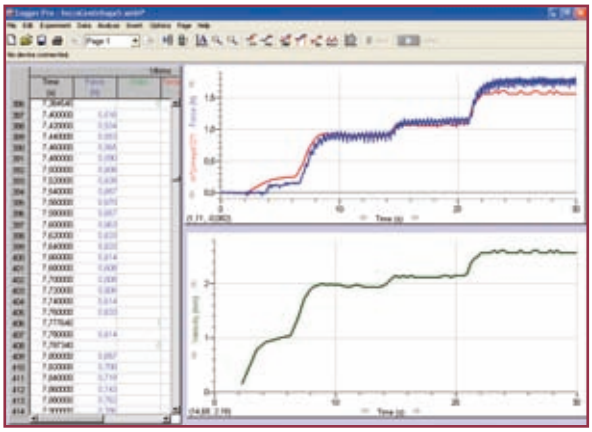
Features
Video capture
GPS data collection
Vernier Spectrometer and Ocean Optics support
Date and time stamps for long-term collection
User-adjustable parameters for total control over calculations
Double y-axis graphs for plotting unlike units on the same graph
Collect data from multiple LabPros, Go! devices, or Ohaus balances
Synchronize videos to sensor data
Easy unit switching
Log graphs
Auto-save feature to protect data during long collections

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*

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.

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 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/s^2
Typical Accuracy: ±1 m/s^2

Also available
Range: -50 ÷ +50 m/s^2
Typical Accuracy: ±0.1 m/s^2

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.

Specifications
Range: 0 ÷ 210 kPa, (0÷2.1 atm or 0÷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)

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

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.

Charge Sensor

2313.10

Ideal for quantitative measurements

The Charge Sensor is used as an electronic electroscope. Unlike a traditional electroscope, 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 used to measure charge polarities. An extremely high impedance voltage sensor with a 0.01F input capacitor makes these measurements possible. The sensor has three operating ranges and a zeroing switch to discharge the input capacitor.

Specifications

Ranges: ±0.5 V (+/- 5 nC), ±2 V (+/- 20 nC), ±10 V (+/- 97 nC)
Typical bias current: 0.005 pA
Input capacitance: 0.01 µF

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 ÷ +6.0 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 ±6.0 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 ÷ +6.0 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 ÷ +6.4 mT
High Sensitivity: -0.32 ÷ +0.32 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 mV ÷ +1,100 mV signal to the 0 ÷ 5 V range of the LabPro.

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°C. It can be used to measure flame temperatures as high as 1,400°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 ÷ 1,400°C
Typical Accuracy: 0 ÷ 900°C: ±2°C,
-200 ÷ 0°C: ±5°C, 900 ÷ 1,400°C: ±15°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 ÷ 125°C
12-bit Resolution (LabPro, Go!Link): 0.08°C (-25 ÷ 0°C), 0.03°C (0 ÷ 40°C), 0.1°C (40 ÷ 100°C), 0.25°C (100 ÷ 125°C)
10-bit Resolution (CBL, CBL 2): 0.3°C (-25 ÷ 0°C), 0.12°C (0 ÷ 40°C), 0.4°C (40 ÷ 100°C), 1.0°C (100 ÷ 125°C)

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% (±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: ±5%

Light Sensor

2315.10

Sensor for experiments involving light

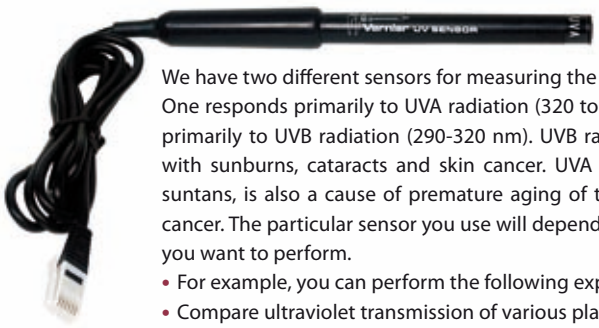
The Light Sensor emulates the human eye in spectral response and can be used over three different illumination ranges, which you select with a switch. Use it for inverse-square law experiments, studying polarizer, reflectivity, or solar energy.

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 ÷35 °C
Low Range: 0-200 µS/cm (0-100 mg/L TDS)
12-bit Resolution (LabPro, Go!Link): 0.1 µS/cm –
10-bit Resolution (CBL, CBL 2): 0.4 µS/cm
Medium Range: 0-2000 µS/cm (0-1000 mg/L TDS)
12-bit Resolution (LabPro, Go!Link): 1 µS/cm –
10-bit Resolution (CBL, CBL 2): 4 µS/cm
High Range: 0-20000 µS/cm (0-10000 mg/L TDS)
12-bit Resolution (LabPro, Go!Link): 10 µS/cm –
10-bit Resolution (CBL, CBL 2): 40 µS/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: +/-50 m/s^2 (+/-5g)
Accuracy: +/-0.5 m/s^2 (+/- 0.05g)
Frequency Response: 0 to 100 Hz

GENERAL ACCESSORIES

To complete Altay's full range of products, we propose a wide variety of accessories, and auxiliary electronic devices!

156 SPHEROMETER

158 OSCILLOSCOPE

158 PHOTOGATE

159 GEIGER MÜLLER COUNTER

Tape Measure

2211.10-15

Basic measuring tools for the school lab

A low cost flexible steel ruler ideal for any school laboratory. Comes in different lengths with thumb lock.

Specifications
Length: 2m (code 2211.10)
Length: 3m (code 2211.12)
Length: 5m (code 2211.15)

Vernier Caliper

2213.10

The original accurate measuring tool

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!

Specifications
Range: 0 ÷ 160 mm
Sensitivity: 0.05 mm
Weight: 0.2 kg

Goniometric Circle

2216.10

Angle measurement instrument

The Goniometric Circle is a useful device to measure angles. The yellow - blue scale facilitates the measurement. 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: Dia. 21x1cm - Weight 0.1 kg).

Specifications
Size: Dia. 21x0.5 cm
Weight: 0.1 kg
Range: 0 ÷ 360°
Sensitivity: 1°

Micrometer Screw Gauge

2213.15

A precise instrument to measure thickness of a material

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.

Specifications
Range: 0 ÷ 25 mm
Sensitivity: 0.01 mm
Weight: 0.2 kg

Spherometer

2215.01

Precisely measure curve surfaces

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.

Specifications
Range: -10 ÷ +10 mm
Sensitivity: 0.005 mm
Weight: 0.2 kg

Micrometer Dial Gauge

2214.00*

Length comparator

The Micrometer Dial Gauge allows precise measurement of differences in length.
It is very useful in the study of the thermal expansion in solids.

Specifications
Range: 0 ÷ 10 mm
Sensitivity: 0.01 mm
Weight: 0.2 kg

** Minimum Order Quantity 5 pcs*

Precision Mass Set

2220.60-66*

A complete set of masses for daily use in laboratory. Available with different masses set, from 1 mg to 1 kg.

Specifications
Range: 1 mg ÷ 50 g
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*)

Tubular Spring Balances (Metal)

4110.01-07*

Dynamometer

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.

Specifications
Range:
1 N (code 4110.01)
3 N (code 4110.03)
6 N (code 4110.05)
10 N (code 4110.07)

Tubular Spring Balances (Plastic)

4110.20-24*

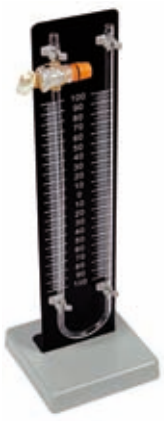
Dynamometer

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)

U-Tube Manometer

2242.20

A manometer made from a U-tube glass, 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 while the reference pressure (which may be atmospheric) is applied to the other. The difference in liquid level represents the applied pressure.



Specifications
Range: 0 ÷ 100 mm
Sensitivity: 1 mm

Digital Chronometer

2231.52

Handy to use LCD stopwatch with single memory function.

Specifications
Accuracy: 0.01 sec

Analogue Chronometer

2231.05

Mechanical stopwatch for time measurement.

Specifications
Main quadrant:
0 ÷ 60 sec
Secondary quadrant:
0 ÷ 30 min
Sensitivity: 0.1 sec

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

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.

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)

Digital Teslameter

2280.50

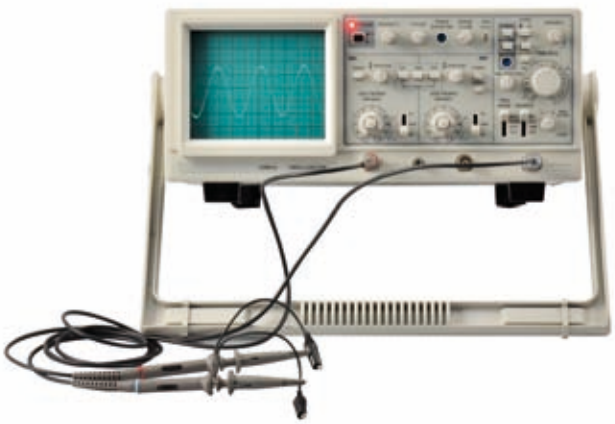
All in one solution for measuring alternating and direct magnetic fields. With digital display, zero point adjustment, analogue output. Supplied with probe, and power supply.

Specifications
Ranges: 20 mT, 200 mT, 2,000 mT

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/ 1OHz—25MHz; Mode: Ch1, Ch2, Dual, ADD; Deflection: 5mV/div ~ 5V/div, 10 step, ±5%; Mag. ratio: x5, ±10%; Rise time: <8.8ns; Impedance: 1MΩ, 25pF (direct); Max. voltage: 300V(DC+ACpeak), 400V via probe

Horizontal System
Sweep mode: X1, X5; X1, X5alter; Sweep rate: 0.2S~0.1μS/div, ±5%; Mag. ratio: x5, ±10%; Trigger System; Mode: auto, normal, TV-V, TV-H; Trig source: INT, CH2, LINE, EXT; Trig sensitivity: 1OHz—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 ±2%, 1kHz

Also available
40 Mhz Oscilloscope (code 2280.80); 100 Mhz Oscilloscope (code 2280.90)

Digital Multimeter

2275.10

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.

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 kΩ, 20 k Ω, 200 kΩ, 2 MΩ, 20 MΩ, 200 MΩ
Farad: 2 nF, 20 nF, 200 nF, 2 µF, 20 µF

Alcohol Thermometer

2245.15 -25*

Measure temperature

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.

Specifications
2245.15 - Range: -10°C ÷ +110°C
Accuracy: 1°C
2245.25- Range: -10°C ÷ +200°C
Accuracy: 2°C

** Minimum Order Quantity 5 pcs*

Geiger Müller Counter

2236.00

A simple radiation measuring instrument

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.

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

Function Generator

2290.10

Advanced functions generator for circuit tests

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.

Specifications
Input: 220 V, 50 Hz
Output: Frequency Range: 0.01 ÷ 10 Mhz
Amplitude Range: 10 Vpp 50 W
Output Impedance: 50 Ω +/- 10%
Complete datasheet available on request

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 ÷ 200 Hz,
100 ÷ 2 kHz, 1 kHz ÷ 20 kHz
Amplitude Range: 0 ÷ 20 Vpp
Output Impedance: 4 Ω, 600 Ω

Electronic Digital Timer Set (Stopwatch edition)

2232.56

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.

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
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

Transformer

2403.64-61

AC Transformer for multiple applications

These general purpose transformers are useful in many applications in schools, as supply unit for lamps, circuits and so on.

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

Universal Base

5405.70

Universal base designed for a wide variety of uses

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.

Specifications
Complete Universal Base
(code 5405.70)

▲ *Base mount sample*

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 Dia.

** Minimum Order Quantity 5 pcs*

Laboratory Jack

5406.30-34

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.

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)

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 17x15 cm – Rod lenght 50 cm

5404.55
Base 25x16 cm – Rod lenght 65 cm

5404.60
Base 32x20 cm – Rod lenght 80 cm

Bosshead

** Minimum Order Quantity 5 pcs*

5401.22*

This Bosshead is the simplest solution to clamp 10 mm diameter rods.
Made of hard PVC, is inexpensive but really durable.

Connecting Leads

2522.02-14*

Fundamental to all electrical and electronics experiments

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.

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)

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.

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.

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.

Consumables

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

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*

Vacuum Pump

4184.21

Specially designed pump that removes gas molecules from a sealed volume in order to leave behind a partial vacuum.

Specifications
Air bleeding speed:
1.5 m3/h
Pressure limit: 10 ÷ 30 Pa
Noise: ≤ 65 dB
Size: 30x15x25cm
Weight: approx. 7.5 kg

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)

ALTAY MOBILE LAB

All you need for physics, chemistry and biology experiments
in a compact and mobile cart

Altay Mobile Lab

4915.00

This is a stand alone system designed for 11-15 years old students and particularly useful for all those educational environments lacking equipped science classrooms.

Specifications
Size: approx. 92x65x148 cm
(height/depth/width)
Weight: approx. 180 kg

▲ *Mechanics*

The cart is completely mobile and has 5 storage drawers, protecting your equipment in shock-free, moulded sponge pods.
The drawers pull all of the way out providing safe yet easily accessible storage of your valuable equipment.
All equipment are organized by scientific discipline for quick and easy set-up and equipment control.
Do all of your science experiments on the acid resistant work surface.
The Altay Mobile Science Laboratory is designed for easy access to water, gas and electricity.
It is ideal for all teaching environments and its modular design guarantees flexibility and adaptability for all of your science experiments.

▲ *Electricity - Thermology - Magnetism*

▲ *Optics - Acoustic - Accessories*

▲ *Biology - Accessories*

▲ *Chemistry*

ALTAY MOBILE LAB

Description and Technical Specifications

Altay's MOBILE LAB® cart comes with a universal power supply equipped to operate with any user voltage – just connect the cart to an electrical outlet, flip the switch and you are ready to go.

STRUCTURE AND MATERIALS OF THE CART

The main structure of our MOBILE LAB® is made of sturdy, acid-resistant aluminium, while the front, back and side panels of the cart are made in mild steel oven-painted by using special coat resistant to chemicals, scratches and fire.

The top and the cover sink are made in chemical resistant HPL The sink is acid-resistant polypropylene (approx. height/ depth/width 15x30x20 cm), the water tap is in stainless steel and folds down if necessary.

WATER SUPPLY

- There are 2 tanks made of acid-resistant polyethylene, each with a capacity of 10 litres.
  One pumps clean water to the tabletop tap; the other works as sewage system and is connected to the sink drain.

SECURITY SYSTEM

- One portable powder extinguisher (1 kg)
- One first-aid kit
- Three locking systems (left and right doors plus drawers)

GAS/SPIRIT SUPPLY SYSTEM

- The Laboratory is also provided with two burners: **one supplied by a 240g GPL cylinder and one spirit burner**

CONTROL & ELECTRIC PANEL

1. One power switch
2. One green LED when main power supply is on
3. One yellow LED when optional power supply is on
4. One water pump button with LED
5. One switching-mode power supply with the following characteristics:
- Output voltage range: 0 - 12 Vdc
- Output current range: 0 - 8 A
- One digital voltmeter and one digital ammeter
- Max power: 100 W
- Short circuit and overload protection

The electric panel includes the following:

6. One 110/125 VAC socket; 50/60 Hz
7. Two 220/240 VAC socket; 50/60 Hz
8. Additional sockets are included in the back panel of the cart

HIGH QUALITY WHEELS

- The mobile cart uses zinc plated pressed steel wheels, two with breaks, dia. 12.5 cm maximum static load 150 Kg each, (600 kg total).

POWER CORD SYSTEM

- The cart is provided with a 6 meter re-winding power cord to allow easy access to the nearest electrical source.

The MOBILE LAB® is supplied with
Multilingual Instruction Manuals
(English, French, Portuguese, Spanish, Polish, Romanian, Arabic, Chinese)

*featuring more than **80 EXPERIMENTS** and procedures. The Manual contains a Teacher guideline for experiments setup as well as student work sheets.*

LIST OF EXPERIMENTS YOU CAN PERFORM WITH THE ALTAY MOBILE LAB®

BIOLOGY

Plant Physiology Experiments

- Capillarity – the stem
- Cell turgor practical implications
- Chromatography
- Osmosis
- Osmosis in cells
- Osmosis in potatoes
- Osmosis in potatoes: effects of the concentration
- Osmosis in roots
- Oxygen in water
- Pollen germination
- Starch in leaves
- The pulp of fruits

CHEMISTRY

Experiments of General Chemistry

- Accumulators
- Acid base reactions
- Carbon dioxide properties
- Carbon dioxide production
- Colloids and properties of colloids
- Conductivity and concentration
- Conservation of matter
- Coordination complexes
- Corrosion and cathodic protection
- Daniell cell
- Diffusion in solution
- Displacement (single exchange) reactions
- Effect of temperature on solubility
- Electrolytes and conductivity
- Electrolytic processes
- Enthalpy of neutralization
- Enthalpy of crystallization
- Hydrogen production
- Iodine sublimation
- Lemon cell: an unusual source of electric current
- Melting of sulphur
- Oxygen production and oxigen properties
- Properties of hydrogen
- Salt solution cell
- Sodium carbonate and sodium bicarbonate
- Volta cell
- Water electrolysis
- Water electrolysis basic environment
- Water of crystallization
- Density of substances

PHYSICS

Mechanics

- Analytical balance and investigation of weight as a force
- Belt drive systems
- Communicating vessels
- Composition, decomposition and transmission of forces including the parallelogram law
- Hooke's law
- Inclined plane and friction
- Kinetic and potential energy
- Levers: including first, second and third class type
- Measurement of a length, concept of experimental error
- Pulleys: including fixed, mobile and differential pulleys
- Simple pendulum and spring pendulum

Heat

- Equilibrium temperature of mixed liquids
- Heat capacity of the calorimeter
- Heat sensitivity and thermal equilibrium
- Specific heat capacity of solid and liquid bodies
- Thermometer's time constant
- Solidification's temperature of paraffin

Acoustics

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

Optics

- Focal length
- Investigating mixing of colours
- Lenses laws
- Magnifier
- Microscope - telescope
- Mirrors
- Prism: composition of light
- Reflection and Refraction laws
- Shadow and penumbra
- System of lenses
- The eye
- Thin lens equation

Magnetism

- Attractive and repulsive magnetic forces
- 2D magnetic field viewer

Electricity

- Electric resistance
- Ohm's law
- Series versus Parallel circuits

INDEX

*Packaging details are approximate

PRINCIPLE REFERENCE INDEX

Principle investigated	Code
Energy conservation	4130.20 4130.50 4132.10 4150.00 4861.29 4941.14
Energy conversion	4215.20
Energy levels	4455.02
Energy transfer	4941.16
Energy transformation	4866.29
Energy,kinetic	4132.10
Energy, potential	4132.10
Energy, transformation	4866.29
Enthalpy of crystallization	7615.01
Enthalpy of neutralization	7615.01
Enthalpy of solution	7615.01
Equilibrium of a material point	4114.35
Equilibrium position	4915.00
Equilibrium temperature	4862.19 4915.00
Evaporation	4862.19
Extraction with solvent	7610.01
Eye	4417.50 4417.60 4864.19 4944.11
Faraday ice pail	4865.19
Faraday's law	4867.19
Faraday-Neumann-Lenz's law	4640.60 4831.15
Fehling's test for glucose	7615.01
Fermat's principle	4864.29 4944.20
Ferromagnetism	4867.29
Focal length	4114.37 4417.50 4417.60 4864.19 4864.29 4915.00 4944.11 4944.20
Force pump	4861.39
Force, application point	4114.35
Force, balancing	4114.11 4114.35 4831.16
Force, centrifugal	4142.80 4831.17
Force, centripetal	4142.80 4831.17
Force, composition	4114.35 4861.19
Force, composition and decomposition	4915.00
Force, concept	4114.11 4114.35 4831.16
Force, couple	4114.35
Force, direction	4114.11 4831.16
Force, equilibrium of forces	4114.11 4831.16
Force, intensity measurement	4114.11 4114.35 4831.16
Force, motion	4132.10
Force, parallel	4915.00
Force, resultant	4114.35
Force, rule of the parallelogram	4114.11 4831.16
Forces applied to a rigid body with fixed axes	4114.35
Foucault currents	4941.51
Fourier's equation	4862.19
Fourier's law	4862.19
Free fall motion	4114.36 4134.00 4134.70 4941.21
Frequency	2238.10 4316.05
Frequency vs. length	4316.05
Frequency vs. mass	4316.05
Frequency vs. tension	4316.05
Friction	4138.50 4150.00 4861.29
Fruits pulp	7810.01
Fuel cell	4869.09
Galvanic cells concentration cells	7620.01
Galvanic cells with different redox couple	7620.01
Gamow, Oppenheimer, Bloch puzzle	4861.39
Gauss approximation	4417.50 4417.60 4864.19 4944.11
Geiger - Müller sensor	4832.00
Geotropism roots orientation, effects of	7810.01
Germinating plants, effect of light on	7810.01
Germination rate of seeds	7810.01
Gradient of temperature	4200.35 4831.10
Gravity acceleration	4134.70 4135.10
Gravity acceleration, measurement	4134.70 4137.40 4941.14 4941.21 4941.60
Gravity filtration	7610.01
Gravity waves	4311.80
Hagen - Poiseuille law	4861.39
Hare's apparatus	4861.39
Harmonic motion	4941.16
Hartl apparatus	4864.29 4944.20
Heat	4915.00
Heat capacity	4200.35 4200.36 4831.10 4831.14 4869.09
Heat coefficient	4200.35 4200.36 4831.10 4831.14
Heat sensitivity	4862.19 4915.00
Heat transfer	4200.35 4200.36 4831.10 4831.14
Hooke's law	4163.10 4861.19 4915.00
Humidity	4862.19
Hydraulic brake	4861.39
Hydraulic power	4869.09
Hydrogen production	7615.01
Hydrostatic balance	4163.10
Hydrostatic pressure	4180.20 4184.95 4861.39
Hygrometer	4862.19
Image charge method	4867.19
Impulse - momentum theorem	4941.14
Inclined plane	4114.35 4115.10 4831.18 4915.00
Inclined plane, friction	4861.19
Inductance	4640.75 4731.00 4831.11 4866.19
Inelastic collisions	4130.20 4132.10 4861.29 4941.14
Inertial mass	4132.10
Inertia's law	4861.29 4941.14
Interference	4311.80 4317.90 4864.39 4944.30
Inverse square law	4417.50 4417.60 4864.19 4864.29 4944.11 4944.20

Principle investigated	Code
Inversion of sucrose	7615.01
Investigating Hardness of water	7610.01
Investigating the law of mass conservation	7615.01
Iodine detection	7615.01
Iron core	4731.00
Iron Oxidation States	7610.01
Isochronous oscillations	4114.35 4134.70 4136.50 4137.40 4831.19 4915.00 4941.16 4941.21
Joule's law	4230.65 4862.19
Joules and calories	4235.10
Jurin's law	4182.20 4861.39
Kinetic and potential energy	4861.19 4861.29 4941.14
Kinetic energy	4150.00
Kirchhoff's laws	4831.11 4866.19
Laplace's law	4646.10 4646.15
Laser	4944.30
LED	4868.19
Length	4915.00
Lens power	4417.50 4417.60 4864.19 4944.11
Lens, biconcave and biconvex	4114.37 4417.50 4417.60 4864.29 4944.20
Lens, convergent and divergent	4417.50 4417.60 4864.19 4944.11
Lens, thin lens equation	4417.50 4417.60 4864.19 4915.00 4944.11
Lenses, system of	4417.50 4417.60 4864.19 4944.11
Lenz's law	4867.19
Levers	4114.18 4861.19 4915.00
Light emission	4445.40 4455.02 4470.10 4470.11 4470.12 4470.13 4470.14 4470.15 4470.16 4470.17
Light polarization	4417.50
Light, wavelength	4455.02
Linear motion	4132.10
Locke's law	4862.19
Lorentz's force	4646.10 4646.15
Luminosity	4866.29
Luminous intensity	4417.50 4417.60 4864.19 4944.11
Magnetic and Electrostatic Mapping	4867.19
Magnetic circuit	4867.29
Magnetic dipole	4867.19
Magnetic energy	4831.11 4866.19
Magnetic field	4731.00 4867.19 4867.29
Magnetic field and currents	4739.45 4743.05
Magnetic force	4867.19
Magnetic hysteresis	4729.00 4867.19
Magnetic induction	4640.75
Magnetic moment	4867.19
Magnetic poles	4867.29
Magnetization	4867.19
Magnification	4915.00
Magnifier	4417.50 4417.60 4864.19 4944.11
Magnifying power	4417.50 4417.60 4864.19 4944.11
Malus' law	4864.29
Manometer	4915.00
Mariotte's bottle	4861.39
Mass, measurement	4114.18
Melting of sulphur	7615.01
Metallic salts	7615.01
Metallic salts – Preparation of sodium sulphate	7615.01
Metals with Acids	7610.01
Microscope	4417.50 4417.60 4864.19 4944.11
Mirror, concave and convex	4417.50 4417.60 4864.19 4864.29 4944.11 4944.20
Mixing of colours	4864.29 4944.20
Molar Volume of a Gas	7610.01
Moment of a force	4114.18 4170.00
Moment of inertia	4138.50 4170.00
Moment of inertia, disk	4138.50
Moment of inertia, hollow cylinder	4138.50
Moment of inertia, measurement	4138.50
Moment of inertia, rod	4138.50
Momentum conservation	4114.36 4130.20 4130.50 4132.10 4861.29 4941.14
Monochromatic light	4470.10 4470.11 4470.12 4470.13 4470.14 4470.15 4470.16 4470.17
Motion, decomposition of	4135.10 4941.60
Motion, different types of	4132.10
Multiple slit diffraction	4864.39
Mutual-induction	4831.11 4866.19
Newton's 1st law	4132.10 4861.19 4861.29 4941.14
Newton's 2nd law	4132.10 4861.19 4861.29 4941.14
Newton's 3rd law	4861.29 4941.14
Newton's law of Heating or Cooling	4862.19
Nitric acid preparation	7615.01
Nitrogen in proteins	7615.01
Ohm's law	4831.11 4866.19 4867.19
Optical activity	4864.39
Oscillating system	4132.10
Oscillation's period	4170.00
Osmosis	7810.01

PRINCIPLE REFERENCE INDEX

Principle investigated	Code
Osmosis in cells	7810.01
Osmosis in roots	7810.01
Osmosis in roots II	7810.01
Osmosis in roots II effect of the concentration	7810.01
Ostwald viscometer	4861.39
Oxygen consumption: plant respiration	7810.01
Oxygen in water	7810.01
Oxygen production and properties	7615.01
Oxygen production II	7615.01
Parallel axis theorem	4138.50
Paramagnetism	4867.29
Pascal's law	4861.39
Peltier-Seebeck effect	4862.19
Pendulum's law	4114.35 4134.70 4136.50 4137.40 4831.19 4915.00 4941.16 4941.21
Perfect gas law	4861.39
pH indicator	7610.01
pH of Strong Acids and Bases	7610.01
pH of Weak Acids	7610.01
Phase transition	4862.19
Photometer, grease spot type	4417.50
Photometer, Joly type	4417.60 4864.19
Photometry	4417.50 4417.60 4864.19 4864.29 4944.11
Photoresistor	4868.19
Photosynthesis	7810.01
Photosynthesis carbon dioxide consumption	7810.01
Phototransistor	4868.19
Plane face condenser	4628.32
Plant cell respiration	7810.01
Plotting a Titration Curve	7610.01 7620.01
Polarity of solvents	7610.01
Polarization within a circuit	4868.29
Pollen germination	7810.01
Potassium manganate reduction	7615.01
Potential difference	4623.20
Potential energy	4150.00
Potentiometer	4831.11 4866.19
Power dissipation	4868.19
Precipitation of metallic hydroxides	7615.01
Preparing a germinatination bed	7810.01
Preparing a Standard Solution	7610.01
Pressure, concept	4184.48
Principle of Inertia	4132.10
Prism	4417.50 4417.60 4455.02 4864.19 4864.29 4944.11
Production of methane	7615.01
Production of soap	7615.01
Projectile motion	4135.10 4941.60
Properties of colloids	7615.01
Properties of hydrogen	7615.01
Properties of metallic hydroxides	7615.01
Protection against corrosion: galvanizing	7620.01
Pulley	4114.35 4861.19 4915.00
Pulse glass	4862.19 4915.00
Pulses diffraction	4311.80
Radiation absorption	4832.00
Radioactive decay	4832.00
Radioactive sources	4832.00
Ray tracing	4417.50 4864.19
RC, RL and RLC circuits	4831.11 4866.19
Reactions, acid base	7615.01
Recrystallization	7610.01
Rectification theory in circuits	4868.19
Rectilinear uniform motion	4132.10 4861.29 4941.14
Redox Reactions I	7610.01
Redox Reactions II	7610.01
Reflection	4311.80 4315.80 4864.29 4944.20
Refraction	4114.37 4311.80 4315.80 4864.29 4944.20
Refraction index	4114.37 4417.50 4417.60 4455.02 4864.19 4864.29
Resistance	4230.65 4697.00 4831.11 4866.19
Resistance in an ideal transformer	4729.00
Resonance	4117.40 4137.40 4317.90 4331.27 4915.00 4941.14 4941.16
Reynold's number	4180.10 4861.39
Rigid body	4114.35
RL, RLC circuits	4731.00
Rolling friction	4861.29 4941.14
Rotation of light	4417.50 4864.29
Salt solution cell	7620.01
Saturated and supersaturated solutions	4862.19
Seeds water absorption	7810.01
Series and parallel circuit	4831.11 4866.19
Simple pendulum	4114.35 4134.70 4136.50 4137.40 4831.19 4861.19 4915.00 4941.16 4941.21
Single slit diffraction	4864.39
Siphon	4861.39
Snell's law	4114.37 4864.29
Soap properties	7615.01
Sodium carbonate and bicarbonate	7615.01
Sodium nitrate decomposition	7615.01
Solar power	4869.09
Solubility and miscibility	7610.01
Solubility, the effect of temperature on	7615.01
Solvent and Solute Separation	7610.01
Sound, amplitude	4317.90
Sound, frequency	4317.90
Sound, propagation	4315.60
Sound, speed	4331.27
Sound, wavelength	4331.27
Specific heat	4230.97 4862.19 4915.00
Specific heat of bodies	4230.60
Spectral line, intensity	4455.02
Spring pendulum	4861.19
Springs in series and in parallel	4861.19 4915.00
Stability of a transistor	4868.29

Principle investigated	Code
Standard potentials and the silver/ silver chloride reference electrode	7620.01
Standing waves on a string	4315.35
Starch in leaves	7810.01
Static and dynamic friction	4115.10 4831.18
Stationary waves	4311.80
Stevino's law	4180.44 4861.39
Stoke's formula	4861.39
Sulphur dioxide preparation and properties	7615.01
Sulphur in proteins	7615.01
Sulphur, allotropic states of	7615.01
Sulphurous acid preparation and properties	7615.01
Superimposed pulses	4311.80
Supersaturated solutions	7615.01
Surface tension	4861.39
Telescope	4417.50 4417.60 4864.19 4944.11
Temperature gradient	4200.36 4831.14
Terminal velocity	4861.39
Thermal conductivity	4200.36 4831.14
Thermal expansion	4200.10 4200.15 4200.18 4200.22 4200.60 4200.80 4210.32 4862.19
Thermal radiation	4862.19
Thermistor	4868.19
Thermometer's time constant	4915.00
Thermometric Titration	7610.01
Thermostat and thermocouple	4862.19
Thermostat, concept	4200.60
Thermostat, demonstration model	4200.80
Time constant	4230.65
Time constant of a thermometer	4230.60 4862.19
Titration, acid base	7610.01
Titration, weak acid and strong base	7610.01 7620.01
Torricelli's theorem	4861.39
Torsional modulus	4170.00
Total reflection	4114.37 4864.29
Total refraction	4311.80
Trajectory description	4132.10
Transformer	4866.29

Principle investigated	Code
Transistor	4868.19 4868.29
Transistors	4868.19
Transpiration	7810.01
Transpiration – stomatas	7810.01
Triple-in-axis pulley block	4114.35
Triple-in-line pulley block	4114.35
Trommer's test on aldehydes	7615.01
Tuning fork	4317.90 4915.00
Umbra and penumbra	4864.19
Uniform accelerated rectilinear motion	4132.10 4861.29 4941.14
U-tube manometer	4861.39
Vacuum distillation	7610.01
Vacuum filtration	7610.01
Variable resistance	4694.11 4694.21 4694.31 4694.41 4694.51 4694.61
Velocity	4861.29
Venturi tube	4861.39
Viscosity	4180.10
Vitamin C in Fruit Drinks	7610.01
Volta cell	7620.01
Volta's electrophorus	4865.19
Voltage and current measurement	4831.11 4866.19
Voltage transformation	4729.00
Water analysis	7615.01
Water equivalent of a mixing calorimeter	4230.60
Water of crystallization	7615.01
Waves	4311.80 4315.80
Weight force	4114.11 4115.10 4184.95 4831.18 4861.19
Wind power	4869.09
Zinc and strong bases	7615.01

PACKAGING DIMENSIONS

Code	Description	Gross Weight kg	Width cm	Lenght cm	Height cm
2211.10	Tape Measure - 2 m	0.2	10	10	15
2211.12	Tape Measure - 3 m	0.2	10	10	5
2211.15	Tape Measure - 5 m	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
2220.60	Precision Mass Set - 1 mg ÷ 50 g	0.1	14	10	18
2220.61	Precision Mass Set - 10 mg ÷ 100 g	0.5	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	20	15	10
2231.05	Analogue Chronometer	0.1	15	10	10
2231.52	Digital Chronometer	0.1	10	4	10
2232.52	Photogate	0.1	15	10	10
2232.56	Electronic Digital Timer Set	1	30	20	15
2236.00	Geyger Muller Counter	1	30	20	15
2237.12	Electronic Oscillation Counter	0.3	20	10	10
2242.20	U - Tube Manometer	0.6	15	15	40
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
2275.10	Digital Multimeter	0.6	25	20	10
2280.50	Digital Teslameter	1.3	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	1.5	20	20	25
2300.20	Wireless Dynamics Sensor System	0.5	20	15	5
2300.35	LabQuest 2	0.8	20	20	10
2300.50	Logger Pro 3	0.3	25	20	10
2310.10	Motion Detector	0.4	20	15	5
2310.20	Rotary Motion Sensor	0.3	25	20	10
2311.10	Dual-Range Force Sensor	0.2	25	20	10
2311.20	Accelerometer 25-g	0.1	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	0.2	20	10	5
2312.10	Vernier Photogate	0.1	25	20	10
2312.11	Picket Fence	0.1	40	10	3
2312.12	Ultra Pulley Attachment	0.1	10	10	5
2312.13	Bar Tape	0.1	25	20	10
2313.10	Charge Sensors	0.2	25	20	10
2313.30	Voltage Probe	0.1	25	20	10
2313.40	Differential Voltage Probe	0.1	25	20	10
2313.50	Magnetic Field Sensor	0.1	25	20	10
2313.60	Microphone	0.1	25	15	3
2313.70	Electrode Amplifier	0.1	25	15	3
2314.10	Thermocouple	0.2	25	20	10
2314.30	Surface Temperature Sensor	0.1	25	20	10
2314.40	Relative Humidity Sensor	0.1	25	20	10
2315.10	Light Sensor	0.2	25	20	10
2315.20	UVA Sensor	0.1	25	20	10
2315.21	UVB Sensor	0.1	25	20	10
2316.10	Radiation Monitor (alpha, beta, gamma)	0.3	25	20	10

Code	Description	Gross Weight kg	Width cm	Lenght cm	Height cm
2317.10	pH Sensor	0.1	25	20	10
2317.20	Conductivity Probe	0.3	25	20	10
2401.30	Rechargeable Brick Battery	0.1	6	4	3
2403.61	Universal Transformer Output 5V	0.1	9	7	6
2403.64	Universal Transformer Output 12V	0.1	16	11	6
2403.70	Multitap Transformer	1.5	30	25	16
2407.05	Power Supply 5 kV	2.8	30	32	19
2407.65	Power Supply 30 A	3	30	32	19
2407.70	Power Supply 1.5 A	1.4	30	25	16
2407.75	Power Supply 10 A	3	30	32	19
2407.80	Power Supply 3-4.5-6-7.5-9-12V 1A	1.6	30	25	16
2522.02	Stackable Plug Lead, Plug 4mm, Red, Length 25 cm	0.1	5	5	3
2522.03	Stackable Plug Lead, Plug 4mm, Red, Length 50 cm	0.1	5	5	3
2522.04	Stackable Plug Lead, Plug 4mm, Red, Length 100 cm	0.1	5	5	3
2522.07	Stackable Plug Lead, Plug 4mm, Black, Length 25 cm	0.1	5	5	3
2522.08	Stackable Plug Lead, Plug 4mm, Black, Length 50 cm	0.1	5	5	3
2522.09	Stackable Plug Lead, Plug 4mm, Black, Length 100 cm	0.1	5	5	3
2522.12	Stackable Plug Lead, Plug 4mm, Yellow, Length 25 cm	0.1	5	5	3
2522.13	Stackable Plug Lead, Plug 4mm, Yellow, Length 50 cm	0.1	5	5	3
2522.14	Stackable Plug Lead, Plug 4mm, Yellow, Length 100 cm	0.1	5	5	3
4110.01	Tubular Spring Balance (Metal) - 1N	0.1	3	3	24
4110.03	Tubular Spring Balance (Metal) - 3N	0.1	3	3	24
4110.05	Tubular Spring Balance (Metal) - 6N	0.1	3	3	24
4110.07	Tubular Spring Balance (Metal) - 10N	0.1	3	3	24
4110.20	Tubular Spring Balance (Plastic) -1N	0.1	3	3	24
4110.21	Tubular Spring Balance (Plastic) - 2.5N	0.1	3	3	24
4110.22	Tubular Spring Balance (Plastic) - 5N	0.1	3	3	24
4110.23	Tubular Spring Balance (Plastic) - 10N	0.1	3	3	24
4110.24	Tubular Spring Balance (Plastic) -20N	0.1	3	3	24
4112.50	RED Super Pulley	0.1	6	4	3
4114.11	Force Table	5.3	35	35	55
4114.11-003	Dual-Range Force Sensor Adapter	0.2	12	6	4
4114.18	Demonstration Balance Model	2	50	10	6
4114.30	Magnetic Board	17	100	90	15
4114.35	Mechanics Accessories Set	2.9	45	30	15
4114.36	Falling Bodies Upg for Magnetic Board	0.4	30	30	10
4114.37	Optics Accessories Set	0.5	35	20	15
4115.10	Inclined Plane	2.9	80	20	10
4130.20	Elastic and Inelastic Collision 2D	0.5	30	30	10
4130.50	Collision Balls Apparatus	5.5	50	30	40
4132.10	Linear Air Track System	35	210	25	25
4132.70	Air Blower	2.5	30	20	30
4132.90	Force sensor adaptor for Air Track Slider	0.1	10	6	4
4134.00	Newton's Tube	1	110	15	10
4134.70	Free Fall and Pendulum Apparatus	9.4	170	40	20
4134.75	Remote Control Up. for Free Fall and Pendulum App.	0.3	16	10	8
4135.10	Projectile Launcher	2.5	35	30	15
4136.50	Simple Pendulum	1.8	75	15	5
4137.40	Multiple Pendulum Apparatus	2	15	10	5
4138.50	Moment of Inertia Apparatus	7.8	60	50	20
4142.70	Centrifugal Force Apparatus	7	40	30	30
4150.00	Maxwell Wheel	2.6	32	22	42
4163.10	Hooke's Law Apparatus	2.2	25	25	90
4170.00	Torsion Balance	5.4	55	50	95
4180.10	Fall in a Fluid	1.2	15	15	60

PACKAGING DIMENSIONS

Code	Description	Gross Weight kg	Width cm	Lenght cm	Height cm
4180.20	Pellat Apparatus	3	55	25	30
4180.44	Spouting Jar	1.3	50	20	10
4180.60	Communicating Vessels	0.5	30	20	10
4182.20	Capillary Tubes	0.5	30	21	8
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	1.3	15	15	20
4184.93	Buoyancy balance	0.3	20	15	20
4184.95	Aluminium Cuboid for Buoyancy	0.2	10	15	10
4187.19	Boyle's Law Apparatus	4.3	130	30	15
4200.38	Thermal Conductivity Apparatus by Steam	3.0	33	23	16
4200.45	Steam Generator	3.5	34	25	22
4200.10	Gravesande Ball and Ring	0.2	30	10	10
4200.15	Bar and Gauge	0.5	25	15	3
4200.18	Thermal Expansion Bar	0.8	50	20	15
4200.22	Gunther Expansion Apparatus	2.1	60	15	10
4200.31	Cast Iron Pins	0.1	10	8	4
4200.35	Thermal Leakage System	2	25	21	20
4200.36	Thermal Conductivity Apparatus	1.2	15	20	25
4200.60	Compound Bar	0.1	30	10	10
4200.80	Bimetallic Strip with Electric Contact	0.2	15	15	15
4207.60	Food Colouring	0.8	24	27	9
4210.32	Expansion of Liquids Apparatus	4	40	15	40
4210.73	Thermal Conductivity Apparatus	0.1	35	15	3
4215.20	Crooke's Radiometer	0.3	20	15	15
4230.60	Mixing Calorimeter	1	15	15	25
4230.65	Joule's Law Unit for Calorimeter	0.1	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
4311.80	Ripple Tank	13.5	60	50	20
4315.35	Melde's Apparatus	1.5	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	1.9	70	15	15
4317.40	Pair of 440 Hz Tuning Forks	4	30	25	10
4317.90	Set of Tuning Forks	0.9	35	30	10
4331.27	Resonance Apparatus	5.3	125	35	25
4417.50	Optical Bench with Accessories Deluxe Edition	8.5	125	35	25
4417.60	Optical Bench with Accessories Standard Edition	5.4	125	35	25
4453.22	Newton's Disk	0.8	25	15	25
4453.30	Newton's Disk with Motor	1	32	20	5
4455.40	Altay Handheld spectrometer	0.6	35	25	15
4455.02	Spectrometer	11.2	50	35	35
4470.10	Spectrum Tube - Helium	0.1	25	5	5
4470.11	Spectrum Tube - Neon	0.1	25	5	5
4470.12	Spectrum Tube - Argon	0.1	25	5	5
4470.13	Spectrum Tube - Mercury	0.1	25	5	5
4470.14	Spectrum Tube - Hydrogen	0.1	25	5	5
4470.15	Spectrum Tube - Oxygen	0.1	25	5	5
4470.16	Spectrum Tube - Nitrogen	0.1	25	5	5
4470.17	Spectrum Tube - Carbon Dioxide	0.1	25	5	5
4470.50	Spectrum Tubes Holder	0.2	25	5	5
4480.10	Chromatography Set	2.2	25	25	10
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	0.1	15	10	3
4611.65	Bar Magnets - (ALNICO) - 5 x 1.5 x 1 cm	0.1	5	5	3
4611.71	U-Shaped Magnet	0.3	5	5	3
4611.72	Horseshoe Magnet - Flat	0.1	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	0.2	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	0.3	5	5	10
4613.80	Magnetic Needle on Stand	0.1	20	10	10
4614.50	Demonstration Compass	0.1	17	17	5
4614.60	Linear Oersted Apparatus	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	0.2	45	10	10
4625.50	Gold Leaf Electroscope	0.7	15	10	20
4628.32	Aepinus Air Condenser	3.5	40	25	30
4640.60	Rotating Coil	3	40	40	25
4640.73	Coil Flux Max	0.1	10	8	4
4640.75	Induction coils	4	15	15	20
4640.76	Induction Coil 600 turns	2	10	10	5
4640.77	Induction Coil 1100 turns	2	20	20	10
4640.79	Coil 1200 Turns	2.4	15	15	40
4640.90	Double Winding Coil	3	75	20	15
4646.10	Laplace Apparatus	1.7	55	25	30
4646.15	Laplace Rail	1	35	20	20
4694.11	Sliding Contact Rheostat - 2.9 Ohm	2.5	35	10	15
4694.21	Sliding Contact Rheostat - 10 Ohm	2.5	35	10	15
4694.31	Sliding Contact Rheostat - 50 Ohm	2.5	35	10	15
4694.41	Sliding Contact Rheostat - 120 Ohm	2.5	35	10	15
4694.51	Sliding Contact Rheostat - 300 Ohm	2.5	35	10	15
4694.61	Sliding Contact Rheostat - 1400 Ohm	2.5	35	10	15
4697.00	Potentiometer Bridge	3	Dia. 13	0	130
4715.00	Electrical Safety simulator	5.5	50	45	15
4729.00	Demonstration Transformer	6.5	30	20	15
4731.00	Variable Inductance	8	25	15	25
4739.20	Generator model	0.5	15	15	20
4739.45	Demonstration Dynamo	1.5	25	15	18
4743.05	Motor Unit	1	15	15	15
4822.51	Radioactive Beta/Gamma Source (Co-60)	4.2	45	35	20
4822.52	Radioactive Beta Source (Sr-90)	0.1	12	7	6
4822.53	Radioactive Alpha Source (Po-210)	0.1	12	7	6
4830.11	RED Temperature Sensor Plug -In	0.1	20	4	4
4830.43.001	RED Data Collector Photogates, Set of 2	0.1	12	8	5
4830.46	RED Tripod Stand	0.1	4	4	15
4830.82	RED USB Flash Drive	0.1	6	4	3
4830.86	RED Picket Fence	0.1	20	10	5
4830.87	RED Lanyard	0.1	6	4	3
4830.88	RED Force Sensor Accessory Pack	0.1	6	4	3
4830.89	RED Gas Pressure Accessory Pack	0.1	12	8	5
4830.90	RED Motion Sensor protection Cage	0.3	15	10	8
4830.91	RED Support Rod	0.1	12	4	4
4830.94	RED Connecting leads, Alligator Clips	0.1	6	4	3
4830.95	RED Storage Case	3	50	45	15

PACKAGING DIMENSIONS

Code	Description	Gross Weight kg	Width cm	Lenght cm	Height cm
4830.99	RED Connecting leads, Banana Clips	0.1	6	4	3
4831.00	Thermal leakage Stem System	3	25	30	20
4831.00	RED Sensor Universal Adapter	0.1	14	8	8
4831.01	RED Motion Sensor Adapter for Mech. Multiuse	0.1	12	8	5
4831.02	RED Force Sensor Adaptor for Cart	0.2	14	8	8
4831.03	RED Force Sensor Adapter for Force Table	0.1	12	8	5
4831.04	RED Motion Sensor Adapter for Optics Multiuse	0.1	6	4	3
4831.05	RED Force Sensor Adapter for Inclined Plane	0.1	6	4	3
4831.06	RED Universal Magnet Support	0.1	6	4	3
4831.07	RED Photogate Support for Track Set	0.1	20	10	5
4831.11	Electricity Stem System		50	45	15
4831.13	Hope's Apparatus Stem System	1.8	24	27	15
4831.14	Thermal Conductivity Stem System	4	33	23	20
4831.15	Rotating Coil Stem System	4	40	40	25
4831.16	High Performance Force Table STEM System	6.4	35	40	55
4831.17	Centrifugal Force Stem System	9	40	40	30
4831.18	Inclined Plane STEM System	3.8	80	20	10
4831.19	Simple Pendulum STEM System	2.6	75	15	10
4832.00	Radioactivity Bench	2.3	45	35	15
4840.12	RED Motion Sensor	0.8	24	27	9
4840.13	RED pH Meter	0.8	24	27	9
4840.14	RED Force Sensor	0.8	24	27	9
4840.14	RED Photogate Sensor	0.8	24	27	9
4840.16	RED Voltage & Current Sensor	0.8	24	27	9
4840.17	RED Gas Pressure Sensor	0.8	24	27	9
4840.18	RED Light Sensor	0.8	24	27	9
4840.19	RED Microphone	0.8	24	27	9
4840.22	RED EKG Probe	0.8	24	27	9
4840.23	RED Dissolved Oxygen Probe	0.8	24	27	9
4840.24	RED CO_2 Gas Sensor	0.8	24	27	9
4840.25	RED Magnetic Field Sensor	0.8	24	27	9
4840.36	RED Blood Pressure Sensor	0.8	24	27	9
4840.42	RED Temperature Sensor	0.8	24	27	9
4840.83	RED Wall Charger Power Supply	0.2	12	8	5
4841.01	Elementary School RED Set 1	1.7	25	28	20
4841.02	Elementary School RED Set 2	4.2	25	28	50
4841.03	Middle School RED Set 1	3.4	25	28	50
4841.04	Middle School RED Set 2	5.0	25	28	60
4841.05	Physical Science RED Set 1	3.4	25	28	50
4841.06	Physical Science RED Set 2	5	25	28	60
4841.07	Physics RED Set 1	3.4	25	28	50
4841.08	Physics RED Set 2	5	25	28	60
4841.09	Chemistry RED Set 1	3.4	25	28	50
4841.10	Life Science RED Set 1	1.7	25	28	20
4841.11	Environmental RED set 1	5	25	28	60
4841.12	Physiology RED set 1	1.7	25	28	20
4841.13	Physics RED set 3	7.2	25	28	80
4841.14	Life Science RED Set 2	5	25	28	60
4851.04	Helmholtz Coils	0.1	12	7	6
4861.19	Mechanics System 1	7.4	50	45	15
4861.19	Mechanics System 1 Profile	1.6	Dia. 10	0	70
4861.29	Mechanics System 2	8	50	45	15
4861.29	Mechanics System 2 Profile	3.2	Dia. 10	0	130
4861.39	Mechanics System 3 case 1	9	75	55	20
4861.39	Mechanics System 3 case 2	4	75	55	20

Code	Description	Gross Weight kg	Width cm	Lenght cm	Height cm
4862.19	Heat System	12	75	55	20
4864.19	Optics System 1	7	50	45	15
4864.19	Optics System 1 Profile	1.9	Dia. 10	0	110
4864.29	Optics System 2	6.5	50	45	15
4864.29	Optics System 2 Profile	1.2	Dia. 10	0	70
4864.39	Optics System 3	1.5	30	25	10
4865.19	Electrostatics System	6.5	78	55	20
4866.19	Electricity System 1	5.5	50	45	15
4866.29	Electricity System 2	5	50	45	15
4867.19	Magnetics System 1	5	50	45	15
4867.29	Magnetics System 2	5	50	45	15
4868.19	Electronics System 1	4.5	50	45	15
4868.29	Electronics System 2	4	50	45	15
4869.09	Alternative Energy Sources System	5.5	50	45	15
4870.00	Electrolyzer	0.4	15	15	20
4870.01	Carbon Electrode for Electrolyzer	0.1	6	6	6
4870.03	Nickel Electrode for Electrolyzer	0.1	6	6	6
4915.00	Altay Mobile Lab	190	145	75	105
4922.10	Timing Set	1.2	35	25	15
4941.12	Altay Cart without Plunger	0.5	15	10	10
4941.13	Altay Cart with Plunger	0.5	15	10	10
4941.14	Mechanics Upgrade 1	4.4	35	20	15
4941.16	Coupled Pendulum Set	0.8	55	10	5
4941.17	EM Trigger&Launcher for Cart	0.6	20	15	15
4941.21	Mechanics Upgrade 2	1	30	20	15
4941.21-RC	Mechanics Upgrade 2 (with remote control)	1	30	20	15
4941.51	Eddy Current Set	1	20	20	15
4941.60	Ball Launcher for Cart	1.3	20	20	25
4941.65	Fan for Cart	1	30	25	20
4944.11	Optics Upgrade 1	1.7	25	20	20
4944.20	Optics Upgrade 2	1.6	30	20	20
4944.30	Optics Upgrade 3	0.8	30	20	15
4954.11	Track Set - 1.45m	2.8	Dia. 13	0	150
4954.12	Track Set	2.4	Dia. 13	0	130
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	0.1	10	5	10
5404.52	Universal Retort Stand Base 17x15 cm, rod length 50 cm	1.5	30	65	10
5404.55	Universal Retort Stand Base 25x13 cm, rod length 65 cm	2	30	35	10
5404.60	Universal Retort Stand Base 32x20 cm, rod length 80 cm	2.5	35	80	10
5405.70	Complete Universal Base	0.9	45	10	10
5406.30	Laboratory Jack, 10x10 cm 4.5÷14 cm height	1.4	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	0.3	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

ALPHABETICAL INDEX

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NUMERICAL INDEX