Physics Catalogue 2007

TEMA INTERNATIONAL

Ecos Physics Systems by TEMA International

Dear customers,

we have the pleasure to introduce our new physics catalogue.

Our belief in hands on science has inspired our Company in designing our new products, the Ecos Physics Systems. Altay's experience in the classroom and directly with physics teachers led us to our unique physics teaching solutions.

Ecos Physics Systems, offered in a high impact plastic case with foam inserts, provide for a simple, easy to understand in-depth exploration of all major physics disciplines (*e.g.* mechanics, optics, thermodynamics).
User-friendly instruction manuals provide the guidance necessary to assure a successful learning experience.

Ecos Physics Systems are also capable of working with a complete range of interfaces and sensors to computerize the time consuming exercise of data acquisition and manipulation.

Ecos Physics Systems satisfy not only your demanding technical specifications, but also your equally demanding budgetary requirements.
As the result of a unique modular design, multiple experiments can be performed with common system elements. For example, the same aluminum track of a cart collision experiment can be used both as an optical bench and as a free fall apparatus.

TEMA believes in:

- quality equipment
- quality resource material
- quality technical support
- quality in training
- quality and innovation in data gathering
- wide range of physics solutions

Or, the same electronic timer can be used with the mechanics, free fall or pendulum upgrade packages.

Ecos full line of Physics Systems offers you quality, precision and economy in one package, designed by teachers, for teachers.

Physics teaching solutions designed by teachers, for teachers.

TEMA INTERNATIONAL

ECOS PHYSICS by Altay Scientific

ALTAY SCIENTIFIC

TEMA Instruments of Knowledge

Started as a family business more than 60 years ago, TEMA has grown into a 21st century, international company with operations on five continents employing more than 300 people. As it was 60 years ago, family traditions and values are still the foundamentals of our work. The principles underlying our mission have been the foundation of decades of success. These principles are as important today as in 1938.
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. With a large and established customer base throughout the world, TEMA's "Instruments of Knowledge" position TEMA to provide more profound opportunities for a better future.

TEMA R&D Physics Department

TEMA INTERNATIONAL

TEMA Manufacturing Facility (Rome) - Italy

Altay Shipping Department

Our Vision

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

Our 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, or "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 reinvest in all the communities where we do business.

Our products

All TEMA products are built to the most demanding quality standards. TEMA combines high level R&D with low cost manufacturing to develop and market products that fully satisfy our customers' performance and budget requirements.
TEMA makes its products available to our customers through a global network of specialized dealer partners in the field of science education.

SYSTEM CERTIFICATION ISO 9001 SGS
ISO 9001
Certified Company
n° registered Q.01.330

WORLDDIDAC QUALITY CHARTER THE WQC

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Electronics System 1


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Mounted Electric Meters

Oscilloscope

Low Tension Power Supply Unit

Universal Base

Bench Clamp

Vacuum Pump

Physics Systems

TEMA INTERNATIONAL

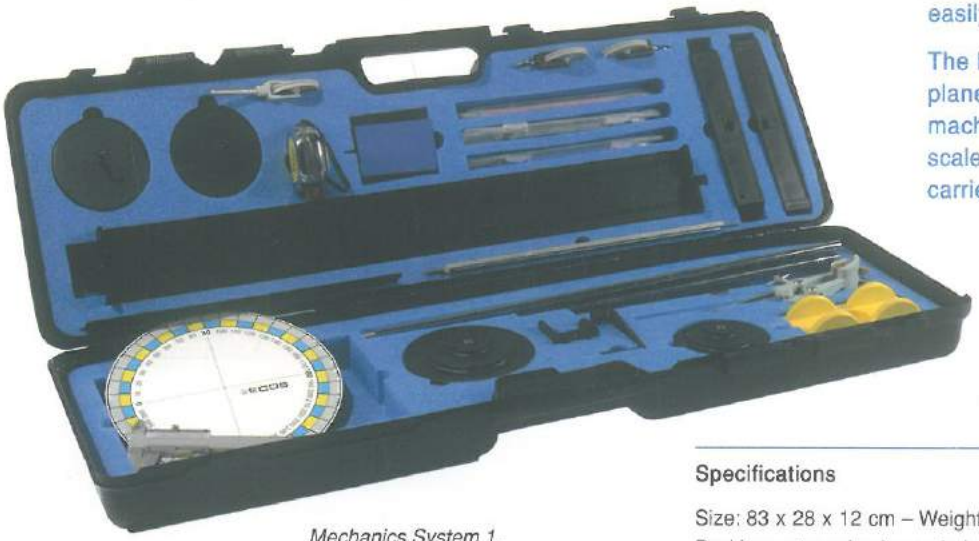
Mechanics System 1

4861.10

An introductory system to study basic mechanics

Our high quality Mechanics System 1 comes in a heavy duty ABS plastic carry-case for ease of storage. Simple to set-up with all components easily accessible.

The kit 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.

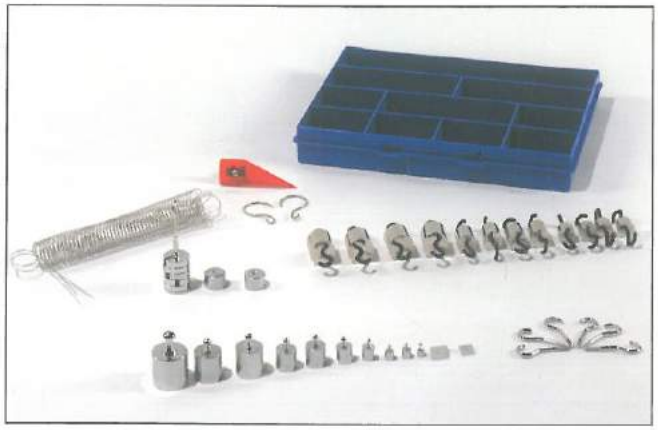


Mechanics System 1.

Accessories box.

Specifications

Size: 83 x 28 x 12 cm – Weight: approx. 6 kg
Packing: external suitcase in hard ABS, internal foam for prevention accidental breackage.



Accessory box with part of its contents.

Main components

- Calliper, metre stick, millimetre and angular scale
- Dynamometers with different ranges
- Pulleys, pulleys with hook and differential pulleys
- Inclined plane with cart • Springs and spring leafs
- Full set of masses for balance and hooked masses for general use
- Scale pans • Friction block
- Multiuse universal bases with a full set of bossheads
- Multifunction support rods and clamps

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

Laws and principles investigated

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

Many of these experiments will be suitable for applied mathematics.

General hardware for experiments.

Measuring instruments

A complete set of tools to learn how to measure fundamental physical quantities such as forces, lengths, angles and masses.

Full set of basic measuring instruments.

List of the experiments detailed in the instruction manual

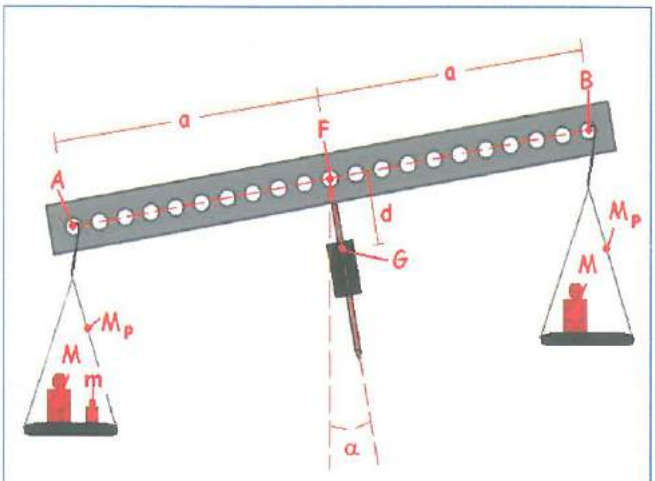
- Belt drive systems
- Composition, decomposition and transmission of forces including the parallelogram law
- Analytical balance and the investigation of weight as a force
- Levers: including first, second and third class type
- Pulley systems: including fixed, mobile and differential pulleies
- Simple 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

Analytic 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 that has arms of equal length.

Assembled analytical balance.



Schematic of analytical balance.

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.

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

Formula defining balance sensitivity.

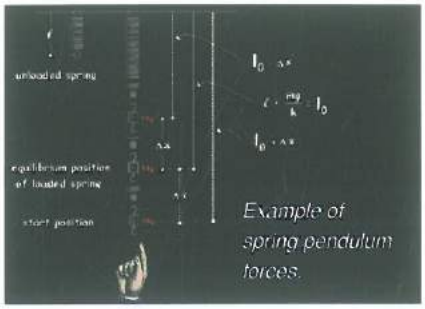
Therefore, we can see that the sensitivity of a balance depends on several design characteristics as well as the patience of the experimenter.
For example, the more stable the design of a balance, the more mass is needed to move the balance noticeably.
Additionally, the more friction at the locations where movement is required, the less sensitive the balance will be.

The Spring Pendulum

Calculate the elastic constant of a spring by means of a spring pendulum

Mechanics System 1 assembled in the spring pendulum configuration.

When the forces acting on the oscillating spring are examined it is possible to find a useful relation between the spring elastic constant, the loaded mass and the oscillation period.

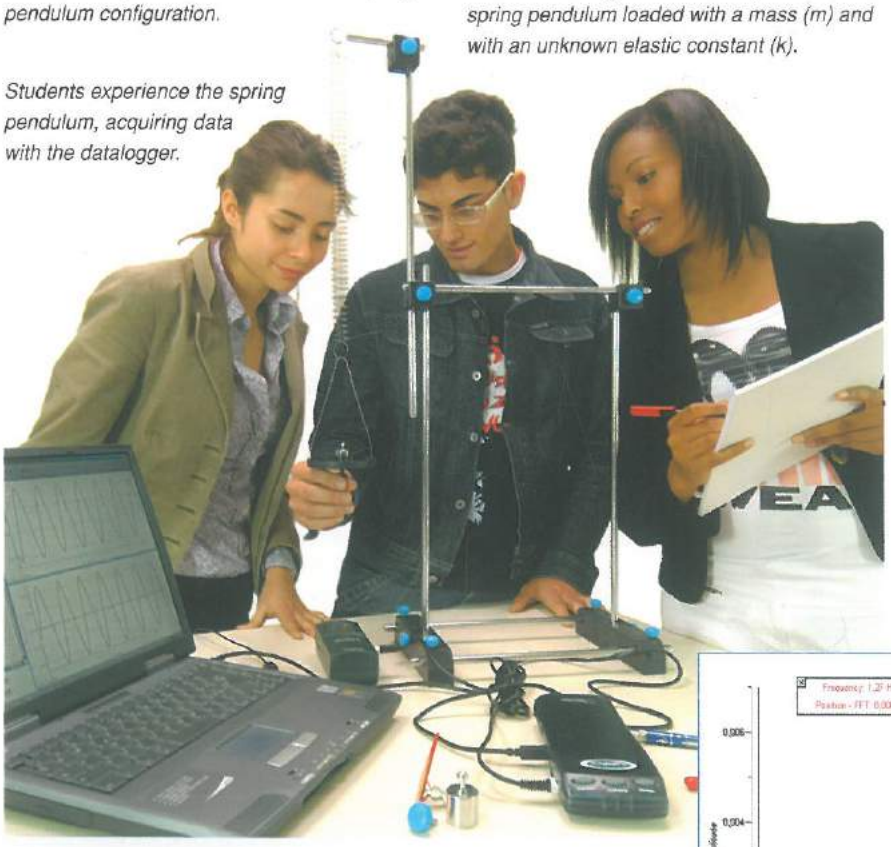


Starting from Newton's Second Law and neglecting the mass of the spring, it is easy to deduce the following relation:

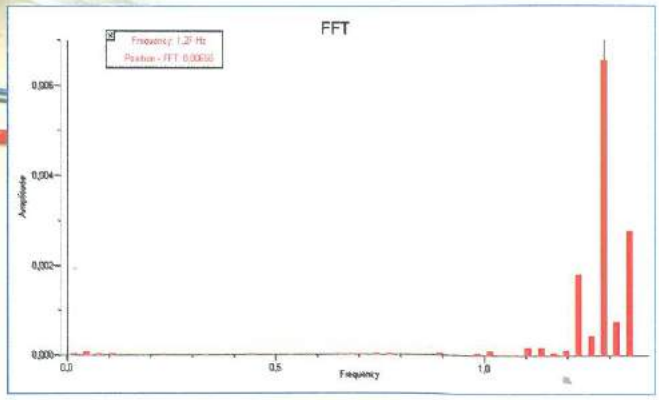
$$T = 2\pi\sqrt{\frac{m}{k}}$$

Formula defining the oscillation period of the spring pendulum loaded with a mass (m) and with an unknown elastic constant (k).

Students experience the spring pendulum, acquiring data with the datalogger.



Using a motion detector it is easy to acquire position data.
This way, it is possible to calculate the oscillation period of the pendulum with the Fast Fourier Transform, a feature of the software.
The histogram represents all the frequency range, the highest bar refers to the main oscillation frequency of the system.



Frequency analysis of the spring pendulum motion.

Further examples of classical experiments

Two more examples on the experimental possibilities offered by this system

Parallelogram of forces.

Mobile and fixed pulley.

Mechanics System 2

4861.20

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

The Mechanics System 2 allows us to verify many kinematics and dynamics principles by using a low friction system.
The basic theory involves topics such as Newton's Laws of Motion, Conservation of Energy and Momentum, Friction and many others.

Specifications

Size: 124 x 28 x 12 cm
Weight: approx. 7 kg
Packing: external suitcase in hard ABS, internal foam to prevent accidental shock

Mechanics System 2.

Main components

- Two dynamics carts (with aluminium flags, bumpers, hooks, triggers, mass holder with a set of slotted masses)
- Electromagnet
- Electronic timer with photogate and spring trigger
- Two accessories boxes
- Aluminium track with supports, bubble level and angle indicator
- Pulley, nylon string and mass-hanger

Electronic timer with electromagnet and photogates.

Aluminium track with carts.

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

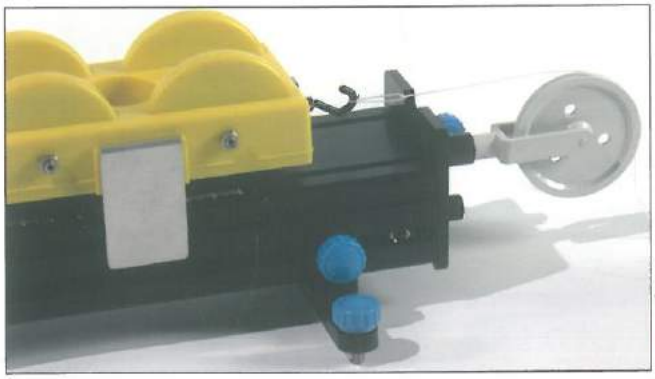
List of the experiments detailed in the instruction manual

- 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

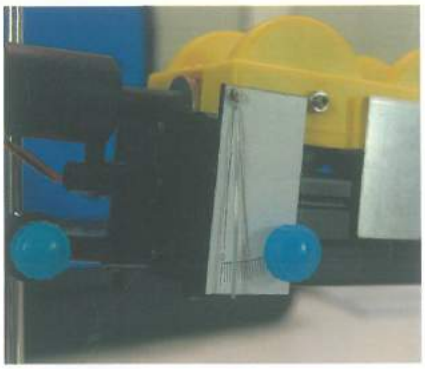
Contents of accessories boxes.

Uniform accelerated rectilinear motion

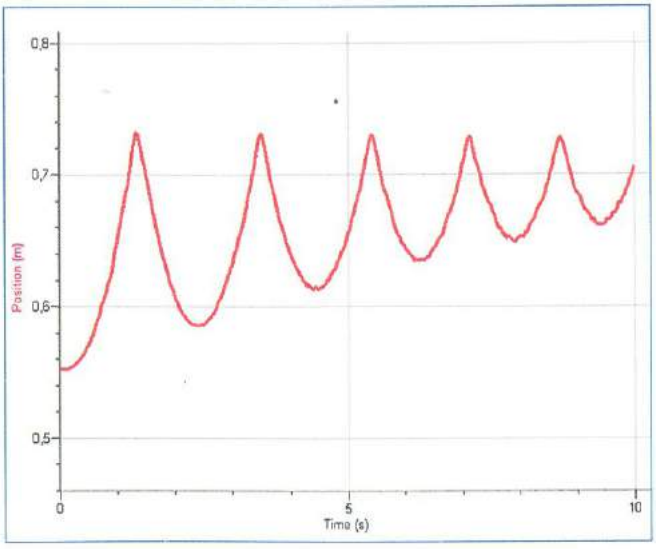
A cart of mass, M, on a horizontal plane is connected, via a string, over a pulley to an object of mass m.
Mass M + m, is accelerated due to gravity and defined by W = mg.
The value for g is determined using photogates and an Altay timer system.



Setup example for study the uniform accelerated rectilinear motion.



Inclined plane angle measurement.



Position vs. time graph of a cart bouncing with a spring on an inclined plane.

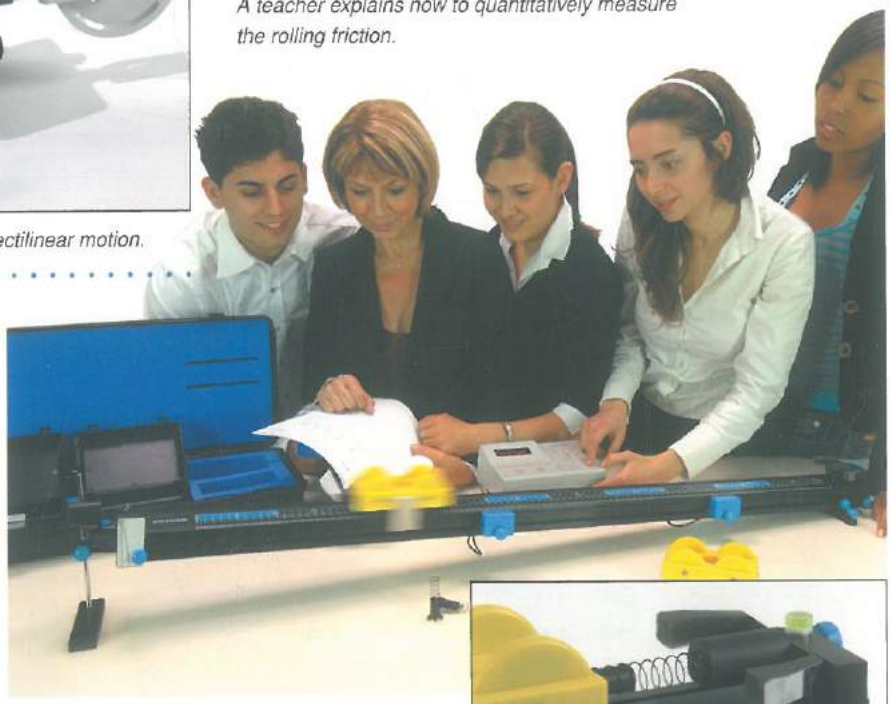
The difference in slope is due to the change of the rolling friction forces and gravity acceleration from concordant to discordant forces when crossing the x-axis.

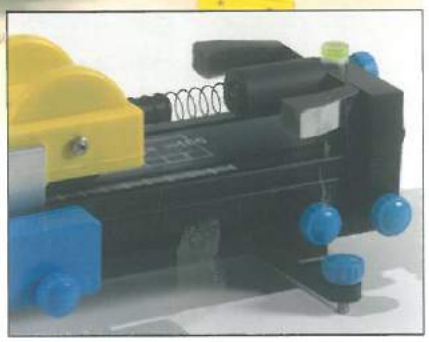
Rolling friction

Quantitative measurement of the rolling friction acting on the cart's wheels

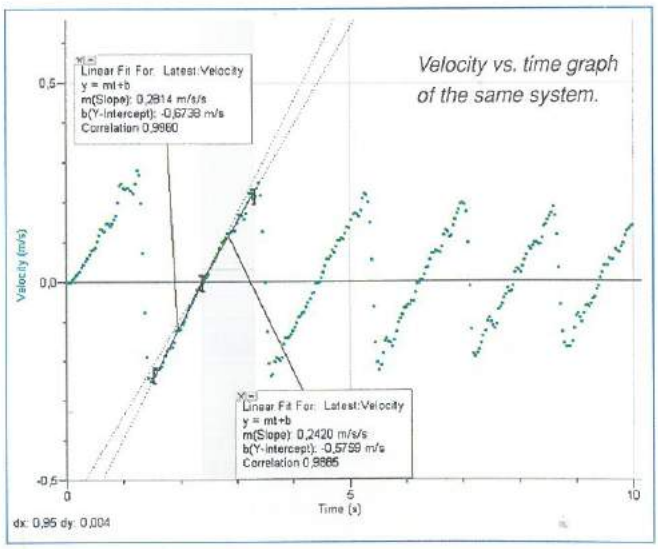
When you incline the plane at a set angle and then release the compressed spring the cart gets an initial velocity.
During the upward motion of the cart, gravity and friction act in the same direction. When the cart reaches the highest point on the inclined plane, it starts to return down the track again. In this instance, gravity and friction act in opposite directions.

A teacher explains how to quantitatively measure the rolling friction.





Detail of the elastic collision between cart and bumper.

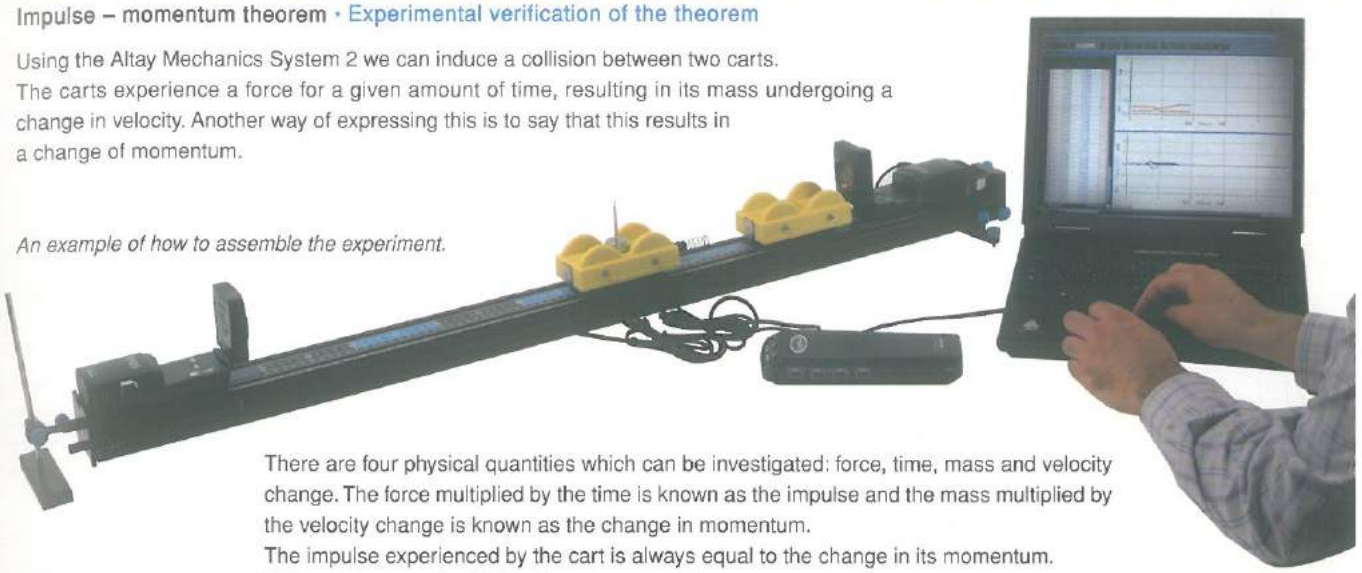


Velocity vs. time graph of the same system.

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.

An example of how to assemble the experiment.

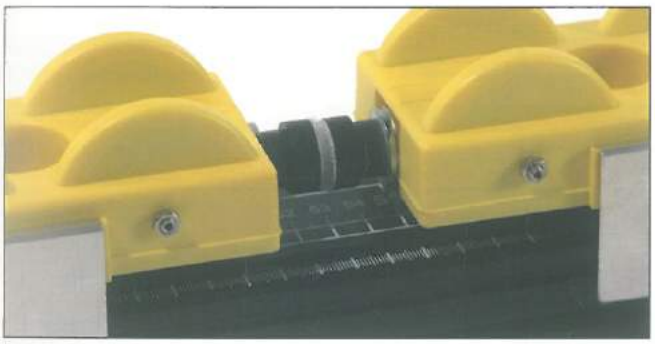


There are four physical quantities which can be investigated: force, time, mass and velocity change. The force multiplied by the time is known as the impulse and the mass multiplied by the velocity change is known as the change in momentum.
The impulse experienced by the cart is always equal to the change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

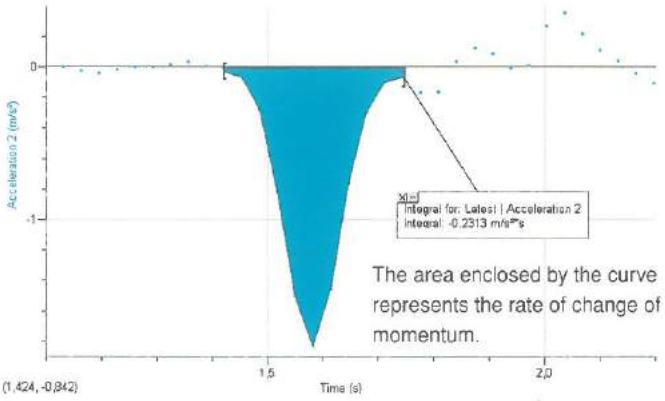
$$F\Delta t = m\Delta v$$

Impulse – momentum theorem.

Further examples of workable experiments

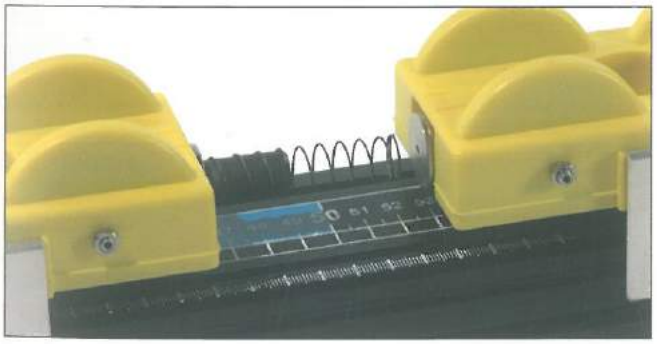


Inelastic collision between two carts.



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

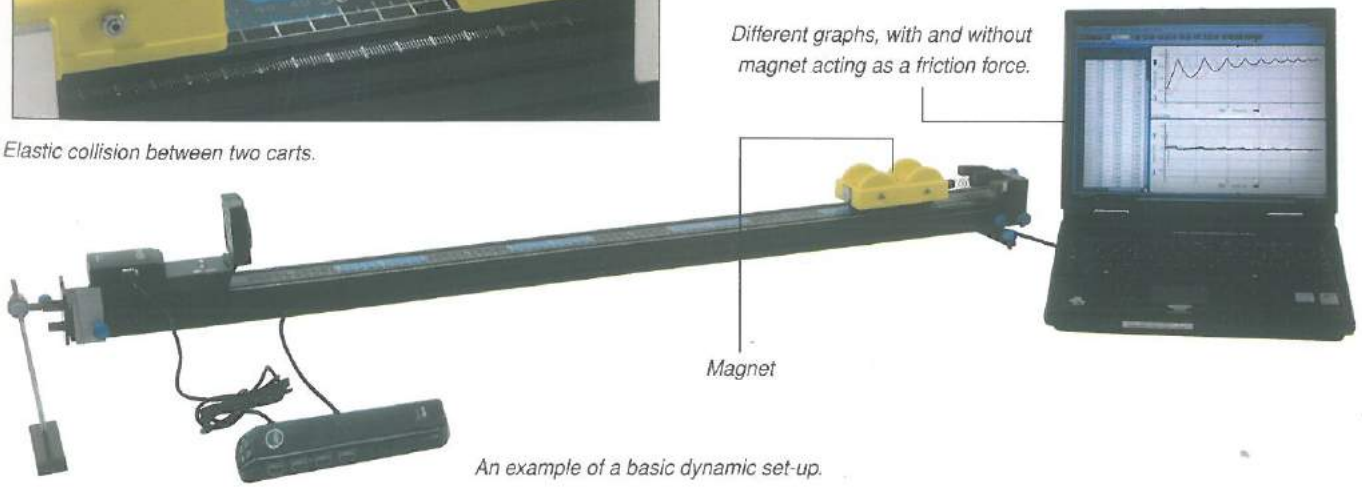
Experimental data acquired with a datalogger.



Elastic collision between two carts.

Setup for study different types of collisions.

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



Magnet

An example of a basic dynamic set-up.

Mechanics System 3

4861.30

A basic introductory mechanics system for mechanics of fluids

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.

Mechanics System 3 case 1, hardware case.

Specifications

Case 1
Size: 73 x 50 x 16 cm – Weight: approx. 8 kg

Case 2
Size: 124 x 28 x 12 cm – Weight: approx. 4 kg

Packing: external suitcase in hard ABS, internal foam for prevention of accidental breakage

Mechanics System 3 case 2, glassware case.

Main components

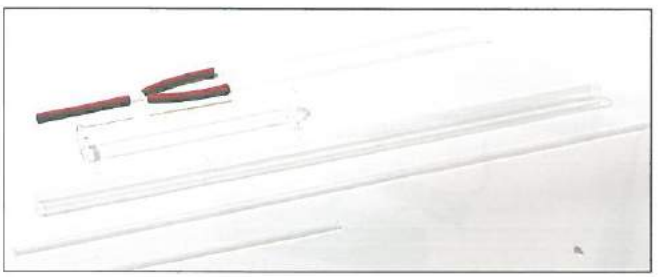
- Range of base stands with full set of accessories
- "G" clamp • Extension clamp
- Ostwald Viscometer • Plastic funnel
- Styrofoam and ping-pong ball
- Silicone tube • PVC transparent tube • Mariotte's bottle
- Cartesian diver with tube • Capillary tubes and communicating vessels
- U shaped tube • Force pump • U-tube manometer
- Air blower with voltage regulator • Plastic beakers
- Potassium permanganate • Silicone grease • Hare's apparatus
- Venturi tube • Two syringes of various dimensions • Pascal apparatus

Hardware case content.

Laws and principles investigated

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

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



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

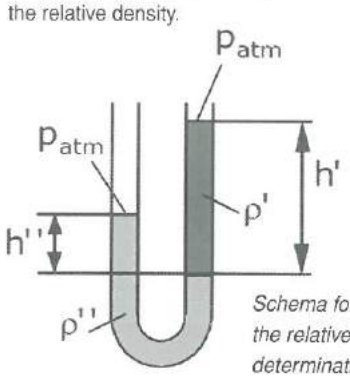
List of the experiments detailed in the instruction manual

- 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

Relative density

The pressure exerted within a liquid depends only from the free surface and from the liquid density. Using two non-mixable fluids inside the U-tube (*e.g.* water and oil) it is possible to verify the equation for the relative density.

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



Schema for the relative density determination.

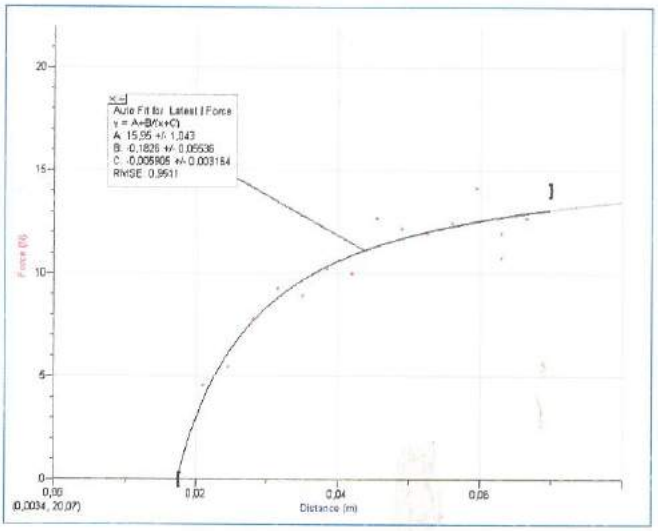
Relative density of two non-mixable fluids.

Perfect gas law

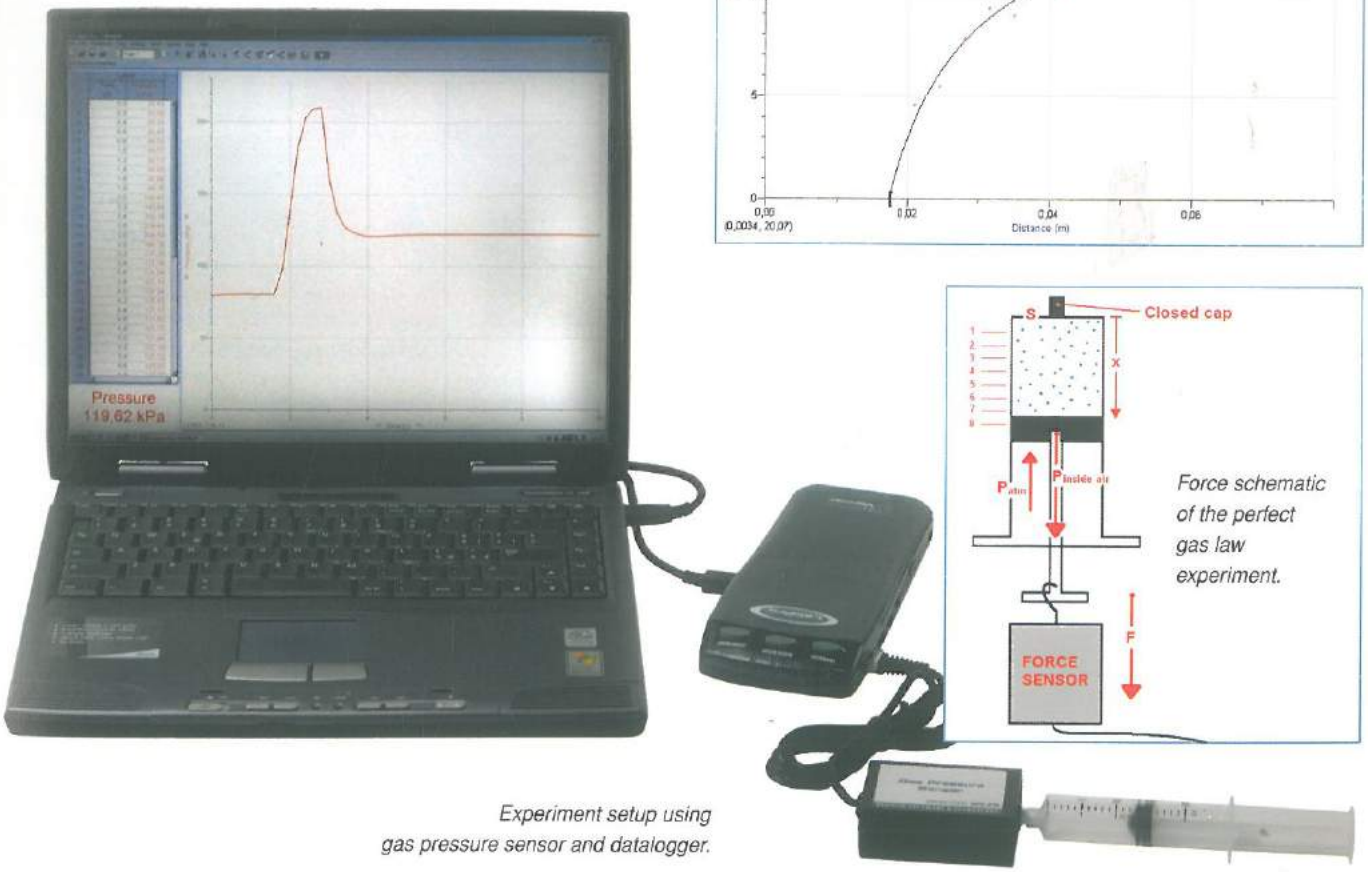
Application of the perfect gas law to an air filled syringe

By measuring the force needed to pull the piston at a certain distance with an air-filled syringe, it's possible to verify the perfect gas law.

Perfect gas law. $$pV = nRT$$



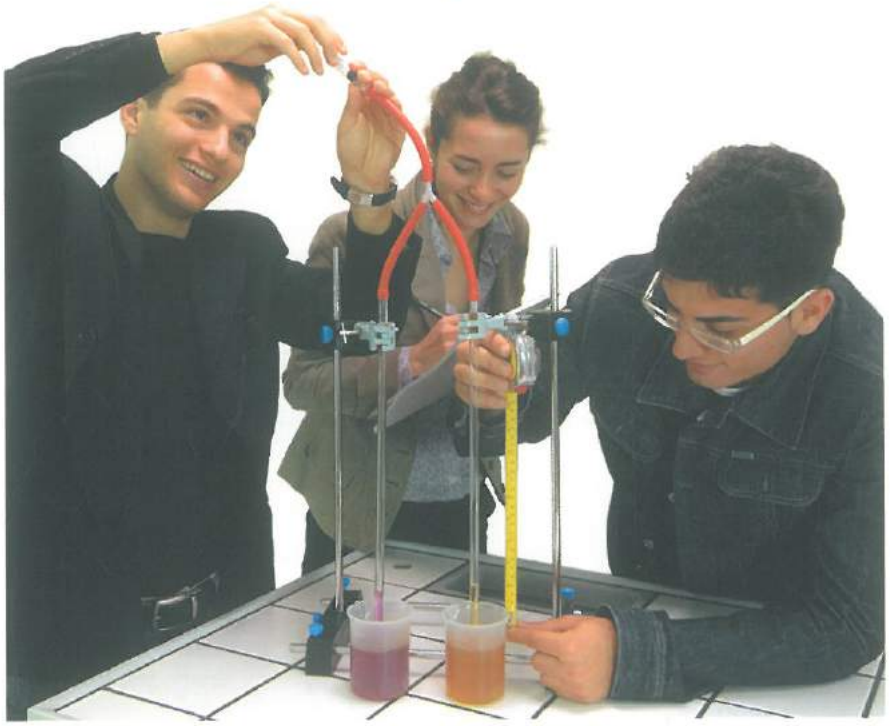
Pressure force graph vs. syringe piston position.



Force schematic of the perfect gas law experiment.

Experiment setup using gas pressure sensor and datalogger.

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



Hare's apparatus consists of an inverted U-Tube immersed in two vessels of fluid.
One vessel is filled with water and the other with a fluid of unknown density.
By pinching the tube at any point higher than the Y Piece, you will notice both liquids rise to a certain height in each tube.
Therefore, when air is removed from the top of the apparatus, the liquids rise in the tubes to heights which are inversely proportional to their densities.
Therefore, Hare's apparatus is used to compare the density of two liquids.

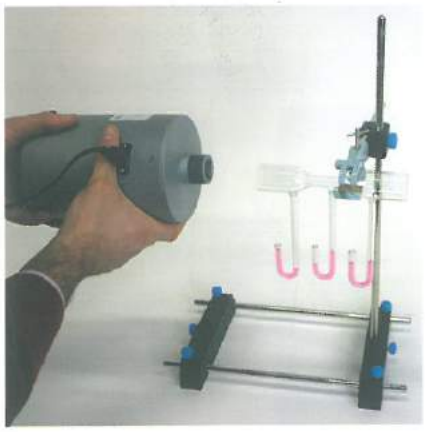
$$\frac{\rho'}{\rho''} = \frac{h''}{h'}$$

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

Students acquiring data from Hare's apparatus.

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

Force pump.



Venturi's tube.

Capillary tube apparatus.

Bernoulli Blower.

Communicating vessels apparatus.

Heat System

4862.10

Study thermology with this compact and easy to use system

This system introduces basic concepts of thermodynamics and heat experiments. It provides a framework for understanding and quantitatively assessing introductory thermodynamics questions and problems.

Heat System in case.

Hardware components for experiments.

Specifications

Size: 73 x 50 x 16 cm – Weight: approx. 6 kg
Packing: durable ABS plastic carry case with foam inserts

Calorimeter with Joule's Law Apparatus.

Main components

- Thermometer, digital multimeter and thermocouple
- Beakers, filtering flask, graduated cylinder, centrifuge tube
- Silicone grease • Silicone tube • U-shaped tube
- Calorimeter with Joule's Law apparatus and connecting leads
- Thermal insulation jacket, set of rubber stoppers and paraffin blocks
- Stainless steel and aluminium cylinders for linear thermal expansion
- U-shaped rods in aluminium, brass, stainless steel with different diameters
- Specific heat cylinders
- Burner head with tripod stand and wire gauzes
- Comparator 1/100 mm with support
- Pulse glass • Potassium permanganate
- Bimetallic strip with electric contacts
- Multiuse universal base • Multifunction support rods and clamps

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

Centrifuge tube, beakers, filtering flask and graduated cylinder.

Using a Pulse Glass to demonstrate Thermal Energy

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

Benjamin Franklin commented, "The instant it begins to boil, a sudden coldness is felt in the ball held." What Franklin discovered was that the boiling temperature of water depends on the atmospheric pressure. This observation inspired James Watt to generate power with a steam machine.

Pulse glass in action.

List of the experiments detailed in the instruction 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

Time constant of a thermometer • To study the thermal sensitivity of a mercury thermometer and a thermocouple

An experiment to give a quantitative explanation of the thermometer's time constant.
This is important as it gives insight to the heat sensitivity of the thermometer.

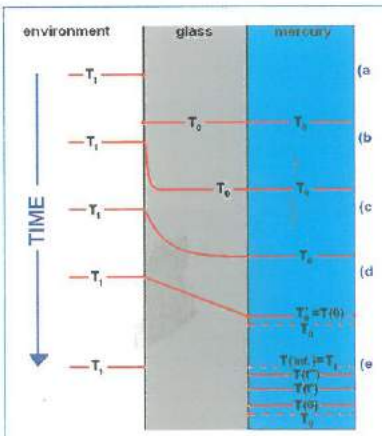
With just a beaker, boiling water and a thermometer it is possible to measure thermal sensitivity.

Newton stated that a hot object cools down at a rate proportional to the difference between its temperature and that of its surroundings.
An easy demonstration of this would be to place a mercury thermometer in hot water and observe the effect on the glass of the thermometer and the mercury inside it. The graph below can be described using the following equation:

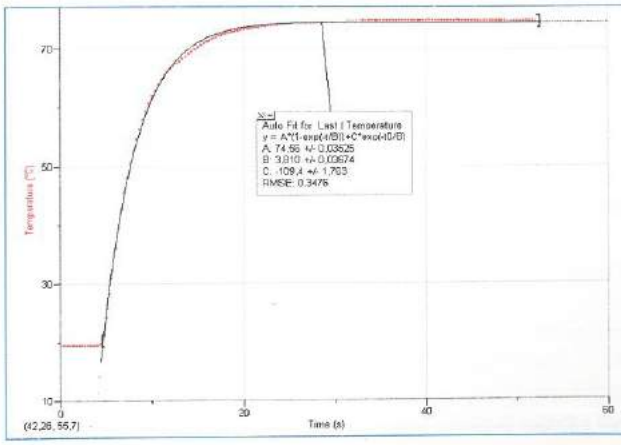
$$T(t) = T_1 + (T_0 - T_1)e^{-\frac{t}{\tau}}$$

Newton's Law of heating and cooling.

Where T(t) is the temperature of the system, T_1 is the temperature of hot water, T_0 is the temperature of the thermometer and τ is the time constant.



Temperature vs. time diagram of a mercury thermometer placed in an environment with higher temperature.



Experimental data showing the heating for a temperature sensor immersed in a beaker with hot water.

Wet and dry bulb hygrometer · The basics concepts of psychrometry cam be demonstrated in then experiments

Setup for the experiment.

With minimal experimental setup time, it is possible to show qualitatively how the air is expanded when heated and contracted when cooled.

Detail of the air expansion in the U-Tube manometer.

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

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

Relative humidity definition formula.

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.

Further examples of possible experiments · Some experiments using the Heat System

Students involved in the thermocouple experiment.

Calorimeter with Joule's Law unit.

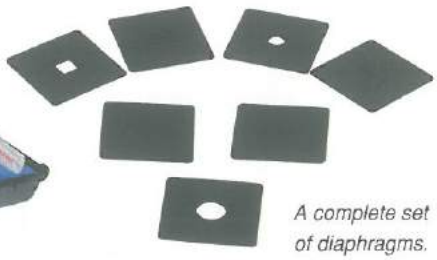
Optics System 1

4864.10

A complete system to study the principal laws of geometric optics

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

Optics System 1.



A complete set of diaphragms.

Specifications

Size: 124 x 28 x 12 cm – Weight: approx. 6 kg
Packing: durable ABS plastic carry case with foam inserts

Set of mirrors, lenses and prism holder.

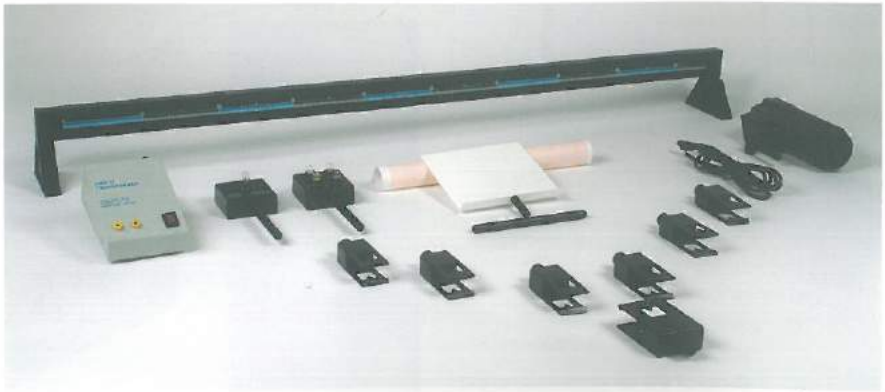
Set of lens – mirror holder.

Main components

- Wire set
- Lamp holders, single and quadruple, with spare lamps
- Slider for holder and projector
- Holder for 50 mm dia. lenses and mirrors
- Transformer for projector
- Prism table
- Projector with (12 V 20 W) halogen lamp
- White metal screen (140 x 140 mm)
- Biconvex lens (dia. 50 mm), f = +50, +100, +150, +200 mm
- Biconcave lens (dia. 50 mm), f = -50, -100, -150, -200 mm
- Concave mirror (dia. 50 mm), f = +50, +100, +150, +200 mm
- Convex mirror (dia. 50 mm), f = -50, -100, -150, -200 mm
- Optical bench, 20 x 40 x 1000 mm
- Wooden rod
- Joly photometer
- Set of seven diaphragms
- Holder for slides and diaphragms
- Millimetre graph paper
- 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



General hardware of the System.

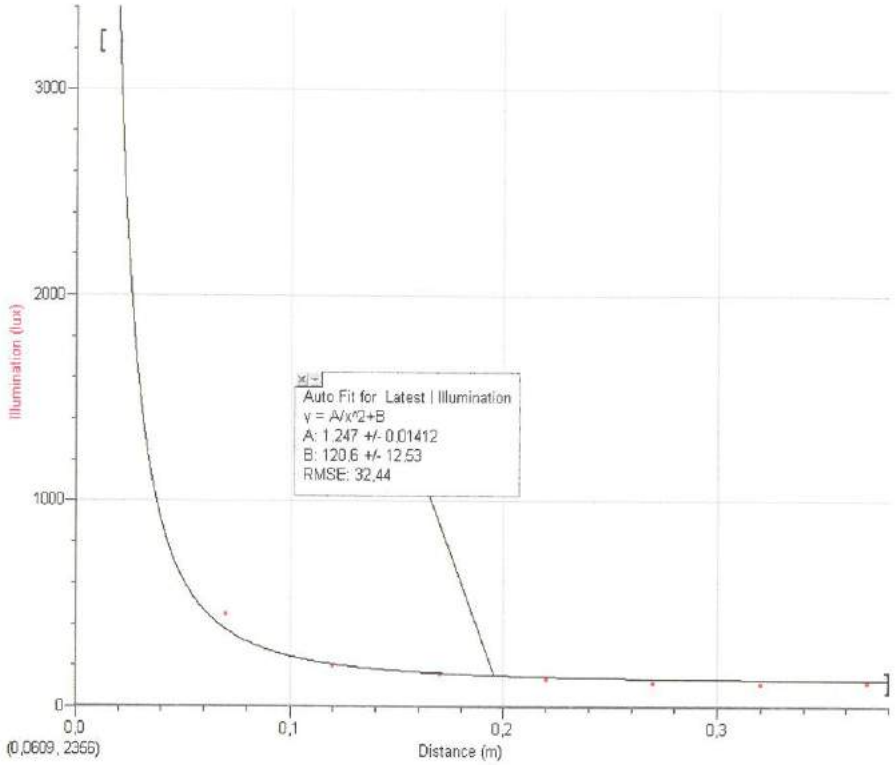
List of the experiments detailed in the instruction manual

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

Joly photometer

Setup for the Joly photometer experiment.

Inverse square law · A classical experiment on the inverse square law



Experimental data collected with a datalogger.

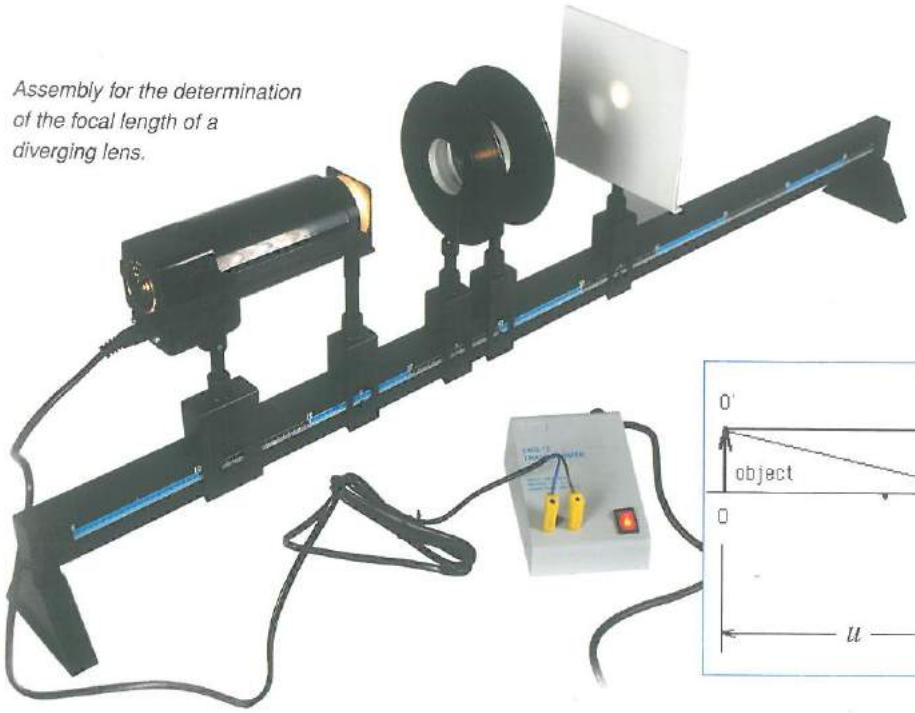
Simple explanation of inverse square law:

$$E = \frac{I}{r^2}$$

According to the photometric law of distance, the irradiance (E) of a point light source decreases in inverse proportion to the square of distance (r) for constant radiant intensity (I).

Focal length of a diverging lens · How to find the exact focal length of a diverging lens

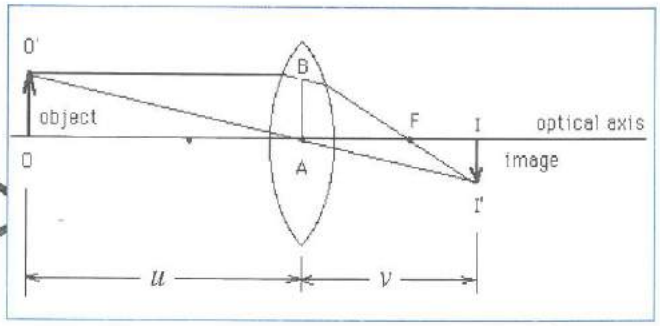
Assembly for the determination of the focal length of a diverging lens.



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").

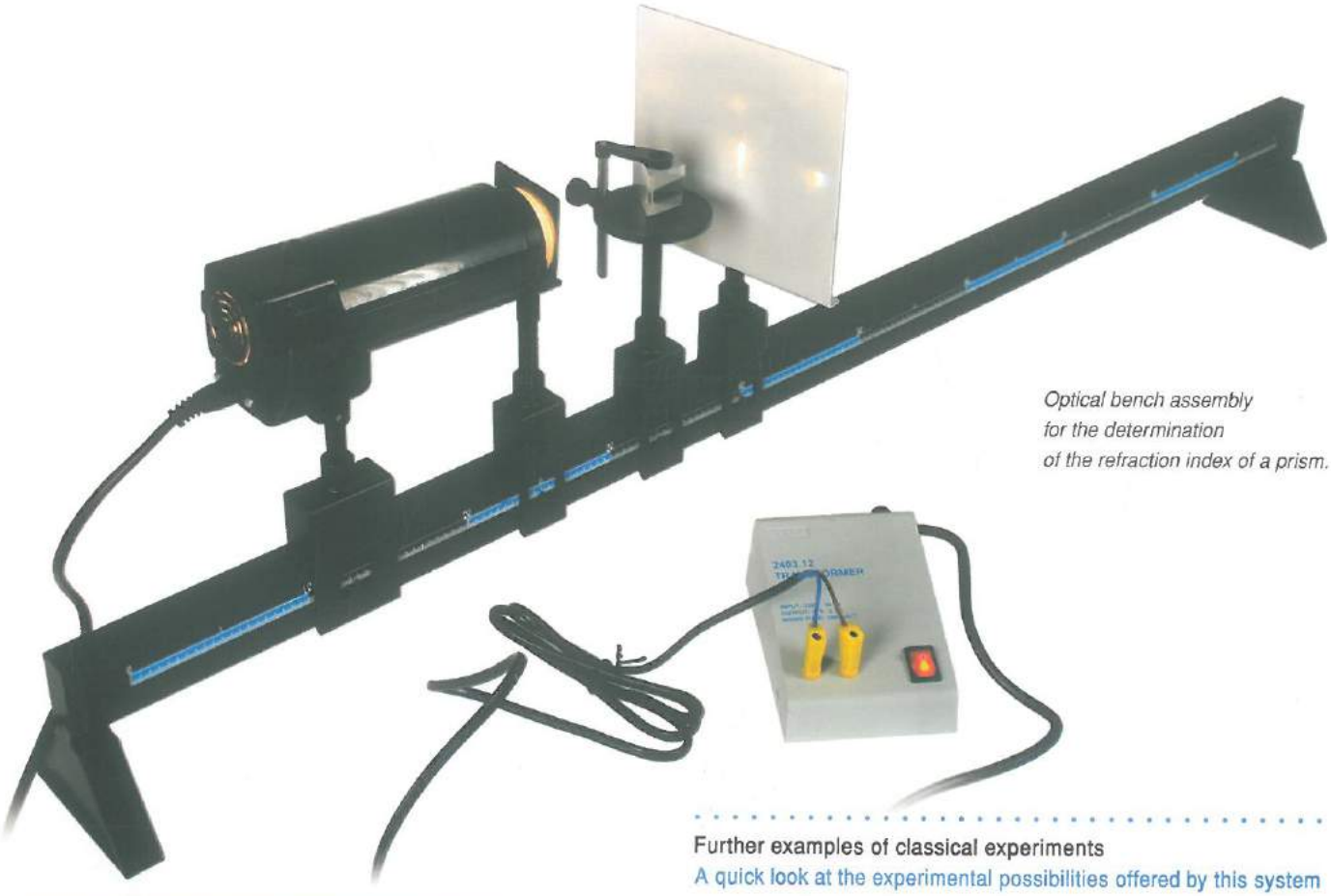
$$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$

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



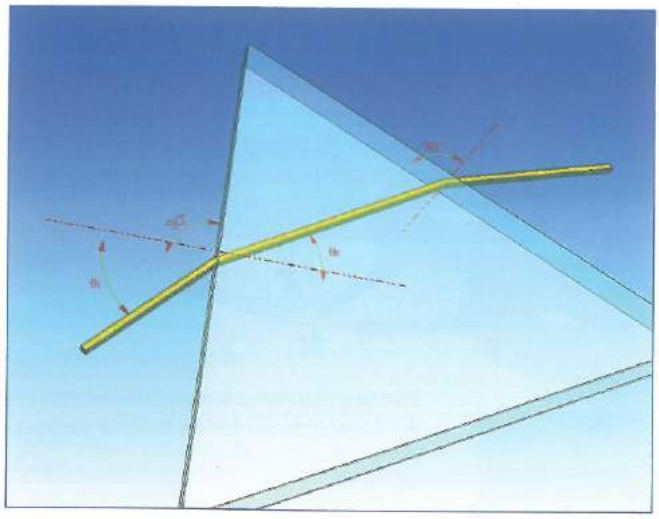
Schematic view of symbols and sign.

Refraction index of a glass prism · By measuring the minimum deviation angle it is possible to get the refraction index of a prism



Optical bench assembly for the determination of the refraction index of a prism.

Further examples of classical experiments
A quick look at the experimental possibilities offered by this system



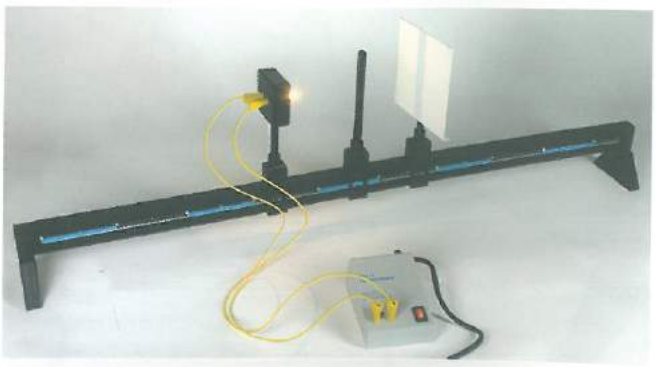
Geometrical representation of Snell's Law.

The draw is a simple representation of Snell's Law, which is represented by the following formula.

$$n = \frac{\sin\theta_i}{\sin\theta_r}$$ *Snell's Law.*

Where n is also known as a refraction index of a given material.

Joly photometer.



Umbra and penumbra.

Optics System 2

4864.21

An intermediate system for geometrical and physical optics

Optics System 2.

The Optics System 2 is designed to study composition of light, light polarization, refraction index as well as many additional aspects of light reflection and refraction.
The system contains a Hartl apparatus, which allows the student to perform many experiments related to the reflection of light on mirrors and to the refraction through transparent bodies.
Also included is our specially designed Altay Optics Box, designed to investigate polarisation in various solutions.
Additionally you can study photoresistance, photometry and verification of Malus' Law.

Specifications

Size: 83 x 28 x 12 cm – Weight: approx. 5.5 kg
Packing: durable ABS plastic carry case with foam inserts

Main components

- Hartl disk, graduated in degrees and mounted on stem
- Optical bench • Supports for optical bench
- Sliders for holders and projector
- Accessories for the Hartl disk: biconcave lens, two biconvex lens, triangular prism, trapezoidal prism, plane and flexible mirror
- Plexiglas cylinder • Pair of polarising filters
- Photometer • Transformer (12 V, 2.5 A)
- White metal screen • Refraction box
- Ray box, complete with set of filters, slits and mirrors

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

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

Lens set with flexible mirror and Hartl disk.

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

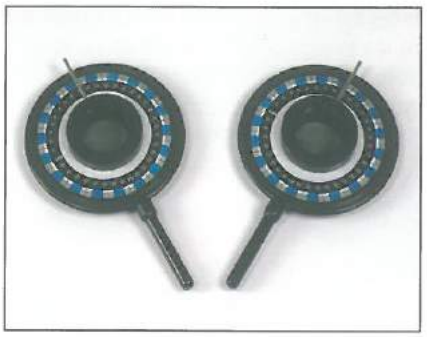
Optical bench with accessories.

List of the experiments detailed in the instruction manual

- Refraction index of a liquid and glass • 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
- Polarisation of light
- Rotation of the polarisation plane in a sugar solution
- Total refraction prism • Investigating mixing of colours
- Focal length of a lens • Malus' Law
- Investigations in quantitative photometry

Using data logging system with light sensor.

Polarising filters

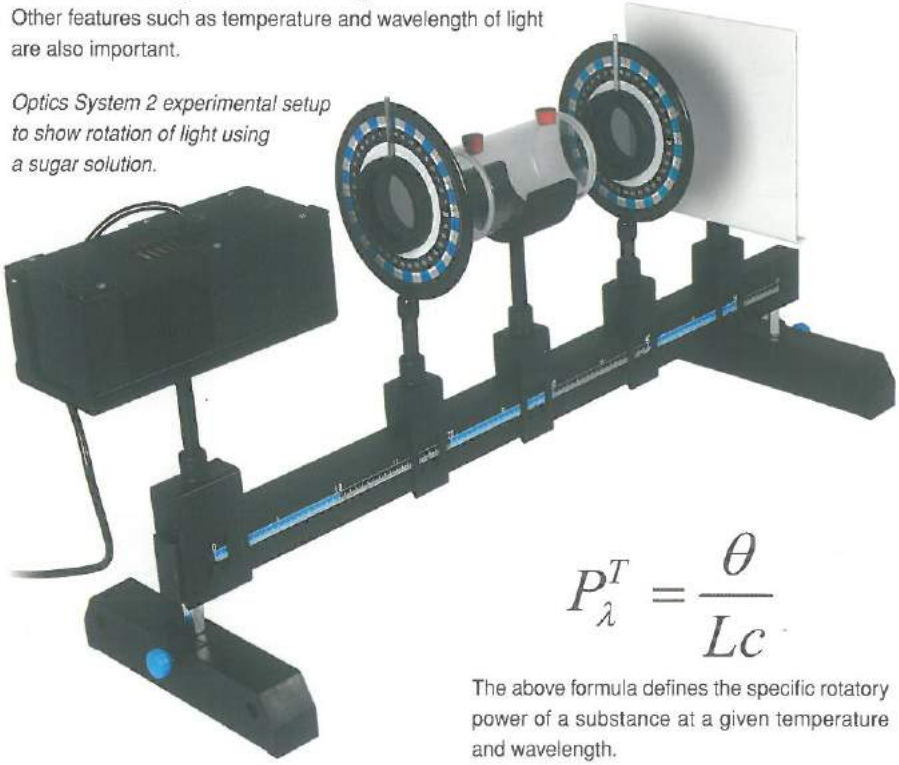


Pair of polarising filters, with scales.

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

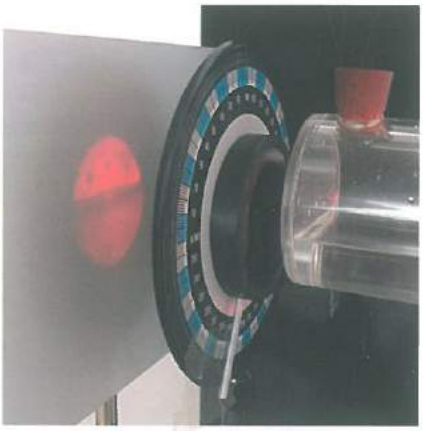
Some substances such as sugar will react when a beam of light is incident on it. They rotate the polarisation plane of the light around its direction of propagation.
This optical activity is a phenomenon connected with the "asymmetry by reflection" of the molecules of many substances. The degree of rotation 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.

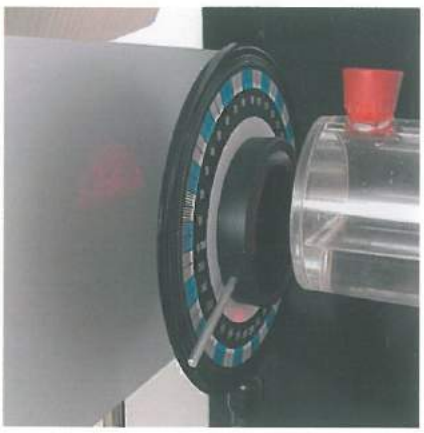


$$P_{\lambda}^{T} = \frac{\theta}{Lc}$$

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



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

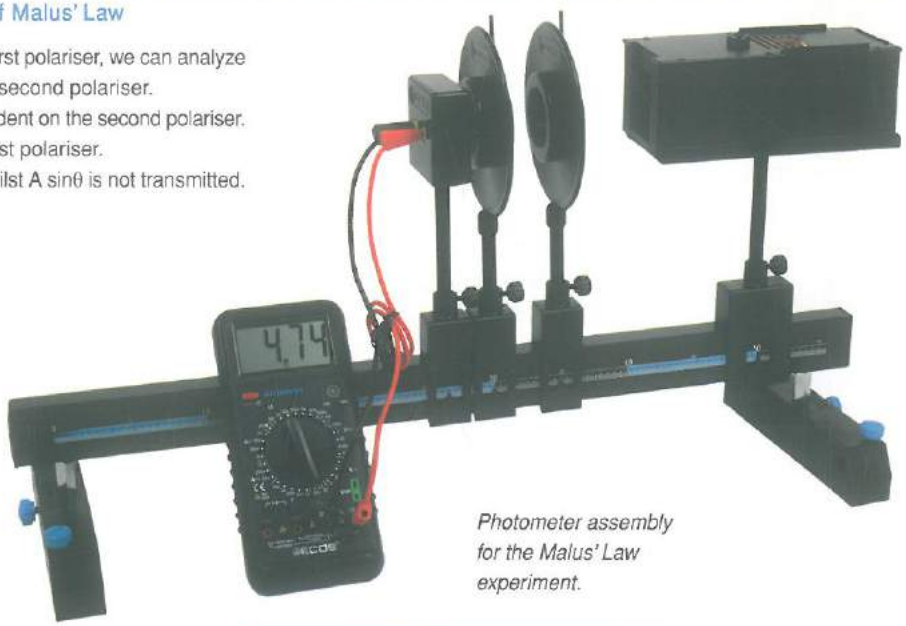


The angle is adjusted until all light is blocked out.

Malus' Law • Explanation and verification of Malus' Law

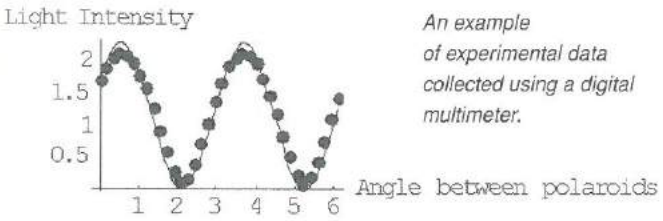
If we consider the polarised light coming from the first polariser, we can analyze how much of this light is transmitted through the second polariser.
Let (A) be the amplitude of plane polarised light incident on the second polariser.
The light is incident at angle to direction of the first polariser.
The component of A, A cosθ is transmitted and whilst A sinθ is not transmitted.

The resistance value is dependent on the angle between the polarisers.

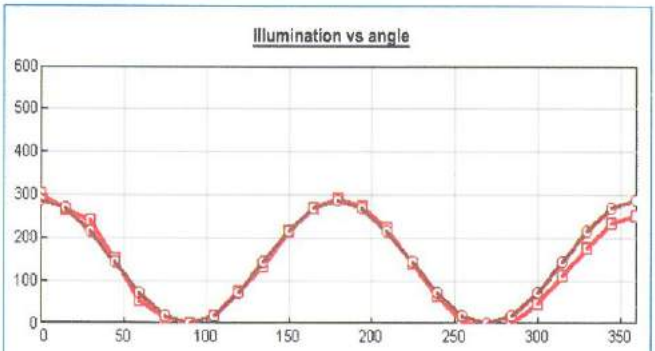


Photometer assembly for the Malus' Law experiment.

The intensity is proportional to the square of amplitude, so that the intensity transmitted is $I_T = I \cos^2\theta$: where (I) is the intensity of light incident on polariser. This is called "Malus' Law".



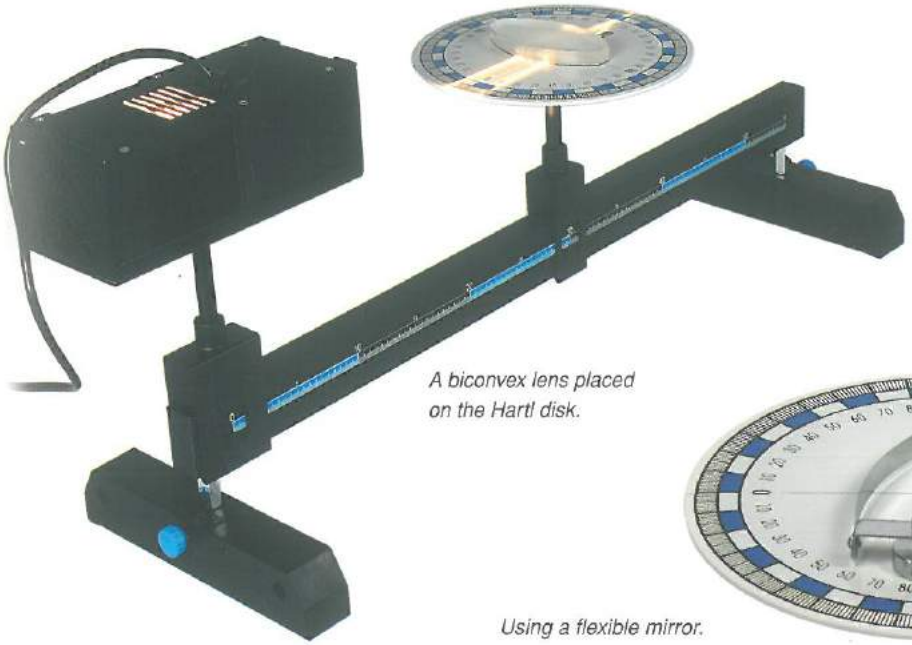
An example of experimental data collected using a digital multimeter.



Experimental data collected using a light sensor and a datalogger.

Further examples of experiments

A quick look at further experiments of the Optics System 2



A biconvex lens placed on the Hartl disk.

Composition of colours.

Using a flexible mirror.

Optics System 3

4864.30

An advanced optics system with diode laser

The Optics System 3 includes everything needed for a complete course in advanced optics.
Our system will take students through reflection, lens theory, diffraction, interference, diffraction grating and multiple slit diffraction.
You can also study many aspects of modern optical technology.
The equipment is easy to use and durable, and the experiments are substantive, yet conceptually easy to conduct. We have designed our Optics System 3 with great care allowing you to rapidly conduct a variety of experiments. 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!

Optics System 3 in its own box.

Specifications

Size: 30 x 23 x 7 cm – Weight: approx. 1 kg
Packing: comes with a durable ABS plastic carry case with foam inserts

Multiple diffraction grating mounted on holder.

Grating on plastic holder.

Solid state laser with cylindrical lens and polariser.

Main components

- Diode laser mounted on stem and base
- Re-chargeable batteries (for Diode Laser) • Power supply
- Cylindrical lens (for ray tracing) • Polaroid filter
- Plastic holders mounted on bases for the gratings and lenses
- Slides with 1 up to 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 bi-dimensional diffraction grating
- Diffraction grating with three different rulings (100, 300, and 600 lines per mm)

Laws and principles investigated

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

List of the experiments detailed in the instruction 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

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.

Assembly example for the diffraction grating experiment.

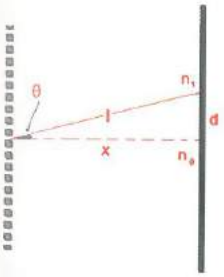
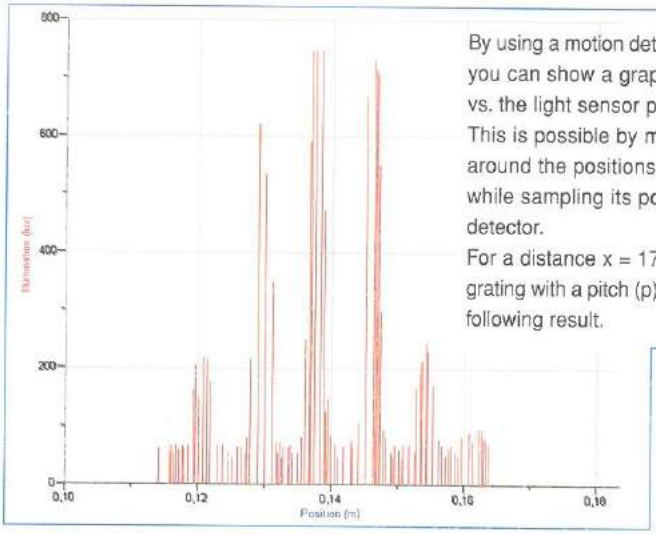


Diagram shows constructive and destructive interference of the light coming from the diffraction grating.

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

Constructive interference.

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



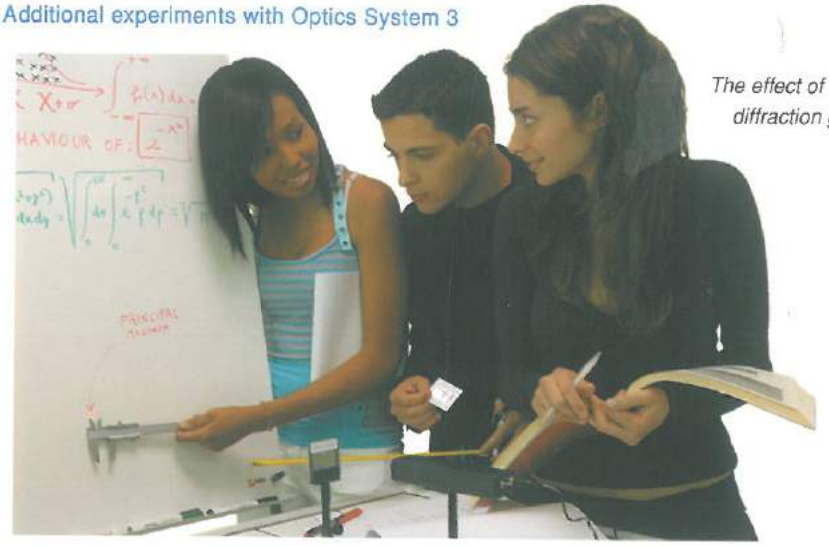
By using a motion detector and a light sensor you can show a graph of the light intensity vs. the light sensor position (*i.e.*, distance). This is possible by moving the light sensor around the positions of maximum intensity while sampling its position with the motion detector.

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.

Further examples of possible experiments • Additional experiments with Optics System 3

Coarse grating interference.



The effect of using a diffraction grating.

Bi-dimensional diffraction grating.

Electrostatics System

4865.10

A qualitative and quantitative overview of the concepts of electrostatics

Electrostatics System comes in a durable ABS plastic 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.

Specifications

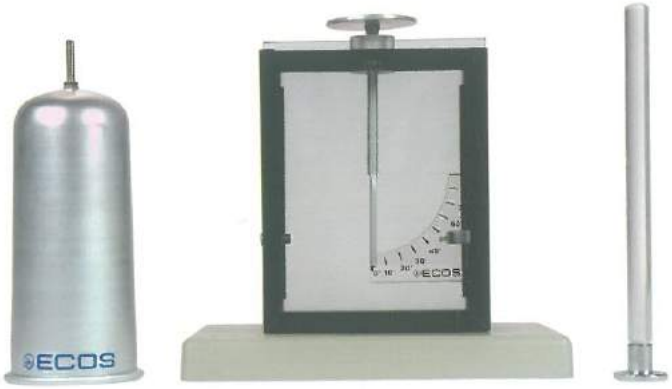
Size: 73 x 50 x 16 cm – Weight: approx. 5.5 kg
Packing: ABS plastic carry case with foam inserts

Main components

- Gold leaf electroscope • Hollow sphere
- Conductive sphere • Pith ball electroscope
- Neon tube
- Electrophorus disc with handle and polyethylene tile
- Proof plane with handle • Aluminium can
- Glass, ebonite and Perspex rods
- Wool and silk rubber • Polyethylene strip
- Faraday's well
- Nylon filament and wire stirrup to support strips and rods

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



Gold leaf electroscope with accessories.

Full set of materials for electrostatics experiments.

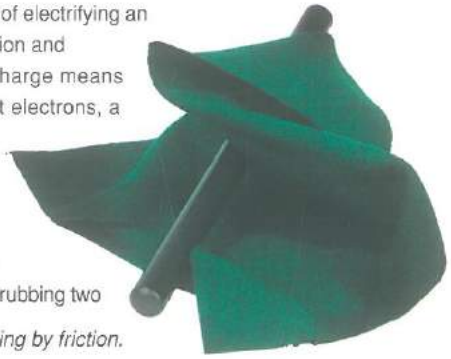
List of the experiments detailed in the instruction manual

- 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

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

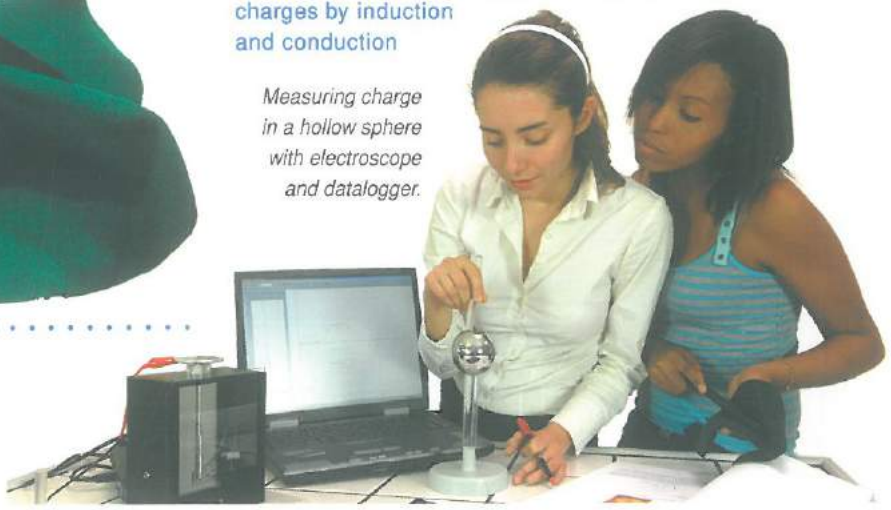
Electrostatics

There are three modes of electrifying an object: friction, conduction and induction. A positive charge means that the object has lost electrons, a negative charge means that the object has gained electrons. The picture shows how to induce a charge using friction by rubbing two



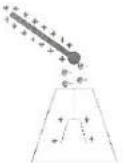
Charging by friction.

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



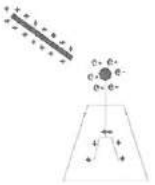
Measuring charge in a hollow sphere with electroscope and datalogger.

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 or 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.

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.

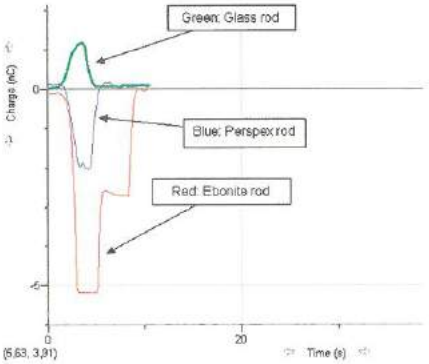


Conduction.

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. 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.



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

Conductive sphere and hollow sphere

How the charge is distributed in different shapes

Charging the conductive sphere.

This experiment shows how the shape of the conductor influences the surface charge on it. The first experiment shows that the surface charge in a conductive sphere depends on the quantity of charge you put in it.

In the second case, despite the amount of charge placed on the hollow sphere, the inner surface remains uncharged.

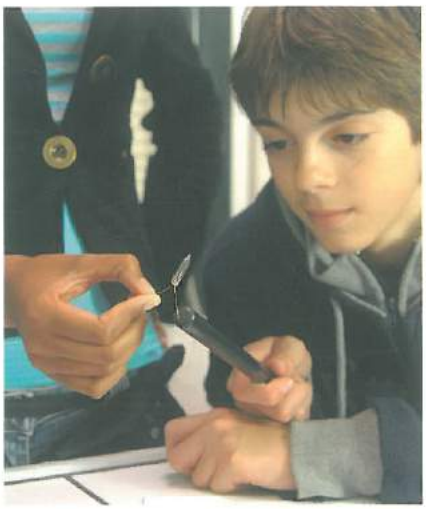
Measuring the inner charge of a hollow sphere.

Measuring the surface charge of a conductive sphere.

Further examples of experiments performed using the Electrostatics System

A quick look at the possibilities offered by this system

Sample use of the pith ball electroscope.



The electrostatic charge causes the neon tube to light.

Magnetics System 1

4867.10

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

Specifications

Size: 50 x 42 x 12 cm – Weight: approx. 4 kg
Packing: external suitcase in durable ABS plastic, internal foam to prevent accidental shock

Magnetics System 1 in its own box.

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.

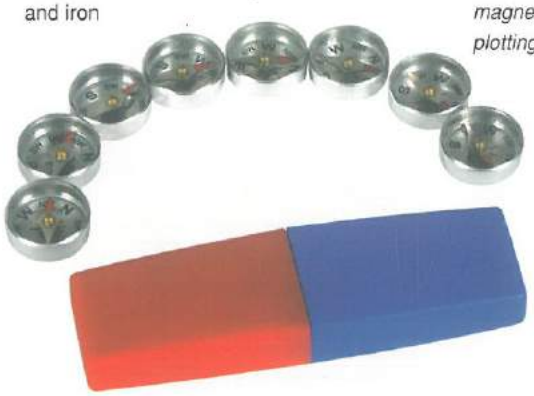
Main components

- Floating magnets with base support
- Neodymium magnets
- Aluminium foil (for eddy currents experiments)
- Magnetic field chamber in 2D and 3D
- Pocket compass • Plotting compasses
- U-shaped magnet
- Two different horseshoe magnets
- Pair of cylindrical magnets
- Magnetic model of the Earth
- Pair of plastic covered bar magnets
- Different pairs of bar magnets (Chrome Steel, Alnico, Ferrite)
- Ring magnets • Cylindrical iron and steel bar
- Hook • Ferromagnetic chain • Iron filings
- Stainless steel sphere

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

Magnet system with all components.

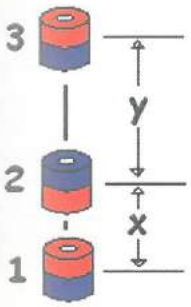


Plastic coated bar magnets with plotting compasses.

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

List of the experiments detailed in the instruction manual

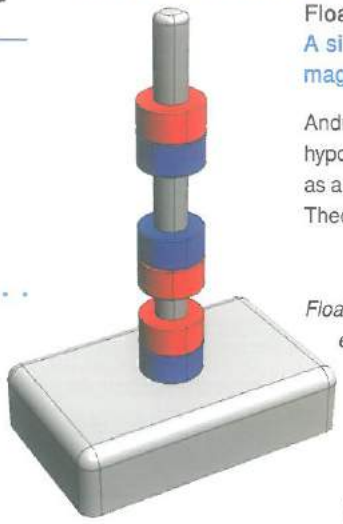
- Magnetic field lines in 2D and 3D
- Deflection of a magnetic needle
- Compasses
- Magnetic dipole interactions
- Magnetic hysteresis of a steel bar
- Eddy currents in an aluminium tube
- The Earth's magnetic field



Variables used in the floating magnets experiment.

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

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).

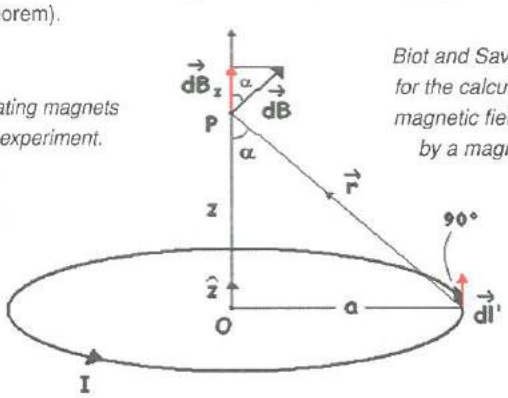


Floating magnets experiment.

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).



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

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

Magnetic drag force

Observe the effect of the eddy currents acting on a magnet falling in an aluminium tube

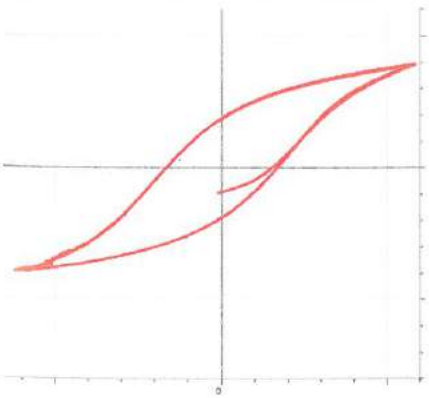
A falling magnet inducing a force inside an aluminium tube which is against itselfs. A nice demonstration of Lenz's Law.

Experiment demonstrating the magnetic drag force acting on a permanent magnet falling in an aluminium pipe.

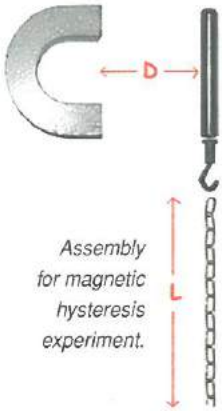
Students demonstrating the effect of the eddy current (Lenz's Law).

Further examples of classical experiments

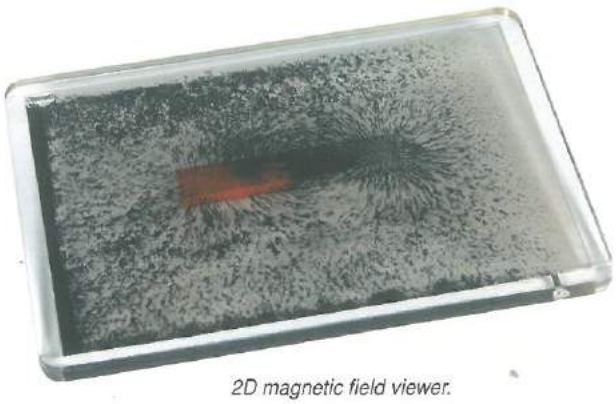
A quick look at further experiments of the Magnetic System 1



Experimental data showing the magnetic hysteresis experiment, using a datalogger with a magnetic field sensor (y-axis) and a current sensor (x-axis).



Assembly for magnetic hysteresis experiment.



2D magnetic field viewer.

Magnetics System 2

4867.20

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

Specifications

Size: 50 x 42 x 12 cm – Weight: approx. 4 kg
Packing: comes with a durable ABS plastic carry case

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

Magnetics System 2 in durable ABS carry case.

Main components

- Pair of bar magnets • Iron filings
- Support for acrylic discs (used in overhead projectors)
- Clear acrylic disc for demonstrating permanent magnets
- Magnetic needle probe
- Plastic funnel for iron filings
- Clear acrylic disc with straight wire conductor, long solenoid and vertical coil
- Pair of ferromagnetic bars • Aluminium ring

Magnetics System 2 components.

Example of the use of the carrying current conductor

Experiment data being taken using a magnetic field sensor.

With a datalogger and a magnetic field sensor it is easy to acquire and elaborate data with a computer.

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

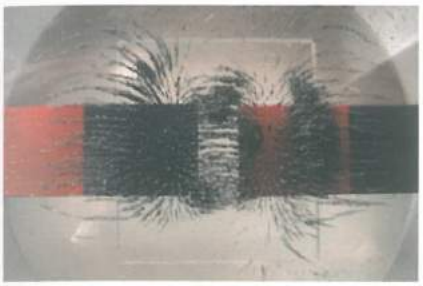
List of the experiments detailed in the instruction manual

- 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

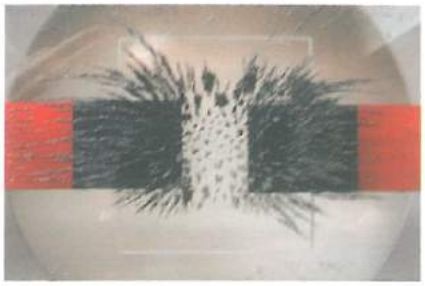
Magnetic field produced by a permanent magnet

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 opposite polarities.

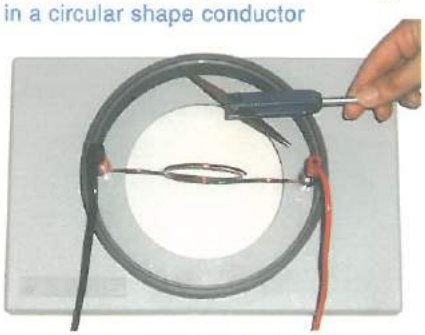


Magnetic field produced by two bar-shape magnets with same polarity.

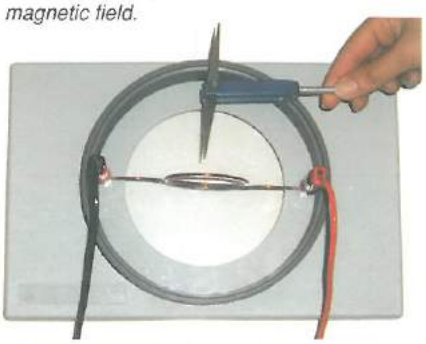
This is a very interesting demonstration showing the lines of force of a magnet using iron filings. Students can easily see where lines of force are greater, simply by the greater density of the iron filings and how they line up, and a very simple way to show how the North and South poles of a magnet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

Magnetic field produced by a current

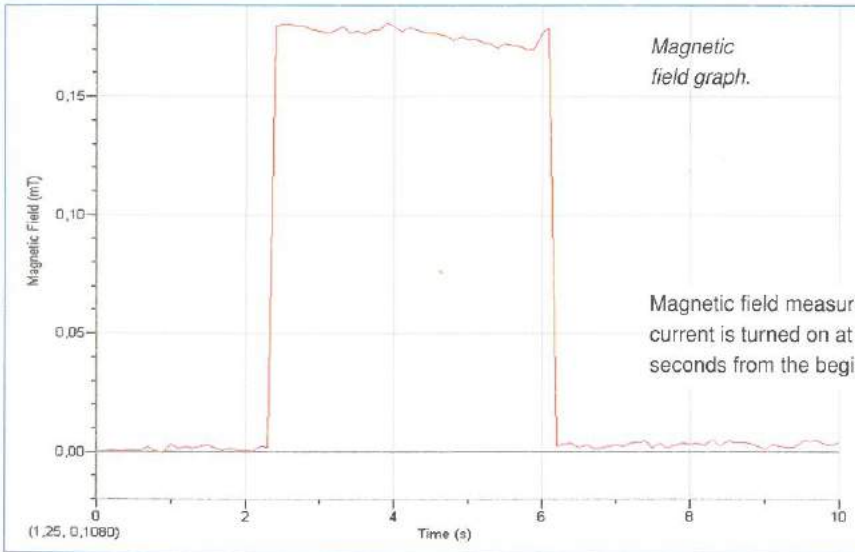
Experiment to show the magnetic lines of force produced by a current flowing in a circular shape conductor



When the current is turned off, the magnetic field probe is aligned with the earth's magnetic field.



When the current is turned on, the magnetic field probe is aligned with the magnetic field produced by the coil.



Magnetic field graph.

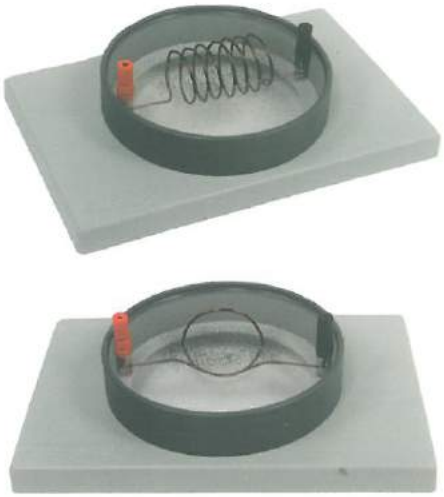
Magnetic field measured at the centre of a circular coil (z = 0) when the current is turned on at roughly two seconds and turned off at roughly six seconds from the beginning of the experiment.

The screen shot shows a nice approximation of Ampère's hypothesis. By utilizing the Biot-Savart Law we can also demonstrate the magnetic field in the centre of a given coil.

Further experiments · Some examples performed with this system

Straight wire conductor prepared with iron filings.

Solenoid shape conductor prepared with iron filings.



Electricity System 1

4866.10

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

Specifications

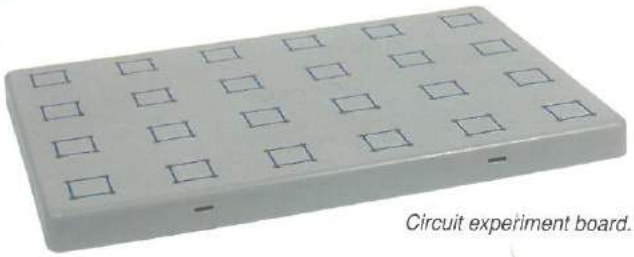
Size: 50 x 42 x 12 cm – Weight: approx. 4.5 kg
Packing: durable carry case in ABS with internal foam

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 in a durable carry case.

Main components

- Board for experiments • Voltmeter
- Ammeter • Resistors • Capacitors
- Coil for inductance experiments, with ferromagnetic and magnetic core
- Potentiometer
- Lamp holder with different voltage lamps
- Two cell holder • Compass • Bridging plugs
- Push button switch • Toggle switch
- Connecting leads



Circuit experiment board.

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

Electrical components.

Voltmeter, ammeter, cell holders, switches and bridging plugs.

List of the experiments detailed in the instruction 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

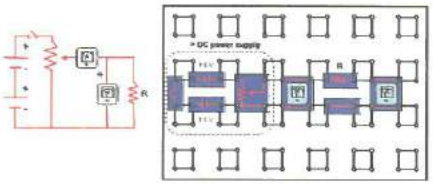
The circuit experiment board for the Electricity System is designed to be easy to use and intuitive. The circuit experiment board consists of a series of sockets which are designed to fit the connector blocks.
The blocks are easily identified by schematic diagram of the component printed on top, so that the student can have a clearly defined view of the circuit or experiment being built.

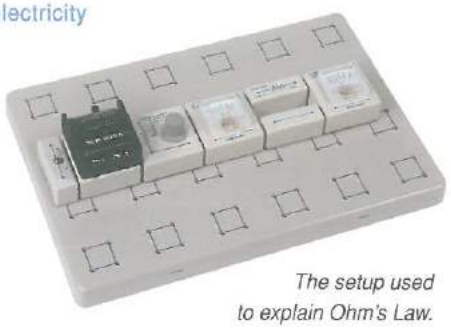
Series and parallel sample circuits experimental setup.

Ohm's Law · The fundamental principle of electricity

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

$$V = IR$$ *Ohm's Law.*





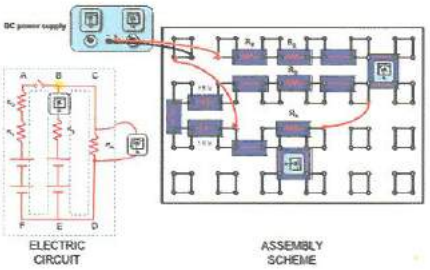
The setup used to explain Ohm's Law.

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.

The Kirchhoff's Laws · Two practical principles for describing electrical circuits

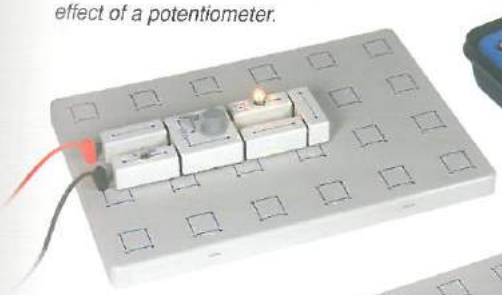
The two Kirchhoff's Laws are very useful tools for solving simple and complex electrical circuits.
The First Kirchhoff's Law (or Kirchhoff's Current Law) states that in every node of a circuit in which two or more branches are connected, the algebraic sum of all currents entering and exiting the junction must be equal to zero.
The Second Kirchhoff's Law (or Kirchhoff's Voltage Law) establishes that in every loop of a circuit the algebraic sum of all voltages in a loop must be equal to zero.



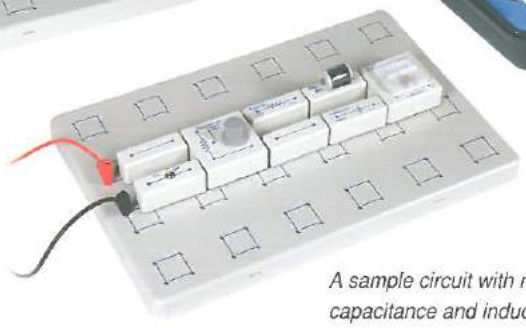
Example of a more complex circuit explaining the application of both Kirchhoff's Laws.

Further examples of classical experiments · More circuits experiments performed with this system

A simple circuit for explain the effect of a potentiometer.



Case can also be used to setup experiments.



A sample circuit with resistance, capacitance and inductance.

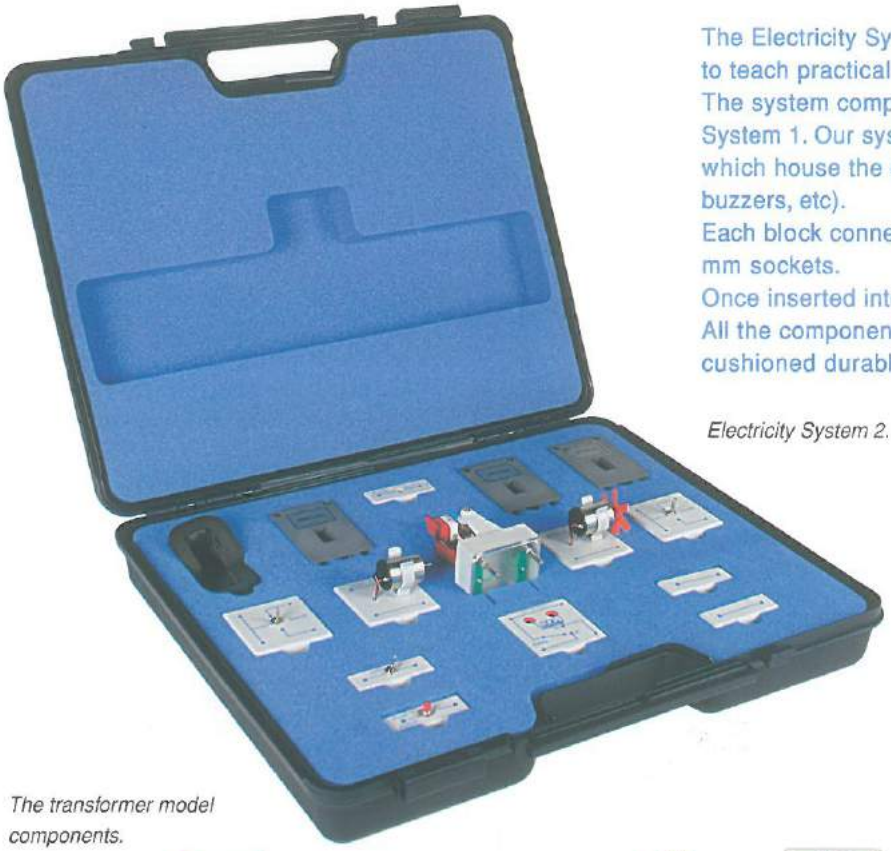
Electricity System 2

4866.20

An advanced electricity lab for electrical circuit projects.

Specifications

Size: 50 x 42 x 12 cm – Weight: approx. 4 kg
Packing: external suitcase in a durable ABS plastic carry case



Electricity System 2.

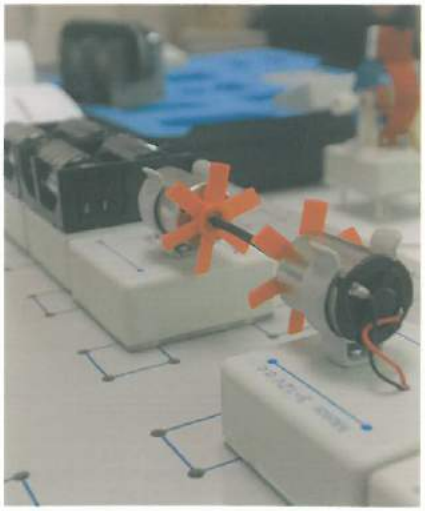
The Electricity System 2 is an advanced system designed to teach practical applications in circuits.
The system completes and can be used with our Electricity System 1. Our system consists of a set of plastic blocks which house the electrical components (such as motors, buzzers, etc).
Each block connects 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 plastic storage case.

Main components

- Motor model • Motor unit
- Propellers for dynamo experiment
- Model of transformer, composed of C core and coils with different number of turns
- Relay • Reversing switch • Buzzer
- Push button switch • Toggle switch
- Bridging plugs • Coil

The transformer model components.

Plug in block components.



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

Mounting detail for a sample experiment.

Laws and principles investigated

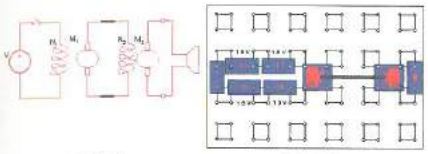
- What is a transformer
- Investigating the behaviour of electric motors
- Looking at electric energy transformation into mechanical energy
- The principle of the dynamo
- Looking at mechanical energy transformation into electrical energy
- Experiments with luminosity

List of the experiments detailed in the instruction 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

Dynamo · How to transform mechanical into electrical energy

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



The electrical energy can then be used to power a buzzer.

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

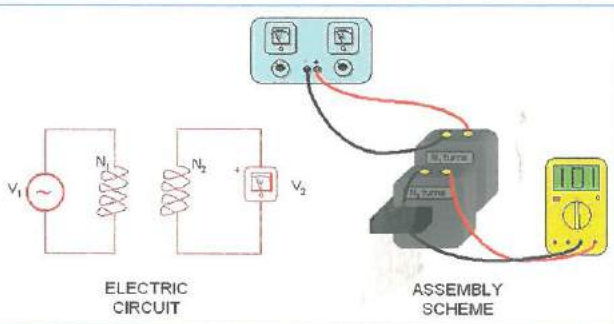
Transforming energy using a dynamo.

Transformers · How to obtain a different voltage

The transformer is an electric machine able to change (transform) an AC input voltage to another AC output voltage. It consists of two coils (primary and secondary) wrapped around the same ferromagnetic core, as shown in the picture.

Using a Transformer.

Experiment using a transformer to change the voltage provided by a power supply.



Let us indicate with N_1 the number of turns of the primary coil and with N_2 the number of turns of the secondary coil, therefore we can define a coil turn ratio as: $\frac{N_1}{N_2}$ while we define a voltage transformation ratio as: $\frac{V_1}{V_2}$

Further examples of classical experiments

Sample setup offered by this system

Motor model.

It can be proved that: $\frac{V_1}{V_2} = \frac{N_1}{N_2}$

That is the transformation ratio is equal to the turn coil ratio.
If $N_1 > N_2$, then the voltage on the primary will be greater than the one on the secondary (step-down transformer).
Otherwise, if $N_1 < N_2$, then the voltage on the secondary will be greater than the one on the primary (step-up transformer).
Students can try to measure (with a digital multimeter) both the voltage at the primary and the voltage at the secondary, for different coil turn ratios, as shown in the picture above.

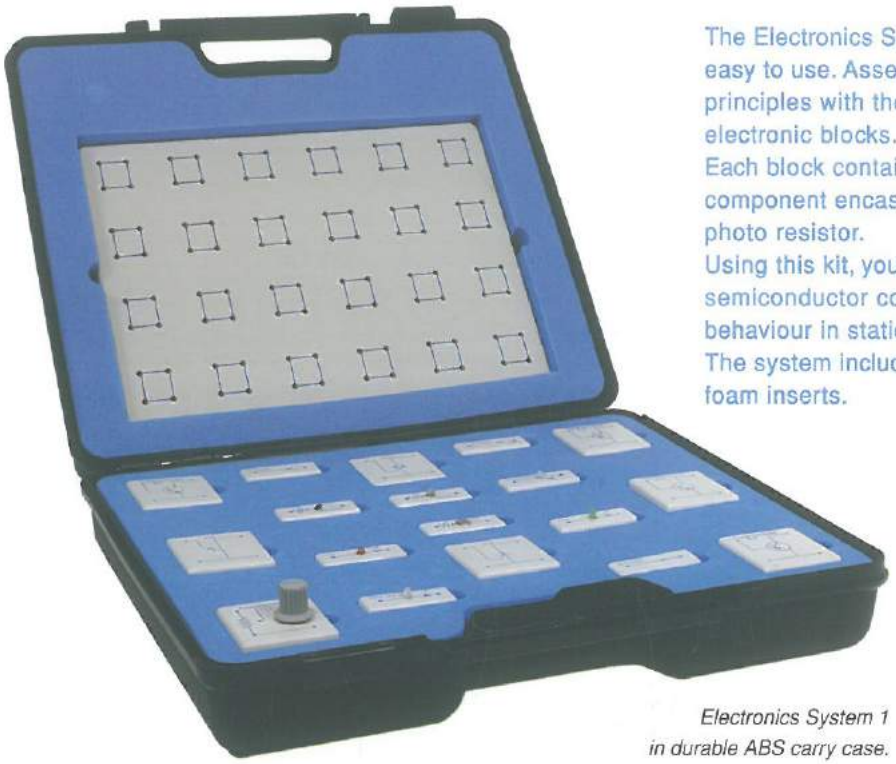
Electronics System 1

4868.10

A comprehensive system introducing the principles of electronics

Specifications

Size: 50 x 42 x 12 cm – Weight: approx. 3.5 kg
Packing: external suitcase in hard ABS, internal foam for prevent accidental shock



Electronics System 1 in durable ABS carry case.

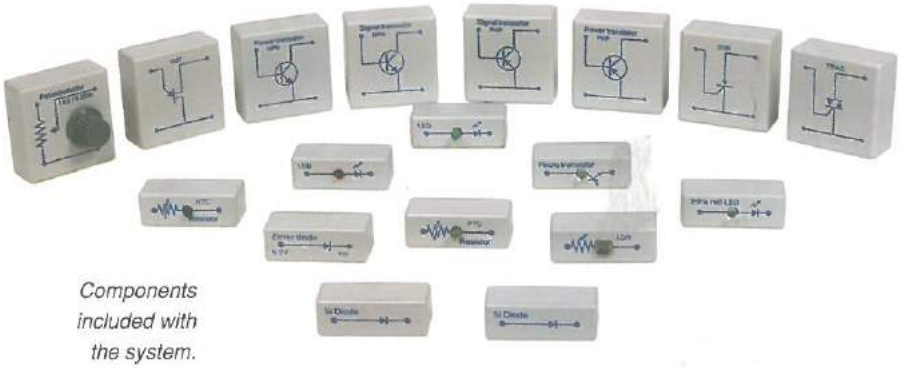
The Electronics System 1 is designed to be rugged and easy to use. Assemble and teach electronic circuits and principles with the minimum of fuss using our easy to use electronic blocks.
Each block contains a fully functional electronic component encased; everything from a potentiometer to a photo resistor.
Using this kit, you can observe and understand how semiconductor components work and their characteristic behaviour in static and dynamic circuits.
The system includes a durable ABS plastic carry case with foam inserts.

Main components

- The Experiment Board • Si diode
- PNP Signal transistor • NPN Signal transistor
- PNP Power transistor • NPN Power transistor
- LED, red and green colour
- Infrared LED diode
- UJT Uni-junction transistor
- SCR Silicon controlled rectifier • Triac
- Photo transistor • Photoresistance LDR
- Zener diode • PTC resistor • NTC resistor
- Potentiometer

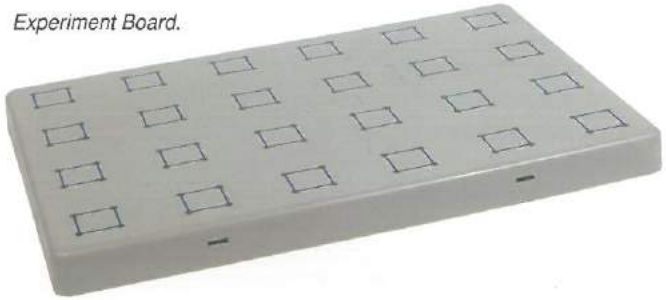
Laws and principles investigated

- Characteristics of diodes
- 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)



Components included with the system.

Experiment Board.



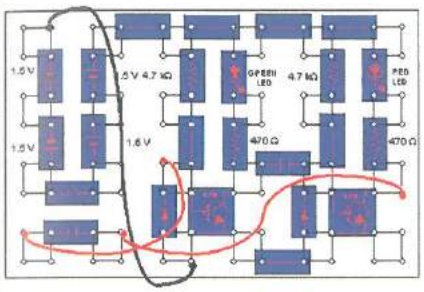
List of the experiments detailed in the instruction manual

- Investigating the diode and the PN junction
- Experiments with rectifier diodes • Working with Zener diodes
- LED 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

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.

ASSEMBLY SCHEME



Flip-flop circuit.

Students mounting the circuit.

The multivibrator is an example of a relaxation oscillator, whose frequency may be controlled by external synchronizing pulses.

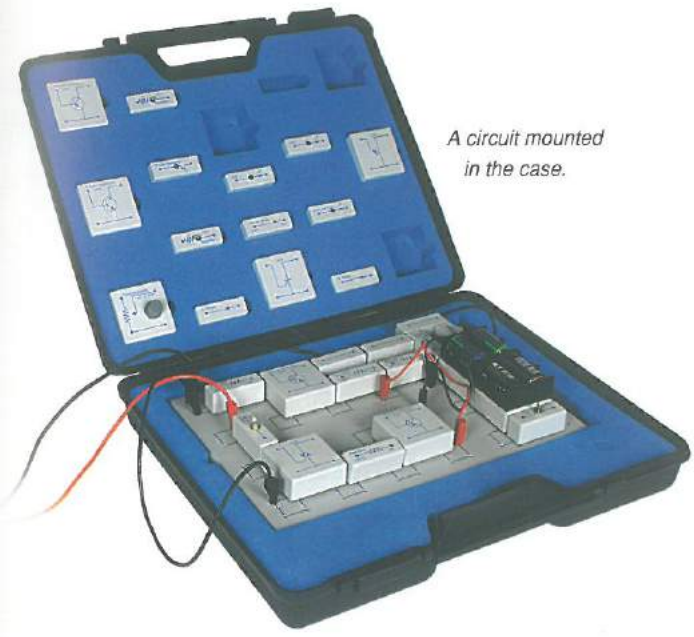
Transistors as current amplifiers

A low-power input signal allows you to control a high-power output signal

A bipolar transistor works as a current regulator. In a NPN transistor, the main current goes from the collector to the emitter, while the small current goes from the base to the emitter.

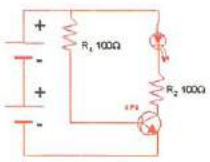
Circuit setup.

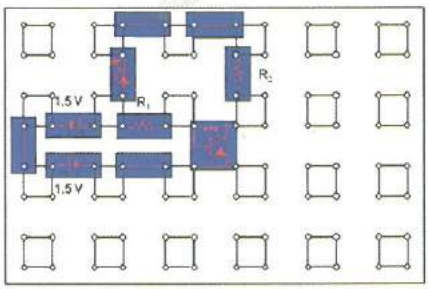
Further examples of experiments with the Electronics System 1



A circuit mounted in the case.

Circuit diagram for a current amplifier using a NPN transistor.





ELECTRIC CIRCUIT ASSEMBLY SCHEME

For example, this experiment highlights the effect of the current amplification using an LED diode. A light-emitting diode (LED) is a diode that glows when a current flows into it in a forward direction.
In our circuit, a resistance R = 100 Ω has been inserted in order to limit the current flowing through the LED. Once the NPN transistor has been properly connected, a current that flows through the LED will glow red.
This means that the small current injected through the base of the transistor has been amplified into a higher current through the collector and the LED.

Electronics System 2

4868.20

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

Specifications

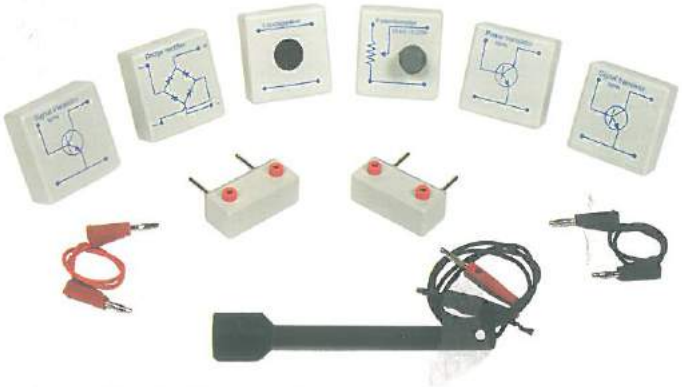
Size: 50 x 42 x 12 cm – Weight: approx. 3 kg
Packing: comes with a durable ABS plastic carry case with foam inserts

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

Electronics System 2 comes with durable ABS plastic carry case with foam inserts.

Main components

- Microphone with cable • Loudspeaker
- Bridge rectifier • Signal transistor NPN
- Power transistor NPN • Set of capacitors
- Set of resistors • Potentiometer
- Set of bridging plugs • Set plugs angled at 90°
- Set of connecting leads

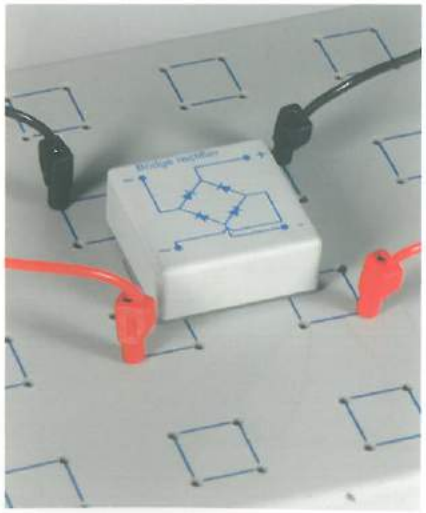


Laws and principles investigated

- 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

Components included into the Electronics System 2.

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



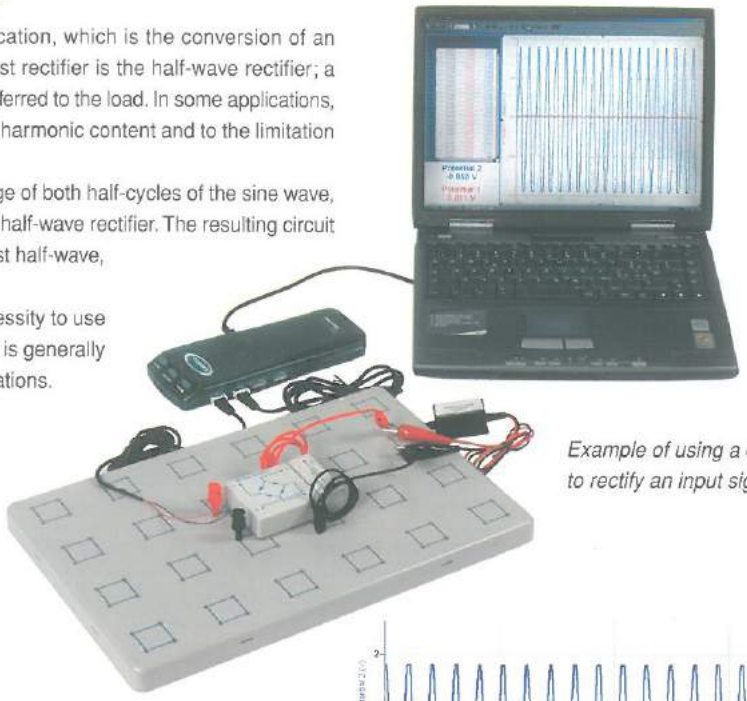
Example of an experimental setup.

List of the experiments detailed in the instruction manual

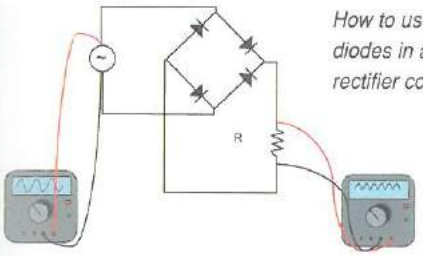
- The bridge rectifier • The voltage follower • The common emitter amplifier
- The common base amplifier • The common collector amplifier
- The current mirror amplifier • The audio amplifier

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

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

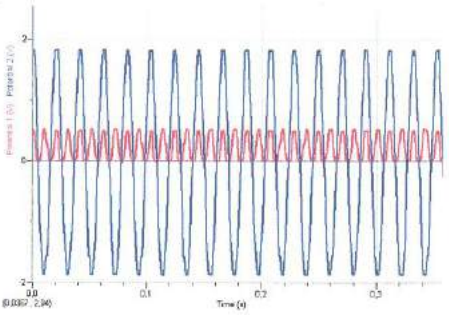


Example of using a diode to rectify an input signal.



How to use four diodes in a bridge rectifier configuration.

By using a datalogger we can easily study rectification in a circuit.
The datalogger is used for recording the signal traces of the input and output.

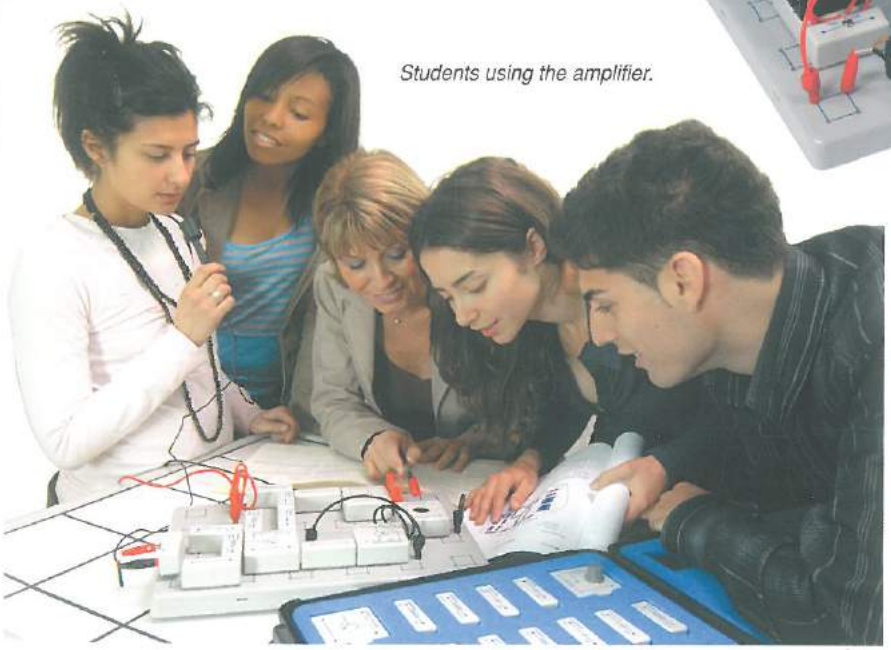


Example of a screenshot (resistance R = 100 Ω, voltage amplitude A input = 2 V, frequency f = 50 Hz). The blue line is the input signal, while the red line is the output, rectified signal.

Audio amplifier · How to design a basic amplifier

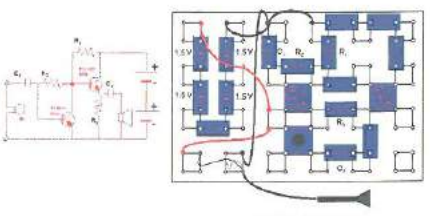
With Electronics System 2 it is possible to design a basic audio amplifier. This is a simple circuit that will boost the input audio signal then generating an output signal by means of a speaker. The circuit is composed of two transistors, one being the driver, the other being the power transistor.

Simple circuit design of basic audio amplifier.



Students using the amplifier.

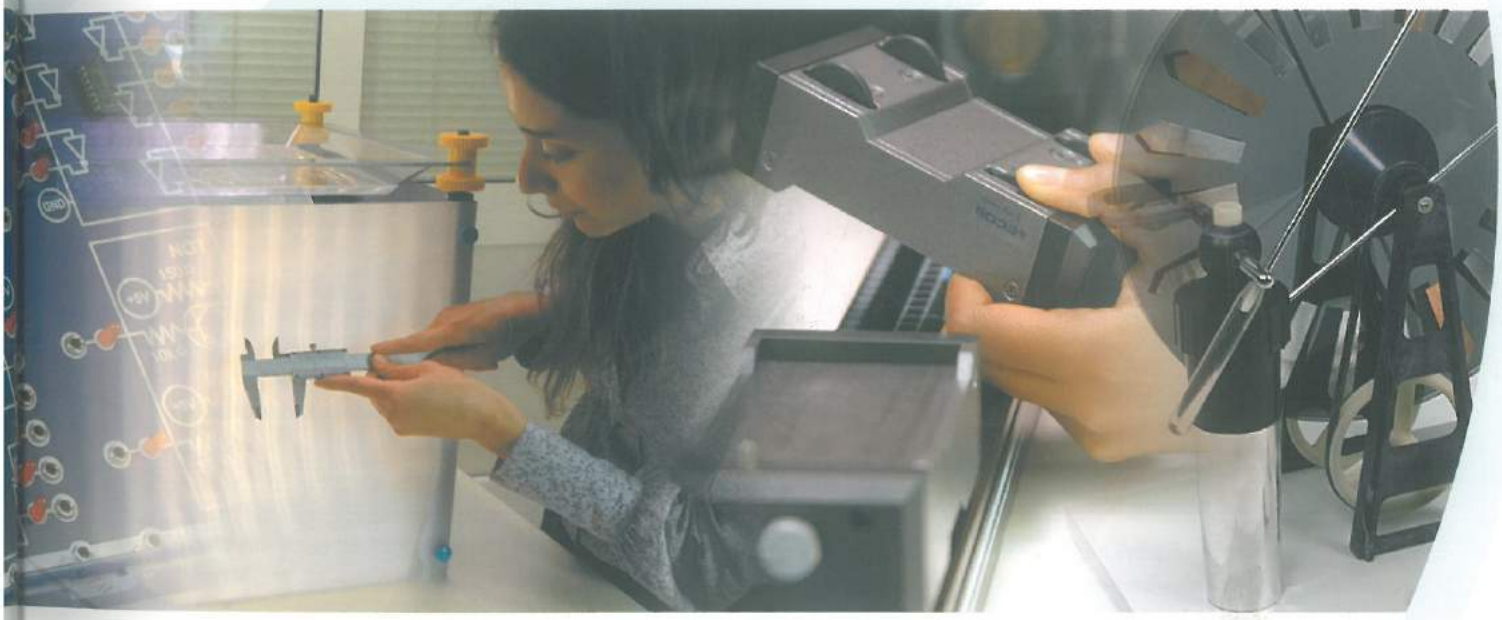
The input audio signal, generated by a microphone, is boosted by the circuit and is picked up at the output by means of a speaker.
The circuit provides the student with a good way to observe the practical behaviour of an amplifier.



Audio amplifier circuit setup.

TEMA
INTERNATIONAL

Single Items

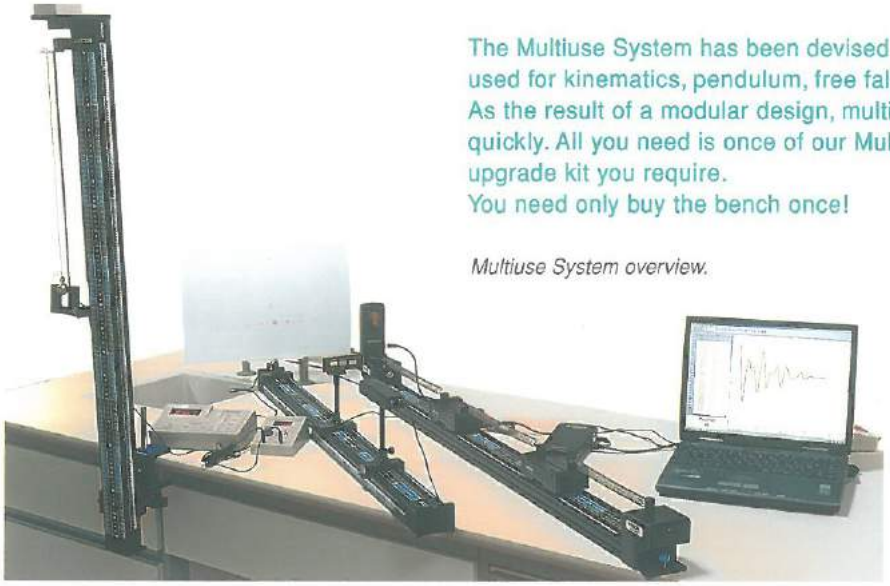


TEMA INTERNATIONAL

The TEMA Multiuse System

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

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 once of our Multiuse Systems, then purchase whatever upgrade kit you require.
You need only buy the bench once!



Multiuse System overview.

Multiuse System used as a dynamics track.

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

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 (code 4954.10)**
  Aluminium track with accessories
- **Mechanics Upgrade 1 (code 4941.10)**
  Two Altay Carts, new design, track's terminals and accessories
- **Mechanics Upgrade 2 (code 4941.20)**
  Spheres for free fall and pendulum experiments, electromagnet, oscillation counter and accessories
- **Optics Upgrade 1 (code 4944.10)**
  Lenses, mirrors, prism and general hardware for the optical bench
- **Optics Upgrade 2 (code 4944.20)**
  Hartl disk, optical bodies for geometric optics experiments and accessories
- **Optics Upgrade 3 (code 4944.30)**
  Laser, diffraction gratings and accessories

Additional items

- **Timing Set (code 4922.10)**
  Electronic timer with photogates
- **Ball Launcher for Cart (code 4941.11)**
  Ball Launcher for Altay Cart, with accessories
- **Altay Cart without Plunger (code 4941.12)**
- **Altay Cart with Plunger (code 4941.13)**
- **Coupled Pendulum Set (code 4941.16)**
- **EM Trigger&Launcher for Cart (code 4941.17)**

All items are also sold separately.

Multiuse System used as an optical bench.

Track Set

4954.10

The TEMA Multipurpose Track Set

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.

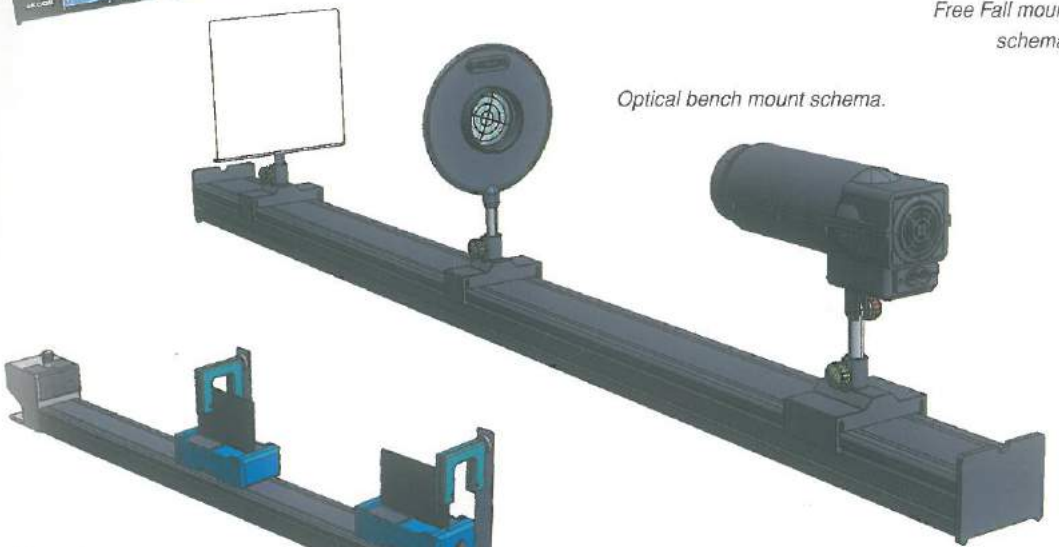
**Designed to produce an almost frictionless track for the Altay Carts, it is also an Optical Bench, a Free Fall Stand for determination of "g" and a Pendulum Stand.
The MultiTrack has clearly defined scales printed on an attractive black anodised base.**

TEMA Track.

TEMA Track.
showing the Dynamics Scale.

TEMA Track.
showing Free Fall and Pendulum scales.

TEMA Track.
with Optical Bench scale.



Optical bench mount schema.

Dynamics mount schema.

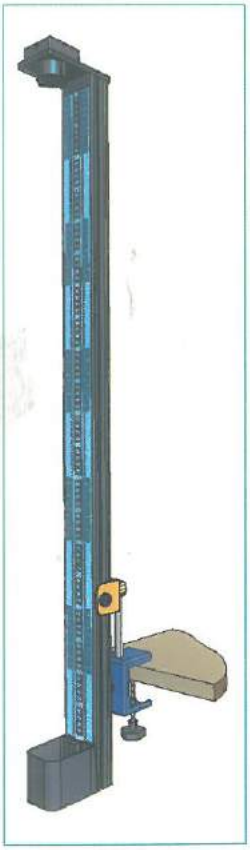
Specifications

Length: 110 cm – Size: 110 x 7 x 4 cm
Weight: approx. 1.5 kg
Also available: Altay Track Set,
Length 145 cm (code 4954.11)

Main components

• Altay Track • Track terminals

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.



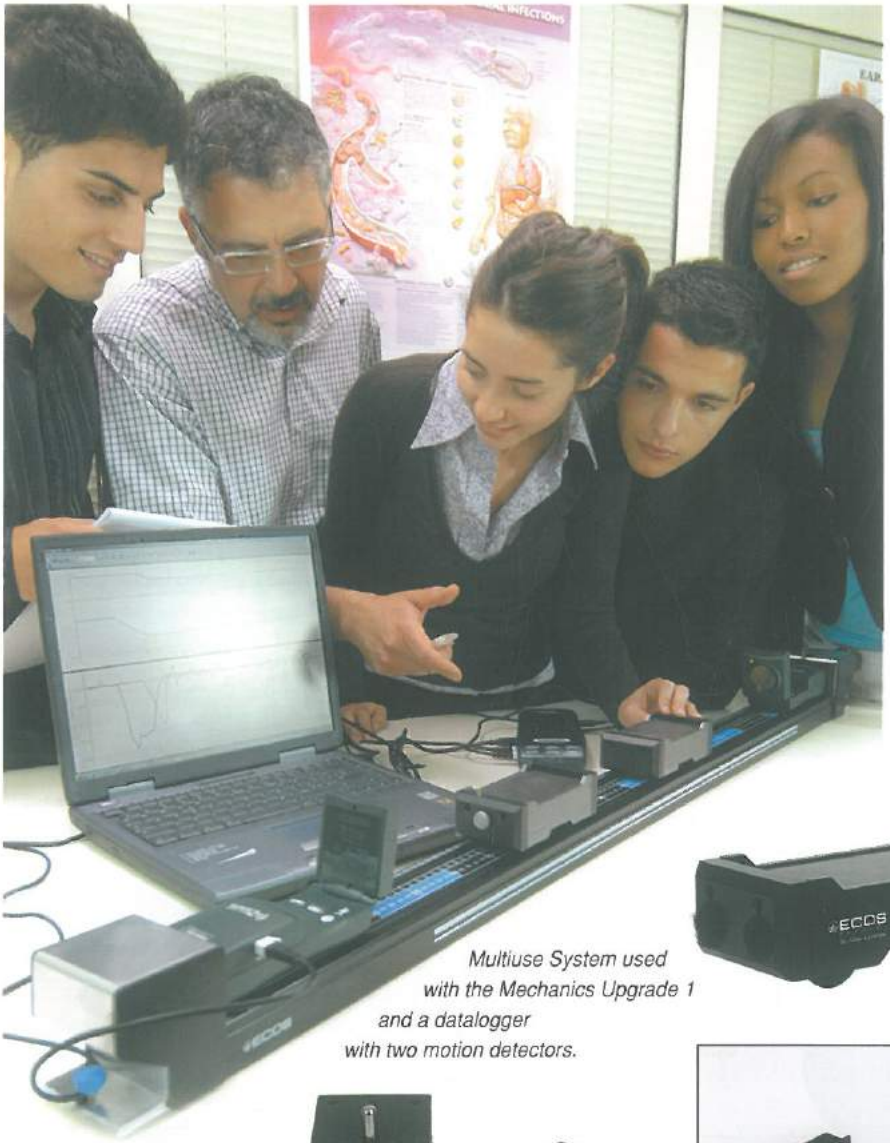
Free Fall mount schema.

The TEMA Multiuse System allows you perform dynamics as well as optics experiments.
If you already have the bench, you can obtain our "Upgrade Systems" to convert from optics to dynamics and vice-versa.

Mechanics Upgrade 1

4941.10

The Mechanics Upgrade 1 will give you a complete Dynamics System



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

Equipment needed

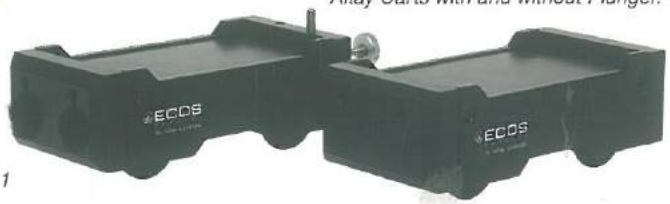
Track Set (code 4954.10)
Timing Set (code 4922.10)
or LoggerPro Data Logger (code 2300.10)
with Two Motion Sensors (code 2310.10)

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 TEMA Carts , you can perform many more experiments as well as interesting demonstrations.

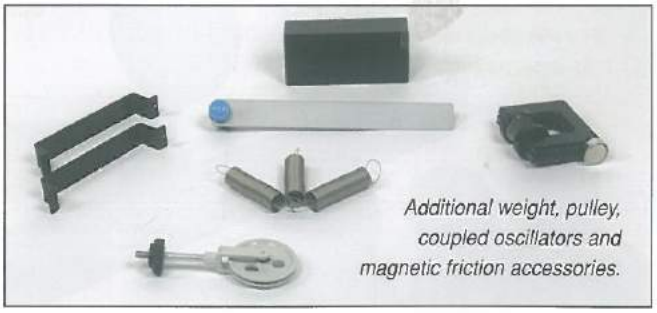
Main components

- Altay Carts with and without Plunger
- Mechanics terminals for Altay Track
- Track bases for inclined plane
- Coupled oscillator accessories
- Additional weight for carts
- Set of screens for TEMA Carts
- Pulley for uniform accelerated motion
- Magnetic friction accessory

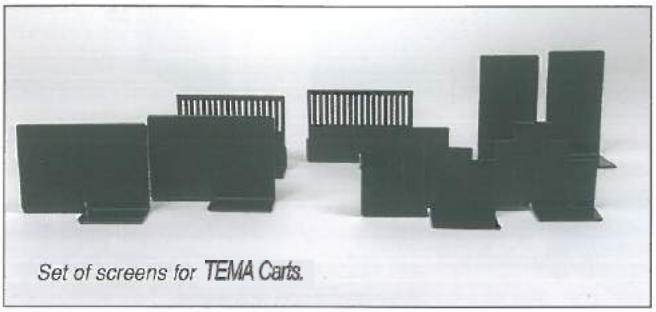
Altay Carts with and without Plunger.



Track bases for inclined plane.



Additional weight, pulley, coupled oscillators and magnetic friction accessories.



Set of screens for TEMA Carts.

Mechanics terminals for TEMA Track.

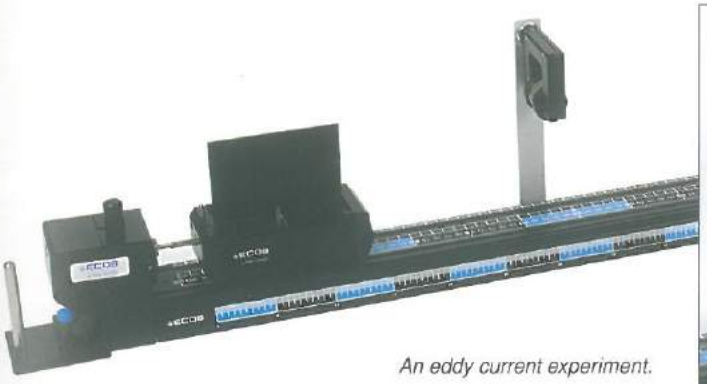
Laws and principles investigated

- Conservation of momentum and energy • Coupled harmonic oscillators
- Determination of acceleration and velocity • Eddy currents and friction
- 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

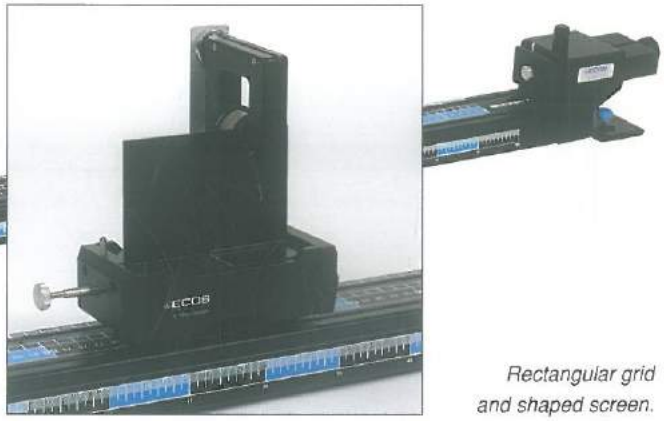
Eddy Current

With the Mechanics Upgrade 1 many eddy current experiments are possible

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



An eddy current experiment.



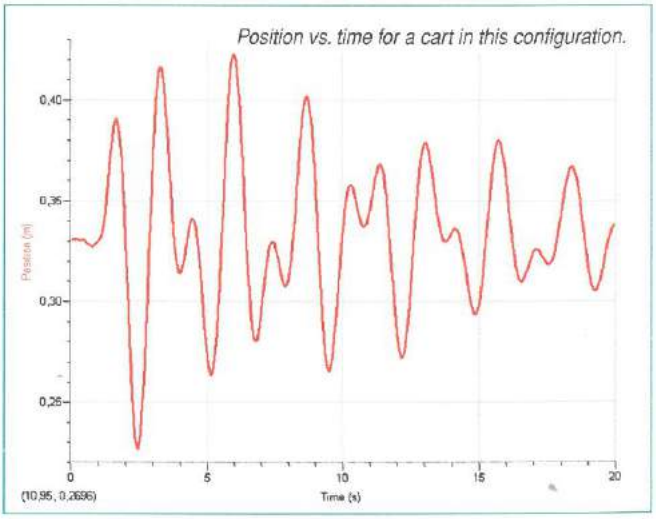
Rectangular grid and shaped screen.

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 into heat without contact between the moving parts.
Heat is generated 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 can be viewed as heat generation in a friction brake.

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

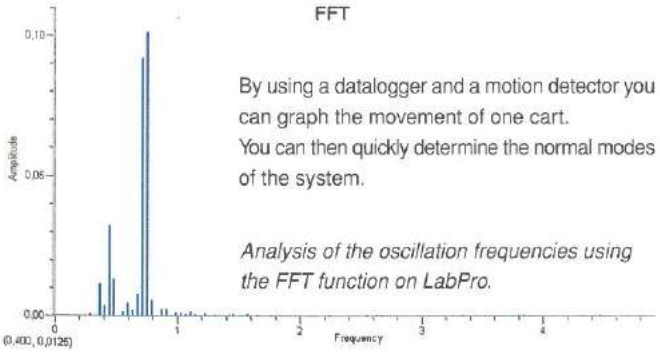
Coupled harmonic oscillators experiment setup.

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).



Position vs. time for a cart in this configuration.

FFT



Analysis of the oscillation frequencies using the FFT function on LabPro.

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).

Mechanics Upgrade 2

4941.20

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

Students acquiring data from Multiuse System in free fall configuration.

Equipment needed

Track Set (code 4954.10)
Timing Set (code 4922.10)

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

Main components

- Clamp and support for vertical mount
- Photogates supports
- Electromagnet with cable
- Basket for falling spheres
- Spheres of different diameter • Metre Rule
- Oscillation Counter
- String with support for pendulum studies
- Brass, wood and PVC spheres with hooks

Free fall accessories.

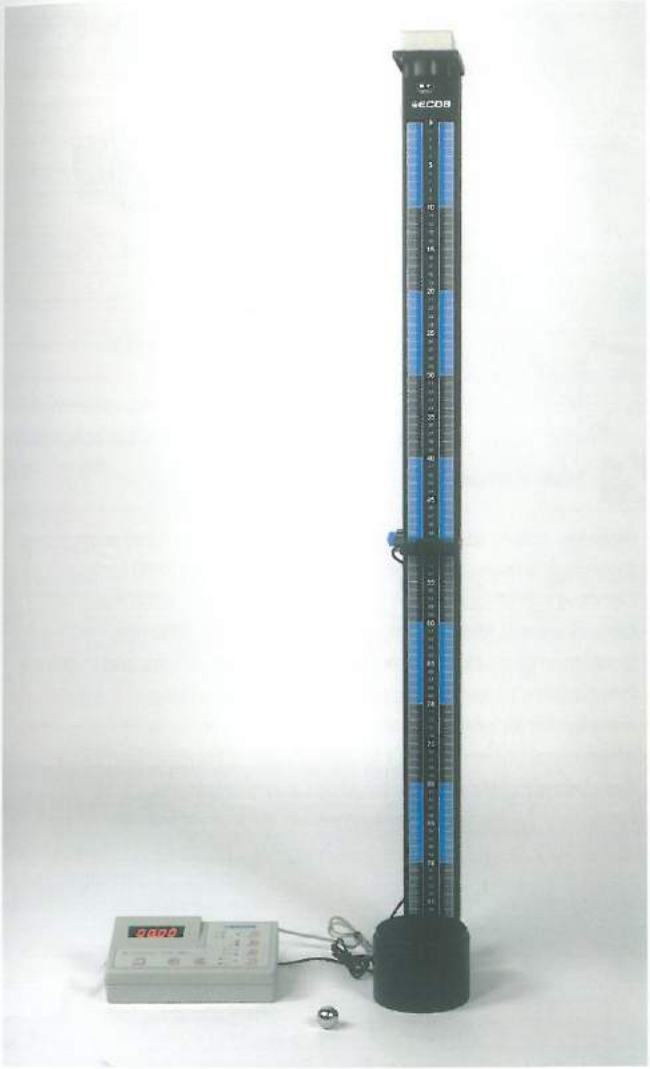
Laws and principles investigated

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

Pendulum accessories.

Free fall motion

Explore free fall motion with Altay Mechanics Upgrade 2



Free fall experiment ready to go.

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/s². This value is usually referred to as 'g'.

$$v_y = gt$$

Free fall motion equations.

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

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).

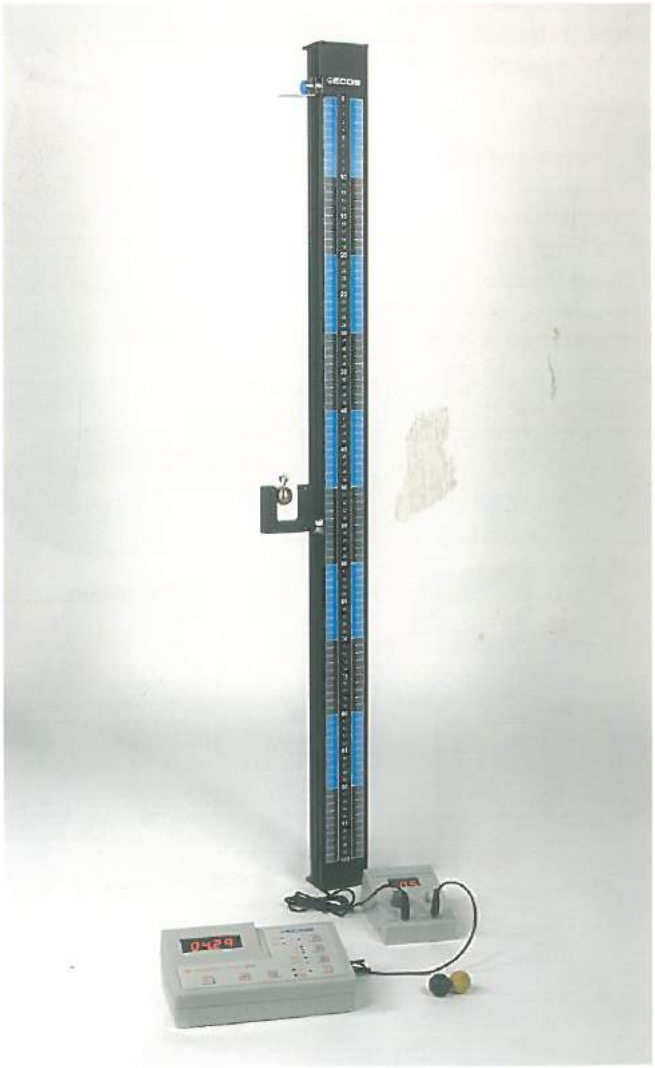
The Pendulum

To investigate the relationship between period, length and the effect of gravity of a pendulum

To set up a simple gravity pendulum you can place the support for pendulum at the zero position on the scale and suspend a mass from this point a chosen length. Giving it an initial push, the sphere will swing back and forth under the influence of gravity over its central (lowest) point.
Measuring the period of oscillation through the oscillation counter; knowing the length of the pendulum, it is easy to calculate the acceleration of gravity using the Pendulum Law.

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

Pendulum Law.



The pendulum experiment setup.

Optics Upgrade 1

4944.10

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

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.

The Optical Bench using Altay Track.

Equipment needed

Track Set (code 4954.10)

Main components

- Biconvex lenses (dia. 50 mm), f = +50, +100, +150, +200 mm
- Biconcave lenses (dia. 50 mm), f = -50, -100, -150, -200 mm
- Concave mirror (dia. 50 mm), f = +50, +100, +150, +200 mm
- Convex mirrors (dia. 50 mm), f = -50, -100, -150, -200 mm
- Equilateral glass prism • Holders for 50 mm dia. lenses and mirrors
- Prism table • Projector with (12 V 20 W) halogen lamp
- Transformer for projector • Wire set
- White metal screen (140 x 140 mm)
- Set of diaphragms • Holder for slides and diaphragms

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

Mirror holders.

Lenses and mirrors.

Detail of the holder.

Projector and optical bench accessories.

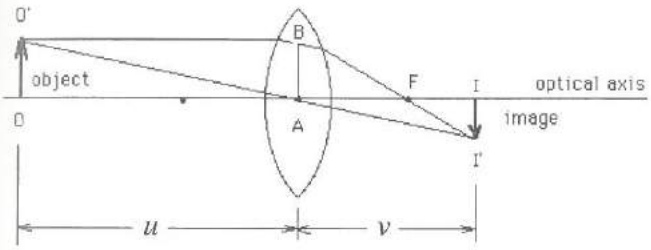
Focal length of a lens

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

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

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

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



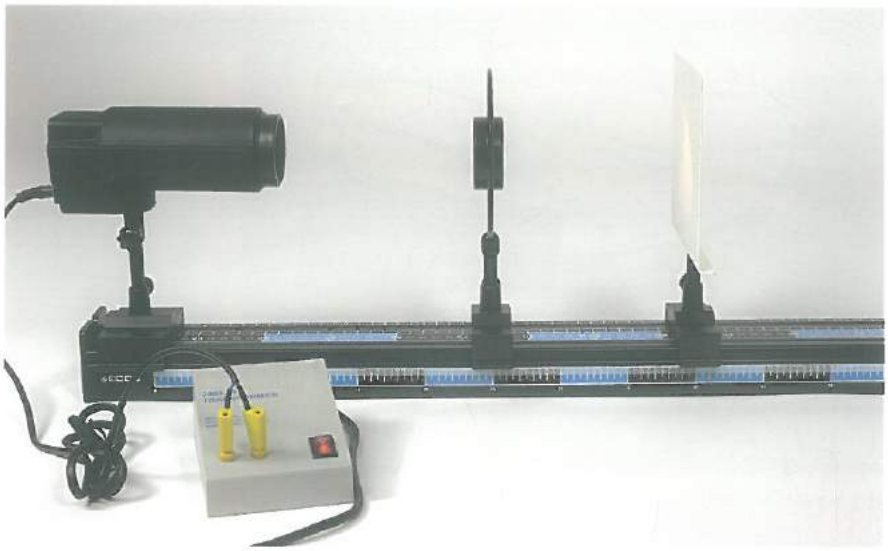
Light propagation through a converging lens.

Thanks to this simple law, involving only three variables, it is easy to calculate f. The Altay Optics Bench makes it easy to set up an experiment to determine a value for f.

Further examples of experiments

A quick look at further experiments of the Optics Upgrade 1

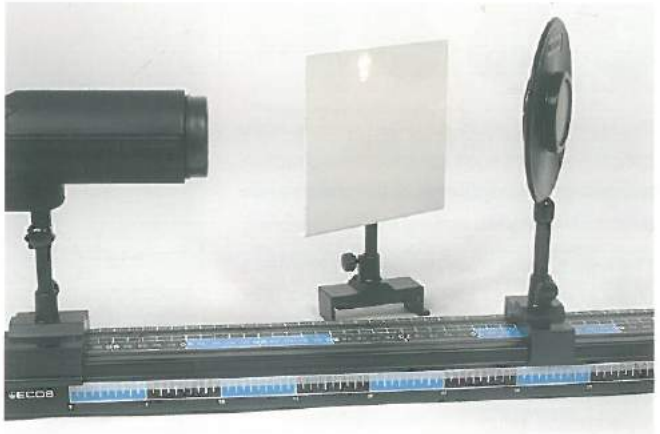
Detail of the equilateral prism mounted on the optical bench.



Optical bench setup for converging lens experiment.

The example below shows an experimental setup to determine focal length of a lens.
Once the image is clearly focussed on the screen the measurement you can easily measure the distance of the object from the lens and the distance of the screen to the lens using of the graduations on the bench.

Focal length experiment detail.



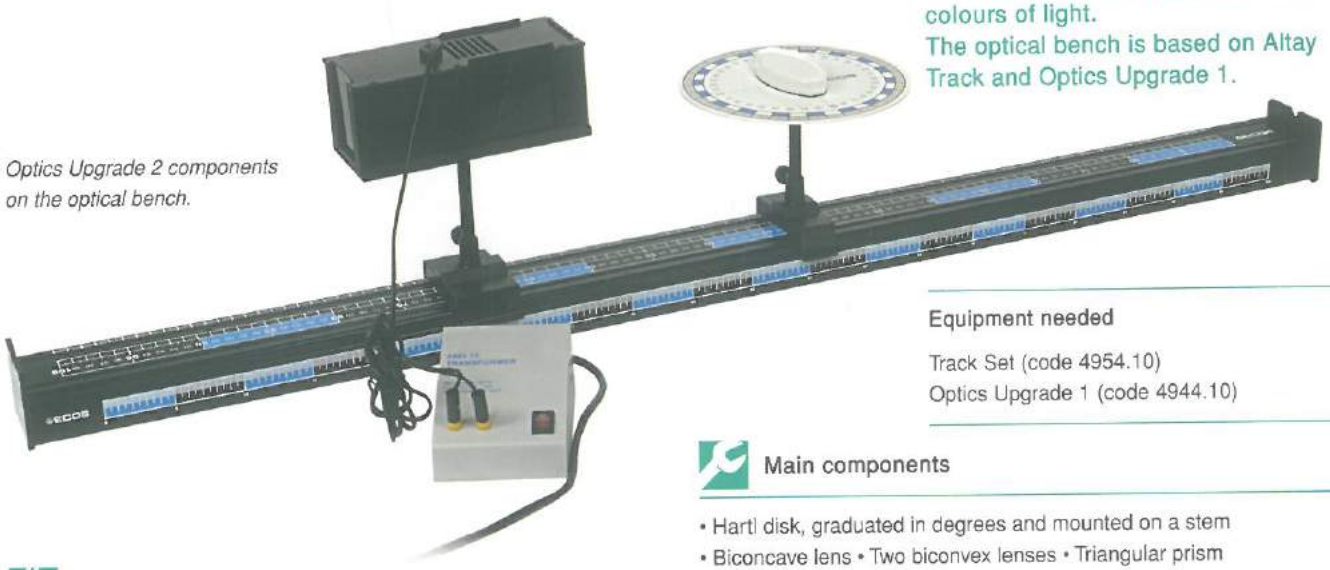
Convergent mirror.

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 and Optics Upgrade 1.



Optics Upgrade 2 components on the optical bench.

Equipment needed

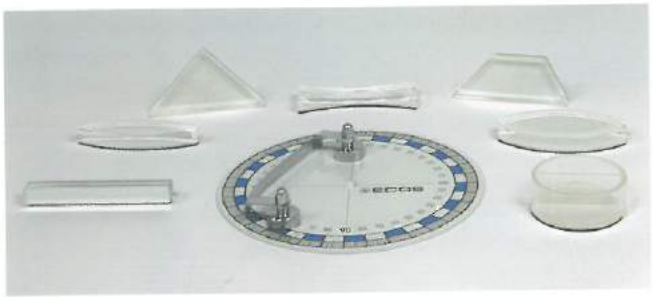
Track Set (code 4954.10)
Optics Upgrade 1 (code 4944.10)

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

Main components

- Hartl disk, graduated in degrees and mounted on a stem
- Biconcave lens • Two biconvex lenses • Triangular prism
- Trapezoidal prism • Plane and flexible mirror
- Altay raybox, complete with set of filters, slits and mirrors



Lenses set with flexible mirror and Hartl disk.

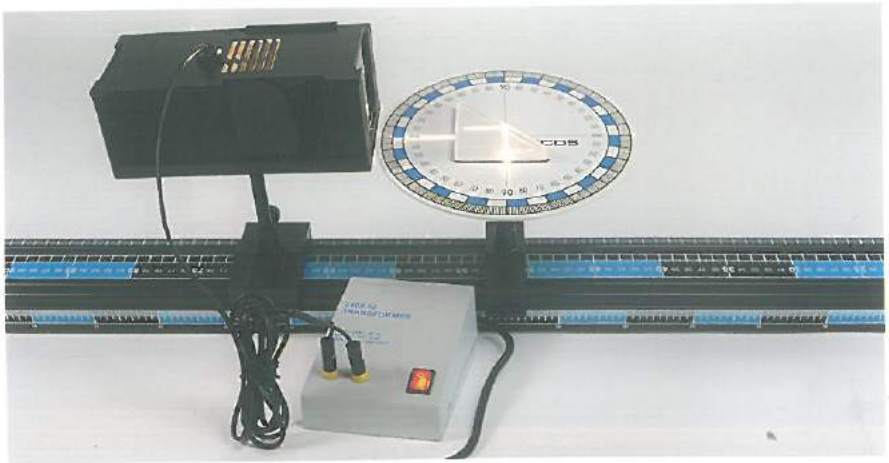
Raybox, coloured filters, slits, two side parts with mirror and filter holders.

Hartl Disk

How to use the Hartl disk for geometric optics studies

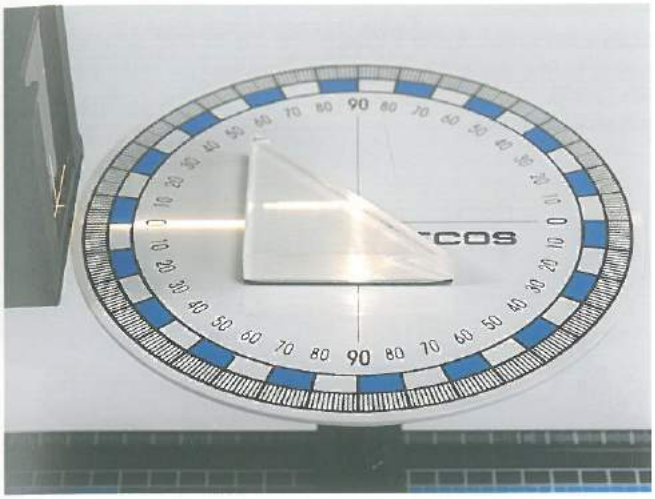
The Hartl disk is designed to demonstrate many optical principles such as reflection, refraction, critical angle, principle rays, dispersion and how a rainbow is made.

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.

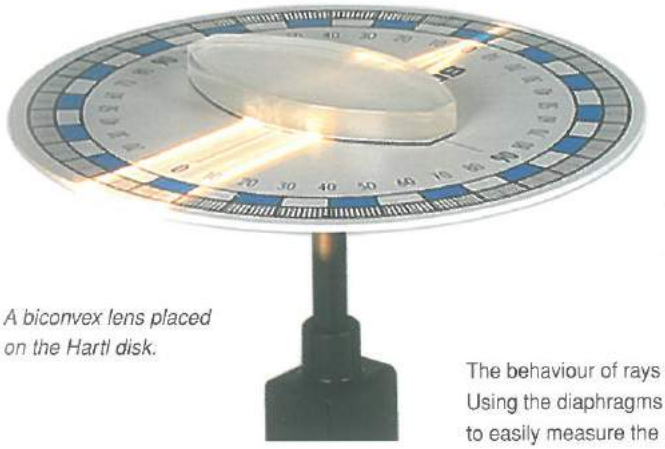


A triangular prism showing total reflection.

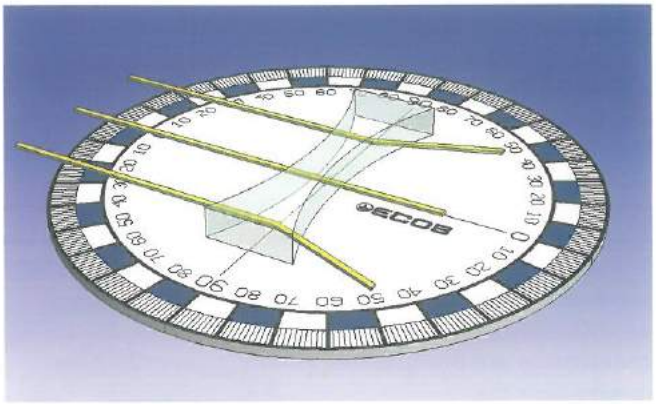
The protractor scale allows students to measure the reflection and refraction angles.



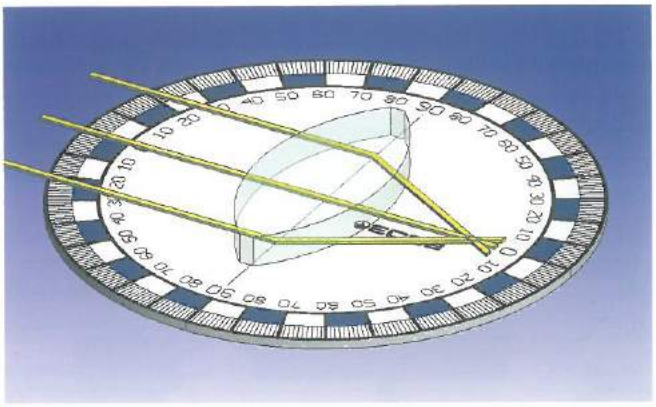
Path of light from raybox.



A biconvex lens placed on the Hartl disk.



Path of a ray of light through a biconcave lens.

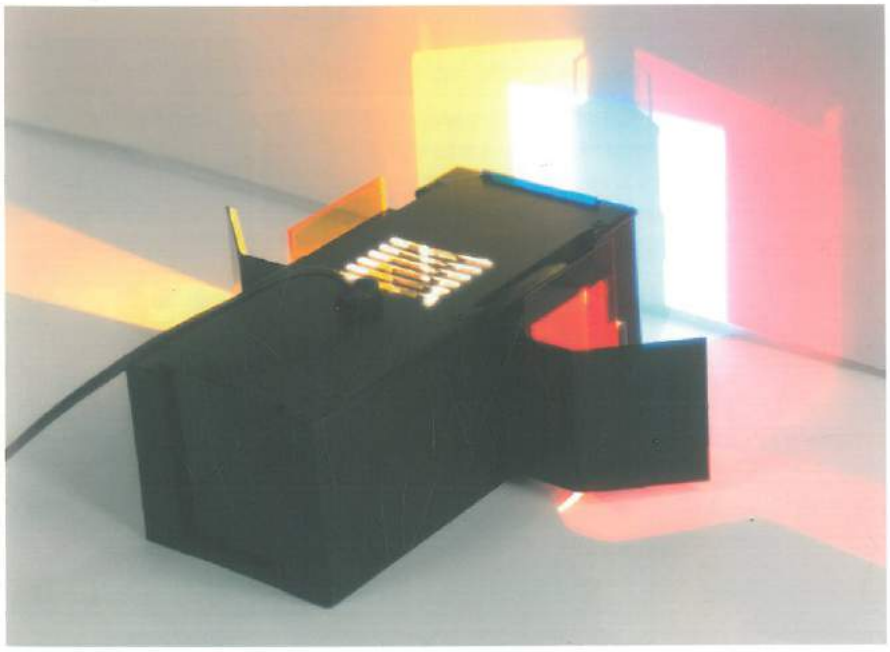


Path of light through a biconvex lens on the Hartl disk.

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.

Colour mixing • How to use the raybox for experiments with coloured filters



White light is composed by the mixture of the three primary colours: red, green and blue. Mixing colours of light, usually red – green – blue, is done using the additive colour system (also referred to as the "RGB Model" or "RGB colour space").

Different combinations of colours produced by red, green and blue.

The addition of the primary colours of light can be demonstrated in class using the Altay raybox. The raybox illuminates a screen (shown above) with the primary colours red (R), green (G) and blue (B).
The result of adding two primary colours of light is easily seen by viewing the overlap on a screen.

Raybox with mirrors for colour composition.

Optics Upgrade 3

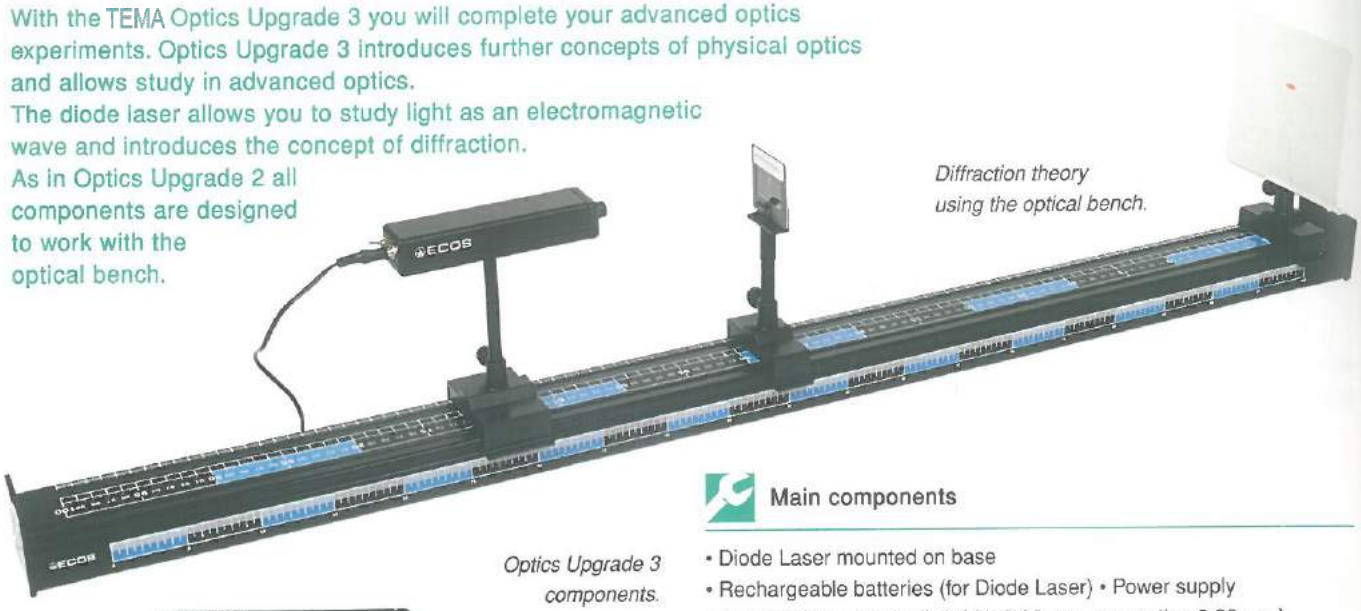
4944.30

Diffraction using a laser

With the TEMA Optics Upgrade 3 you will complete your advanced optics experiments. Optics Upgrade 3 introduces further concepts of physical optics and allows study in advanced optics.
The diode laser allows you to study light as an electromagnetic wave and introduces the concept of diffraction.
As in Optics Upgrade 2 all components are designed to work with the optical bench.

Equipment needed

Track Set (code 4954.10)
Optics Upgrade 1 (code 4944.10)



Diffraction theory using the optical bench.

Optics Upgrade 3 components.

Main components

- Diode Laser mounted on base
- Rechargeable batteries (for Diode Laser) • Power supply
- Slides with 1 up to 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)

Laws and principles investigated

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

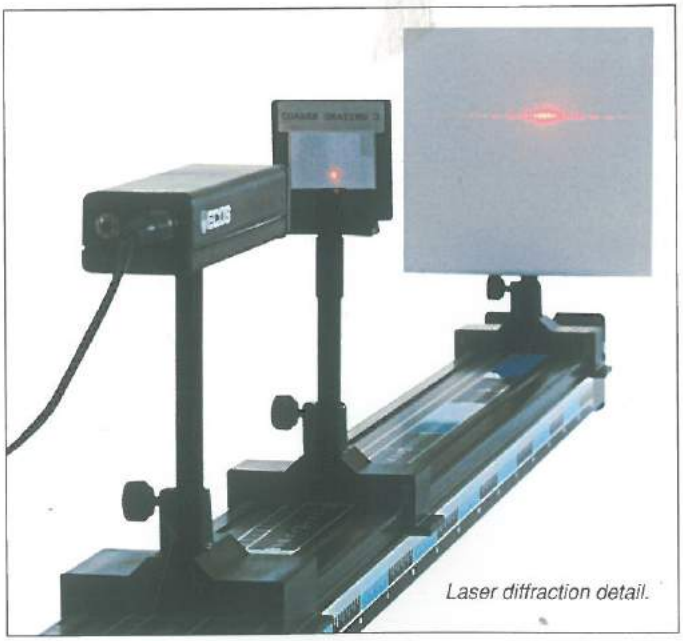
Light diffraction

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.

Optical bench helps measuring distances.

The Optics Upgrade 3 contains all that you need to study diffraction principles from single and multiple slits.
With the help of the optical bench it is easy to verify optics laws measuring the distances between the diffraction grating and the screen.



Laser diffraction detail.

Timing Set

4922.10

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

Timing Set components.

The Timing Set is a complete solution for measuring time in dynamics experiments such as cart collisions and free fall.

The system can be used with our Mechanics Upgrades 1 and 2.
It can also be used in conjunction with the TEMA Oscillation Counter.
These accessories can be used as an alternative to a data logger and a motion sensor.

Main components

- Electronic timer with power supply
- Two photogates with magnetic attachments

Ball Launcher for Cart

4941.11

Ball Launcher for Cart can be used with Mechanics Upgrade 1

Ball Launcher on Altay Cart.

Ball Launcher for Cart.

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

Equipment needed

Track Set (code 4954.10)
Mechanics Upgrade 1 (code 4941.10)

Main components

- Ball Launcher for Altay Cart • Balls

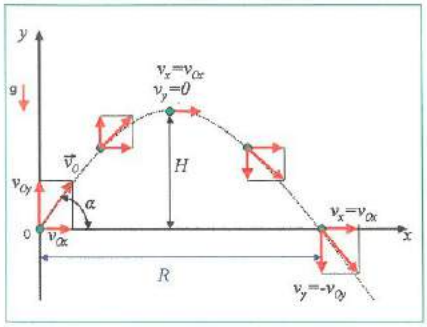
Laws and principles investigated

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

Composition of motion

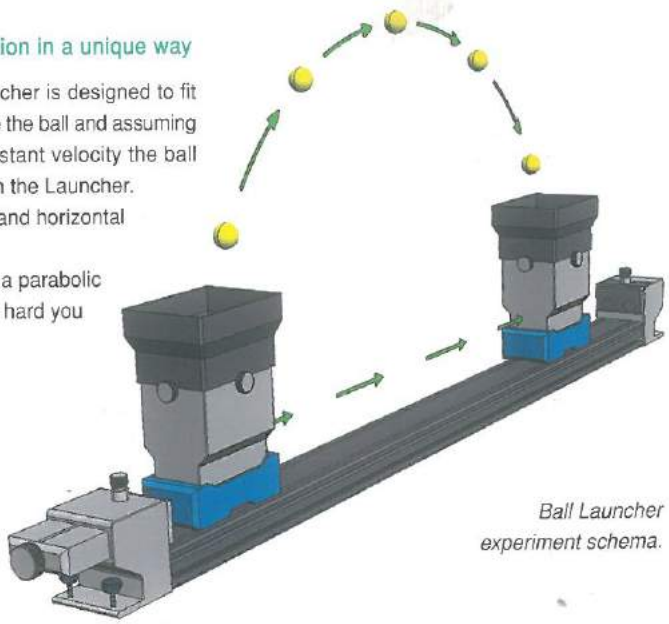
Study the rectilinear uniform motion of the cart with the projectile motion in a unique way

Perform an interesting experiment that is not always intuitive. The Ball Launcher is designed to fit onto our low friction carts. The Launcher is triggered at a certain point to release the ball and assuming that the motion is a constant velocity the ball should then land back on the Launcher.
This shows that vertical and horizontal motion are independent.
The motion of the ball is a parabolic trajectory no matter how hard you push the cart.



Ball motion.

The ball has the same constant velocity of the cart on the x axis and is subjected to gravity acceleration in the vertical direction.
At the end of the horizontal motion (x) the projectile falls again into the launcher because the vertical motion (y) remains the same.



Ball Launcher experiment schema.

Altay Cart without Plunger

4941.12

Specifications

Size: 14 x 7 x 4 cm – Weight: approx. 450 g

Elastic and inelastic collisions with our new cart

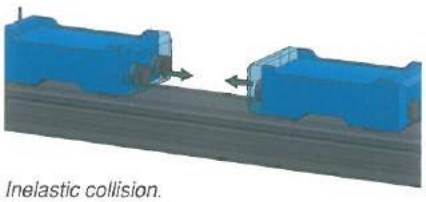
Altay Dynamics Cart (without Plunger).

Magnet for elastic collisions.

Velcro™ for inelastic collisions.

Ideal for all dynamics experiments, the all new Altay Cart is an ideal companion for the Plunger Cart.
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.

One side of the cart is fitted with Velcro™ strips, which are ideal for inelastic collisions, and on the other side, a pair of powerful neodymium magnets, which are ideal for elastic collisions. The cart is also designed to easily accommodate extra masses as well as mounting for data logging sensors.



Inelastic collision.

Cart with retractable weels.

Altay Cart with Plunger

4941.13

Specifications

Size: 14 x 7 x 4 cm – Weight: approx. 450 g

Explosions and collisions with our new cart

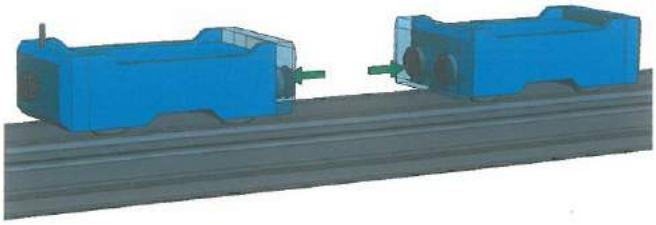
Plunger.

Altay Dynamics Cart (with Plunger).

Magnets and Velcro™ for elastic and inelastic collisions.

The Altay Plunger Cart has been designed specifically for accurate and repeatable experiments results in kinematics.
Manufactured from solid aluminium, the sturdy design prevents any accidental damage in the classroom.
The Altay Plunger Cart has been designed specifically with ruggedness and experimental accuracy in mind.
The cart's wheels are mounted on almost frictionless bearings to give a smooth and effortless motion on the dynamics track.

The cart 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. The other side of the cart contains two strips of Velcro™ and a pair of powerful neodymium magnets, which are designed for alternate elastic and inelastic collisions.



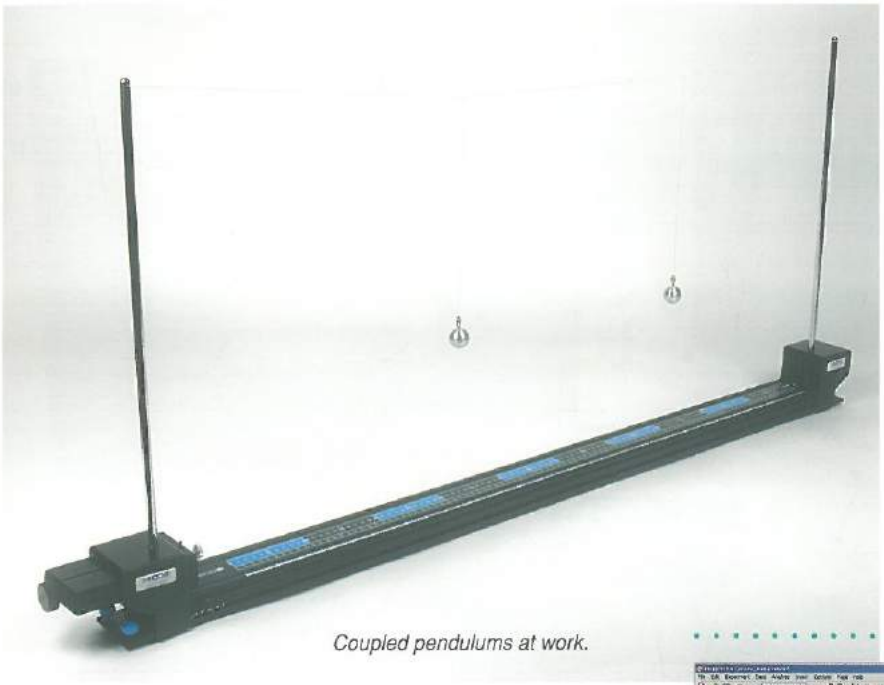
Elastic collision, magnets-magnets sides.

Students experience the collisions.

Coupled Pendulum Set

4941.16

Studying the coupled oscillators effect



Coupled pendulums at work.

Equipment needed

Track Set (code 4954.10)
Mechanics Upgrade 1 (code 4941.10)

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

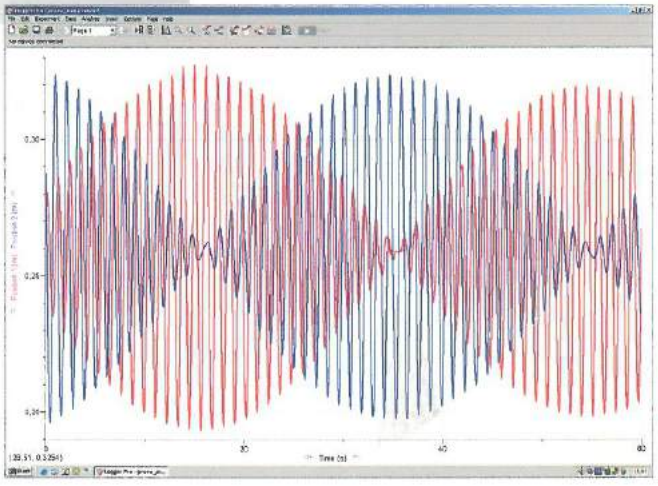
• Threatened rods • Spheres for pendulum • String

Coupled oscillators components.

Normal modes

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

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



Data from the coupled motion of pendulums.

EM Trigger & Launcher for Cart

4941.17

An automatic trigger/launcher for dynamics experiments

EM Trigger & Launcher for Cart.

Equipment needed

Track Set (code 4954.10) – Mechanics Upgrade 1 (code 4941.10)
Timing Set (code 4922.10)

Specifications

Specially designed to fit on Altay Track Set (code 4954.10)

The new TEMA 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).

Demonstration Balance Model

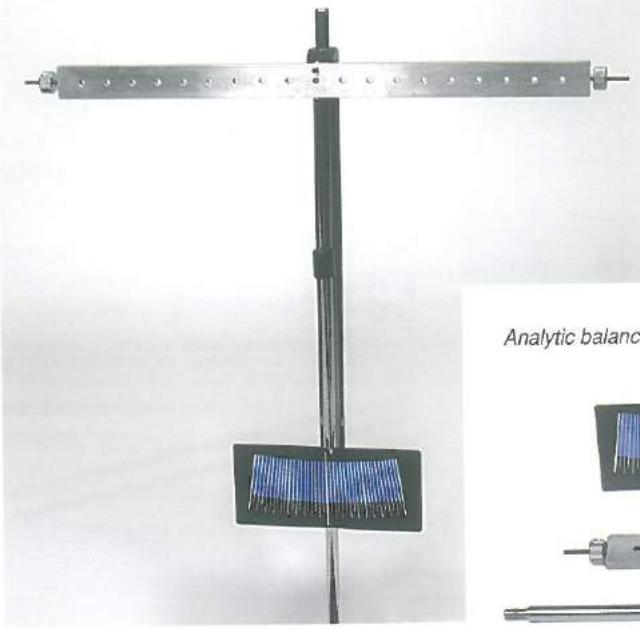
4114.18

The demonstration of levers, static forces and also an analytic balance

Specifications

Height: 50 cm – Arm length: 45 cm
With bench clamp for table mount

Altay's Demonstration Balance Model.

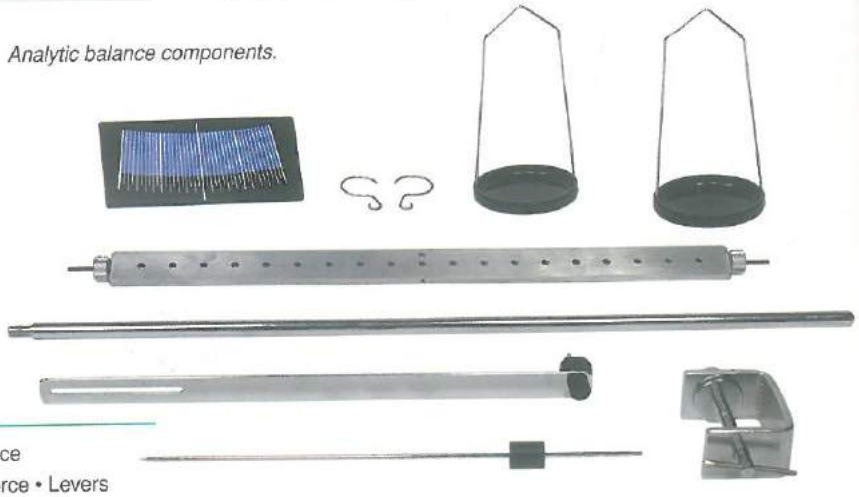


We developed this as more than just a balance.
It is easy to mount thanks to the bench clamp.
With the graduated scale you can demonstrate the effects of different static forces and equilibrium.
Predict what the result might be and see if you are correct!

Main components

- Vertical stem with table clamp • Zero-offset rod
- Horizontal balance arm with equidistant holes to set the scale pans
- Scale pans with hooks • Masses of different weights
- Balance needle and protractor

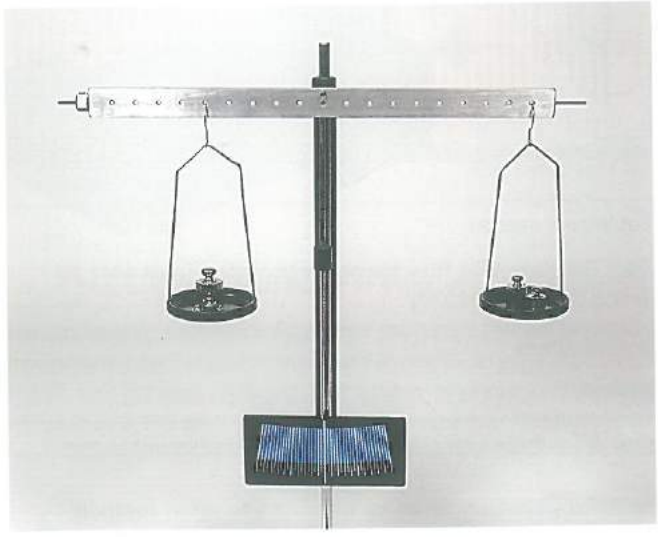
Analytic balance components.



Laws and principles investigated

- Calibration of a balance • Using the Analytical Balance
- Mass determination by comparison • Moment of a force • Levers

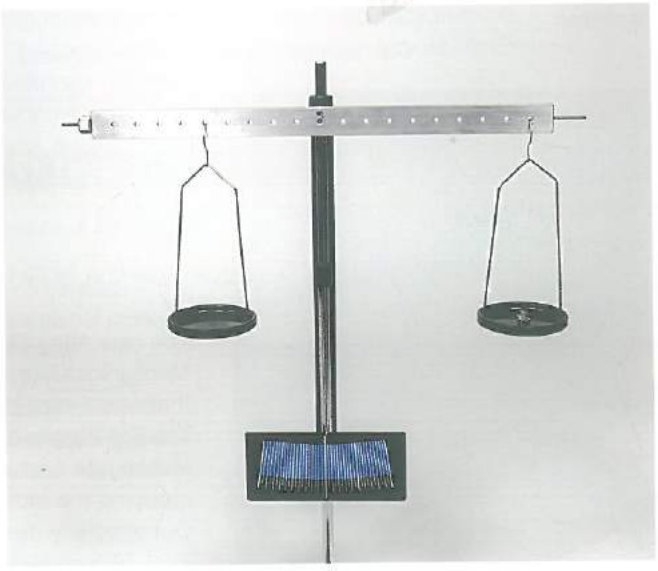
Static equilibrium • How to balance different weights at different arms lengths



Altay's Analytic Balance Model in static equilibrium.

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 take back the balance to equilibrium.



Tare the balance.

Magnetic Black Board

4114.60

A versatile solution for mechanics experiments concerning static forces using a unique magnetic display black board

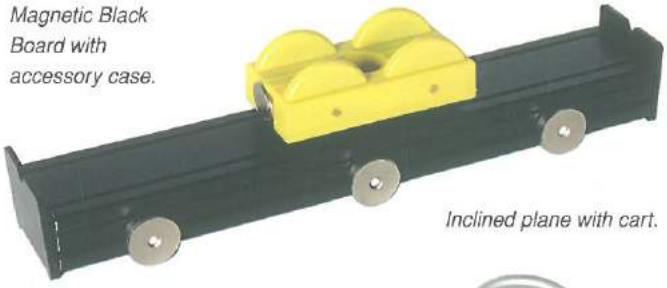
Specifications

Black Board
Size: 72 x 72 x 20 cm – Weight: approx. 11 kg

Accessory Case
Size: 44 x 38 x 10 cm – Weight: approx. 3.5 kg
Packing: sturdy ABS plastic carry case with foam inserts

Magnetic Black Board with accessory case.

The Magnetic Black Board is a unique magnetic mount system where dynamics diagrams are transformed into working demonstrations.
This black board demonstration system illustrates in a unique way mechanical equilibrium, inclined planes, levers, pulley systems, simple machines and much more.
You can also easily attach various springs, weights and scales and perform interesting experiments with ease and accuracy.



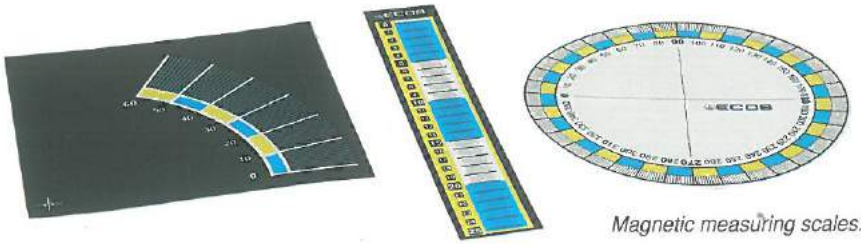
Inclined plane with cart.

Pulleys.

Main components

- Magnetic Black Board
- Cylindrical masses of different weight
- Helical spring with pointer • Magnetic pins
- Inclined plane
- Cart for inclined plane, with hook for forces experiments
- Pulley and pulley with hook
- Weinhold's disk with magnetic support
- Spring balances 1 N and 6 N
- Centimetre ruler with holes
- Magnetic ruler 25 cm and protractors 0 ÷ 60°, 0 ÷ 360°
- Triple-in-line pulley block (block and tackle)
- Triple-in-axis pulley block (block and tackle)
- Set of three geometric objects
- Nylon string 10 m
- Accessories such as rings, hooks and plumb-line

Spring balances, masses, spring with pointer and magnetic holders.



Magnetic measuring scales.

Cart on the inclined plane.

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
- Equilibrium and 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

How to measure the intensity of a force

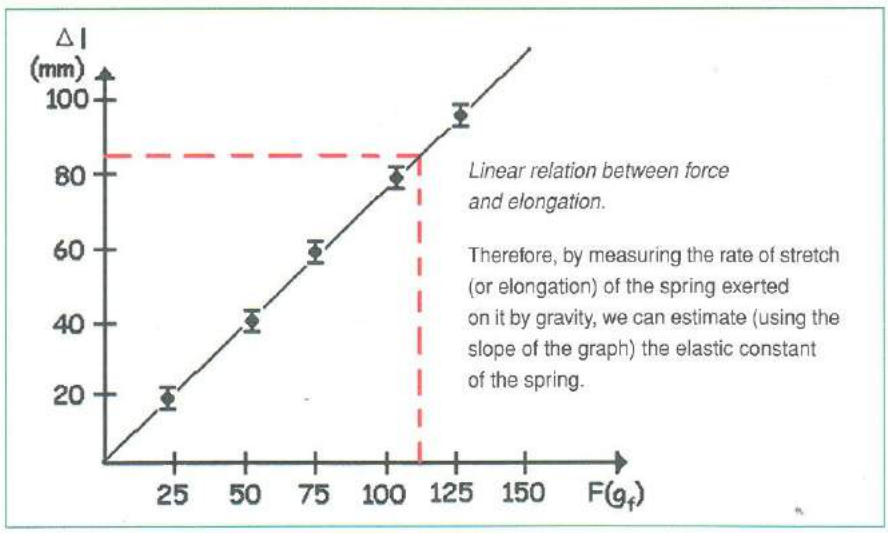
An easy experiment for comparison between forces

In order to truly understand the meaning to the sentence "the magnitude of the force F_1 is two to three times higher than that of force F_2", it is necessary to have a method for comparing the magnitude of the two forces.
One method is to measure the magnitude of one of the two forces and assume the other to be a known reference force.

We can estimated Hooke's constant using a spring, a magnetic ruler and masses of different values.
Each different spring will have its own Hooke's constant value which is directly proportional to how difficult it is to stretch the spring.

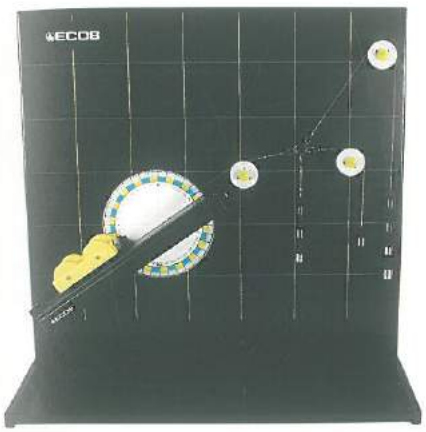
Students setting up the experiment.

Measure of spring elongation.



Linear relation between force and elongation.

Therefore, by measuring the rate of stretch (or elongation) of the spring exerted on it by gravity, we can estimate (using the slope of the graph) the elastic constant of the spring.



Sample setup.

Triple-in-line pulley block experiment.

Examples of other setups for experiments with the Magnetic Black Board

The Altay Magnetic Black Board gives teachers and students the freedom to set up experiments with their own fashion.
Thanks to the magnetic pins, it is easy to place the inclined plane, pulleys and all the other objects everywhere on the board and perform experiments in any configuration.

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

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

Hooke's Law Apparatus.

Main components

- Stand with easy to read graduated scale
- Scale pan for holding masses
- Three helical extensions springs, each having different elastic constant
- Set of masses of 25 and 50 g

Specifications

Size: 30 x 20 x 80 cm – Weight: approx. 2 kg

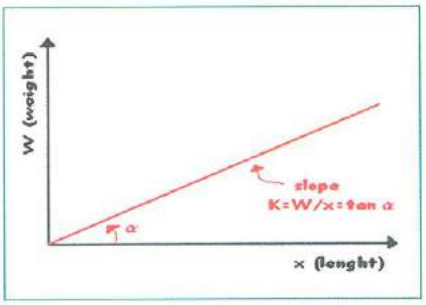
**This rugged experiment features a heavy base to allow student to stretch springs without toppling the unit.
We have printed an easy to read measuring scale on the side for easy reading.**

Laws and principles investigated

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

Hooke's Law Experiment

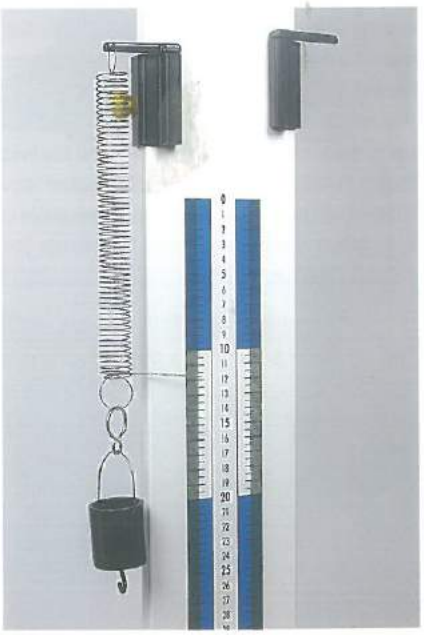
The force applied to a spring is directly proportional to the distance it will stretch.
This behaviour is regulated by Hooke's Law, valid in a limited range of elongation of the spring. The same law allows for the estimation of the spring constant.



Theoretic plot showing the Hooke's Law.

$$F = -kx$$

Elastic constant formula.



The elongation is proportional to the strain.

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.

Elastic and Inelastic Collision in 2D

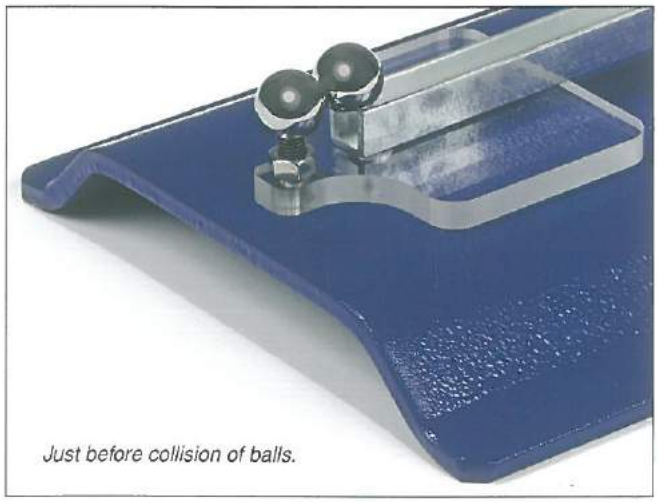
4130.20

Discover energy and momentum conservation laws during collisions

Elastic and Inelastic Collision in 2D apparatus.

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.

Specifications

Track length: 28.5 cm

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

Main components

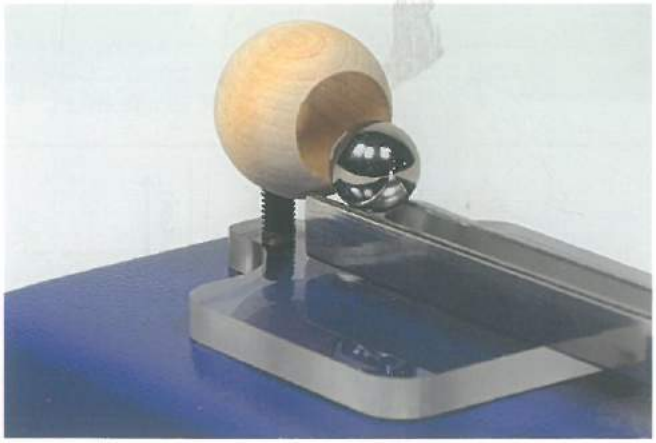
- Aluminium ramp with attached set screw and nut set
- Steel balls, 13 mm • Glass ball, 13 mm
- Wood ball, 25 mm drilled • Plumb line and bob

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.

Inelastic Collision



Using the drilled wooden ball to perform perfectly inelastic collisions.

As you know, perfectly inelastic collisions do not conserve energy but only the total momentum of the system.
The drilled wooden ball placed at the end of the ramp with the hollow facing the track, will catch the rolling ball at the end of the fall. After the collision, they move on together as a one system.
Use carbon and tracing papers to empirically verify the conservation laws.

Linear Air Track System

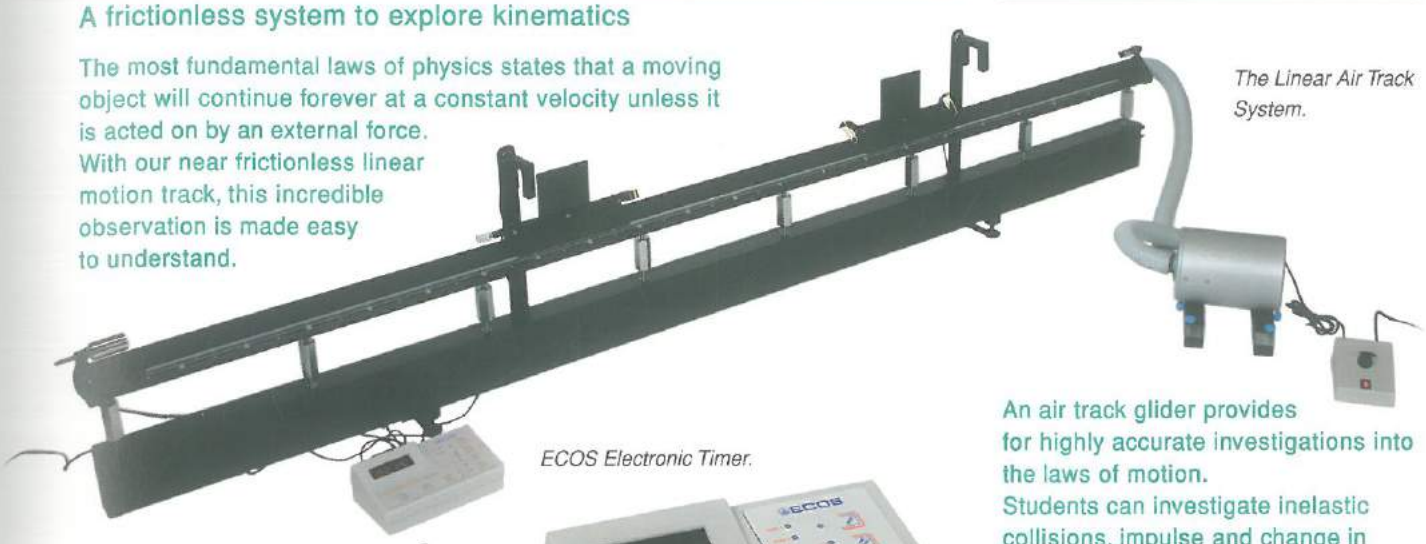
4132.00

A frictionless system to explore kinematics

The most fundamental laws 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 incredible observation is made easy to understand.

Specifications

Linear Air Track length: 220 cm



The Linear Air Track System.

ECOS Electronic Timer.

An air track glider provides for highly accurate investigations into the laws of motion. Students can investigate inelastic collisions, impulse and change in momentum, conservation of momentum, conservation of energy and more in our 2 m long track. Because the frictional forces are negligible the data derived will always be accurate.

Main components

- Linear Air Track • Electronic timer
- Air blower with voltage regulator

Accessories kit containing:

- Aluminium alloy gliders
- Bumpers rubber bands for elastic collisions
- Steel needles and plastic modelling clay for inelastic collisions
- Magnetic bumpers • Metal screens
- Cardboard screens • Plastic rods
- Weights for added friction of gliders
- Weights holder • Electromagnet
- Cylindrical magnets • Pulley with shaft
- Metal bob pendulum with stand
- Photogates with stands

Various air track accessories to perform a wide range of dynamicsex periments.

Basic accessories: gliders, slides, photogates and bumpers.

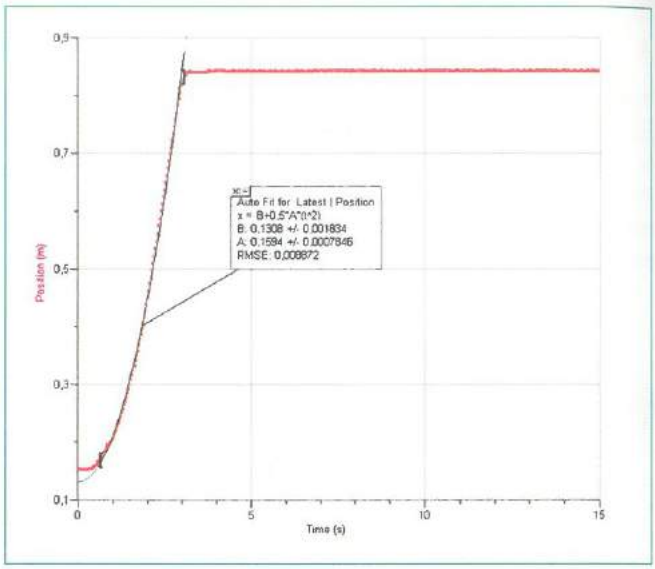
Air blower and voltage regulator.

Laws and principles investigated

- Principles of the inertial mass systems • Conservation of momentum
- Conservation of momentum and energy • Investigating acceleration
- Determination of the velocity of the constant linear motion
- Effect of a force on the motion of an object • Elastic collisions
- Inelastic collisions • Experiments with 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

Using the Altay's Linear Air Track System students can demonstrate precise accelerated motion, due to the near frictionless system.
For example, we can attach a mass via a pulley to a glider and watch its accelerated motion as detected by a position sensor that shows the characteristic parabolic trend in time.

Dynamics • Verify the law of the uniformly accelerated motion

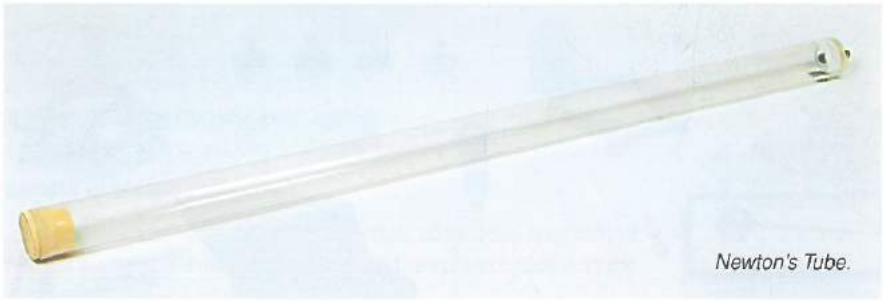


Data acquisition for uniformly accelerated motion.

Newton's Tube

4134.00

A falling body is independent of its mass and shape



Newton's Tube.

Specifications

Size: 5 x 105 cm (dia. x height) – Weight: 0.7 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.

Main components

- Plastic tube • Rubber top • Rubber top with pressure valve

Laws and principles investigated

- Free fall motion in vacuum

Newton's 2nd Law of Motion

To verify that the falling velocity is independent of mass and shape

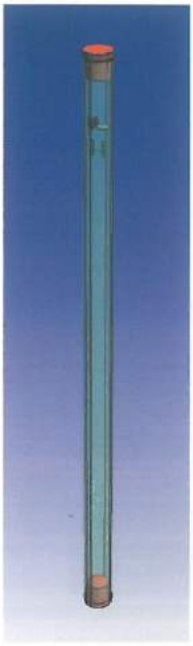
A force will produce an acceleration proportional to the mass of the body, as stated by 2nd Newton's Law of Motion. We can show that acceleration due to gravity (g) is independent of mass (m) as follows:

$$\begin{cases} F_g = mg \\ F = ma \end{cases}$$ which will make: $a = g$

Gravity force and Newton's 2nd Law of Motion.

Theory tells acceleration is independent of mass.

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



Detail of the falling bodies.

Free Fall and Pendulum Apparatus

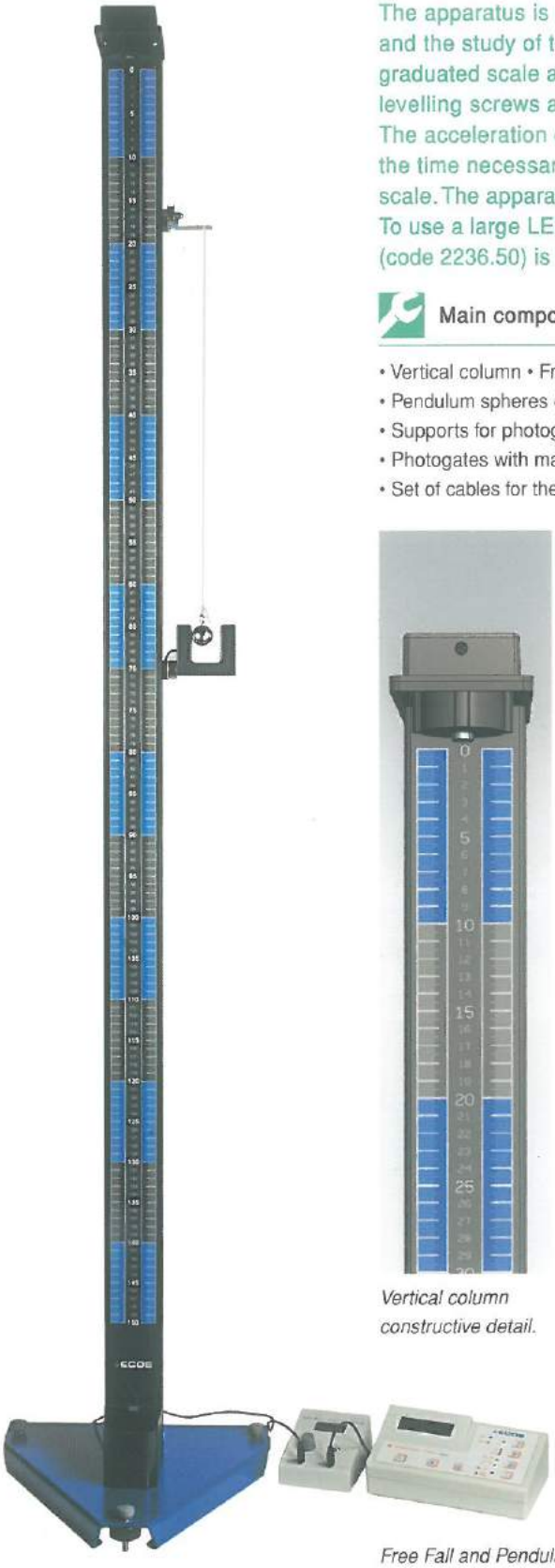
4134.70

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

Specifications

Vertical column height: 170 cm
Scaled surface length: 150 cm

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 ECOS electronic timer.
To use a large LED display for classroom use, the TEMA Large Display (code 2236.50) is an ideal choice.



Main components

- Vertical column • Free fall spheres of different diameter
- Pendulum spheres (with hook) in brass, PVC and wood • Pendulum chord with magnetic holder
- Supports for photogates and pendulum chord • Plasticine® for basket • Electronic Digital Timer
- Photogates with magnetic support • Electronic Oscillations Counter
- Set of cables for the Electronic Digital Timer and the Electronic Oscillation Counter

Vertical column constructive detail.

Free Fall Apparatus components.

Pendulum accessories.

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

Free Fall and Pendulum Apparatus general view.

Free fall motion

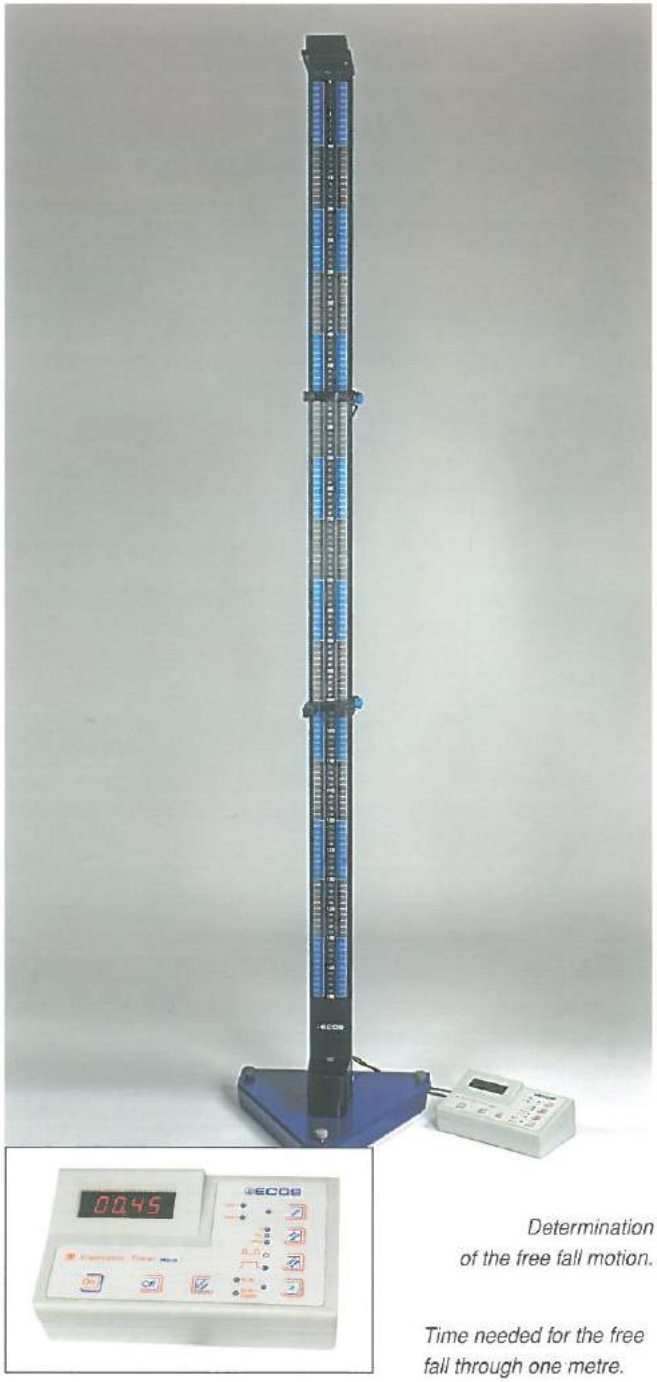
Study of the motion of acceleration due to gravity "g"

If we neglect the friction of the air, the falling sphere is subject only to the acceleration due to gravity defined by 'g'.
Using the Altay Free Fall and Pendulum Apparatus, the formula is straight forward since there is no initial velocity and the starting position is zero.

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

Free fall motion formula.

Using the Altay Free Fall and Pendulum Apparatus, acceleration due to gravity (g) can be easily and accurately determined by fixing a photogate at a defined distance along the scale.

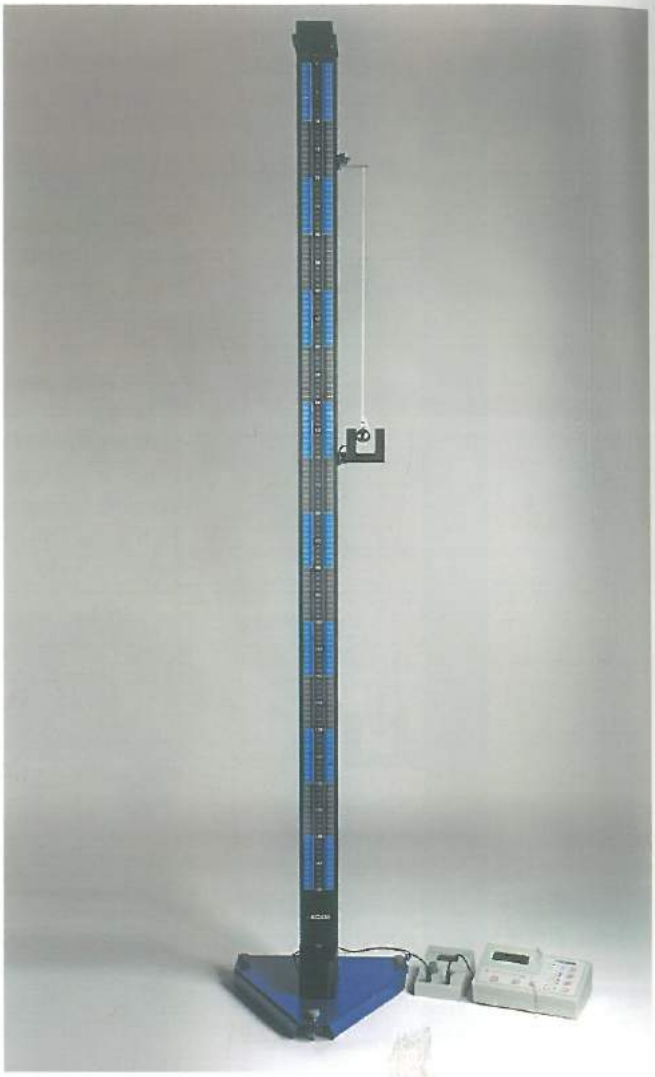


Determination of the free fall motion.

Time needed for the free fall through one metre.

The Laws of the Pendulum

Study of the oscillations in a pendulum



Pendulum configuration.

Timing accessories detail.

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

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

The Law of the Pendulum.

Projectile Launcher

4135.10

The ideal tool to study projectile motion

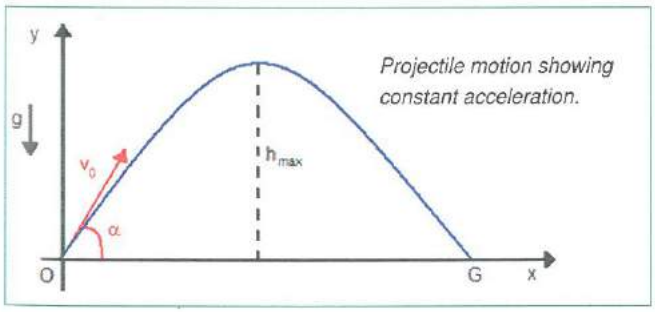
Projectile Launcher with photogates.

Also featured is a sturdy bench top clamp which can be rigidly secured to any table surface to ensure repeatable results each time the projectile is launched. Our launcher can also be fitted with photogates, which allows precise calculations of launch velocities, acceleration and for "monkey and hunter" experiments.
With the help of a simple digital camera and a motion analysis software, it is also possible to study the motion in great detail.

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:

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

General equation of motion of the projectile.

In the formula the motion along x axis is rectilinear uniform, along the y axis is determined by the acceleration of gravity (g) and is negative in the first half of motion and positive in the final trajectory.

Equipment needed	Specifications
Photogates (code 2232.52)	Screen size: 30 x 20 cm
Electronic Digital Timer (code 2232.50)	

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

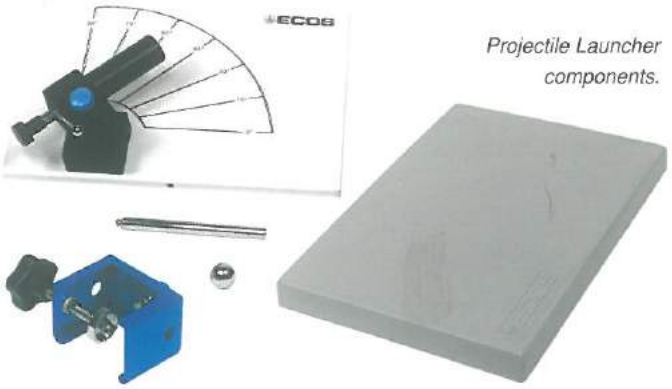
Having seven different launch angles (in 15° increments) from 0° to 90°, it gives you the option of horizontal and variable angle launching positions.
The Altay Projectile Launcher is designed with safety in mind, having our four setting spring mechanism fully enclosed.
Each of the four launch positions are released by means of a simple arm release mechanism which ensures minimal contact and hence repeatable launches time and time again.
Our unique piston design means that we have minimised projectile spin so that we can ensure the highest accuracy in hitting the exact stop each time.

Laws and principles investigated

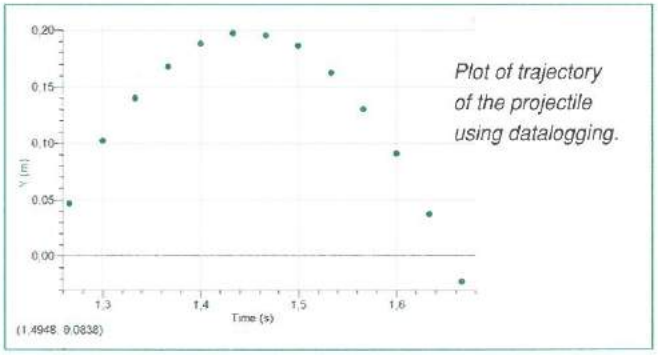
• Projectile motion • Decomposition of motions • Acceleration of gravity

Main components

• Projectile Launcher • Bench Clamp for table fixing • Landing mat • Projectile



Projectile Launcher components.



Plot of trajectory of the projectile using datalogging.

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.

Multiple Pendulum Apparatus

4137.40

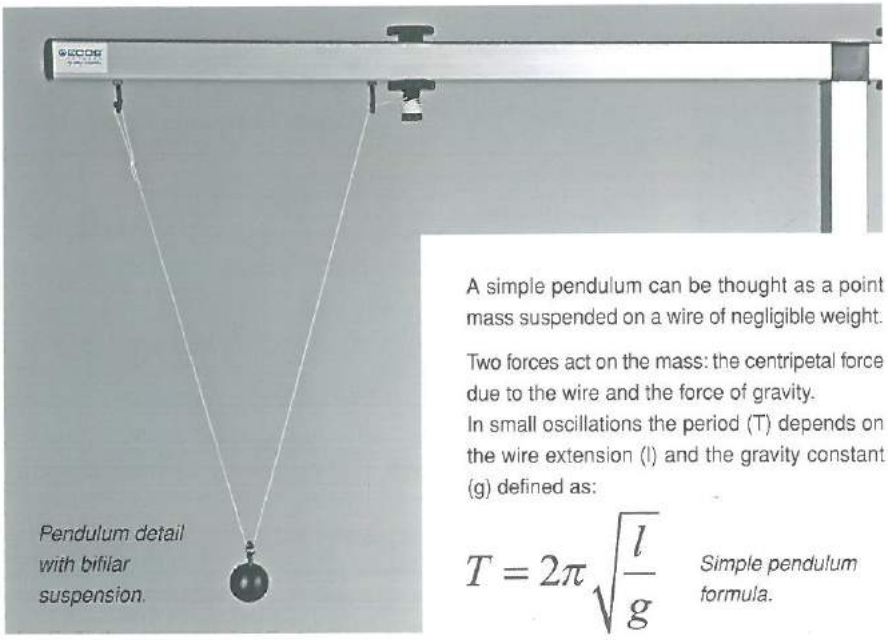
Understanding the Laws of the Pendulum

The Multiple Pendulum Apparatus.

Laws and principles investigated

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

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.

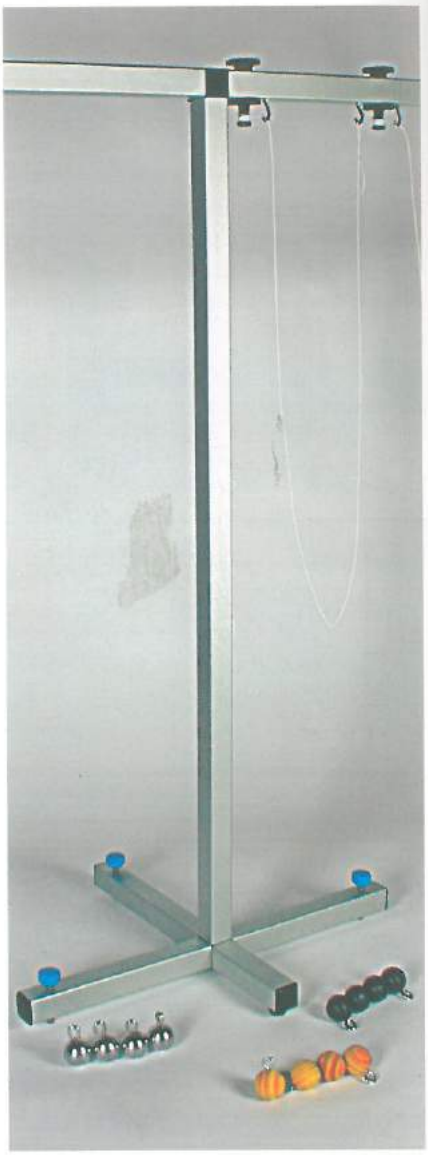
Specifications

Size: 104 x 30 x 35 cm – Weight: approx. 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 the how influential mass can be on a pendulum system.
The apparatus can also be used to measure gravity and acceleration.

Main components

- Quadruple pendulum aluminium support
- Set of four brass spheres
- Set of four PVC spheres
- Set of four wood spheres • Nylon string



Multiple Pendulum Apparatus components.

Moment of Inertia Apparatus

4138.50

An experimental approach to the moment of inertia

Moment of Inertia Apparatus.

Equipment needed

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

Specifications: disk dia. 36 cm and 20 cm – Rod 65 cm

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.

Main components

- Two scaled aluminium discs • Plastic disk with pins
- Graduated rod • Air blower with voltage regulator • Clamps
- Demountable differential pulley • Hollow cylinders: 2 x 40 g, 2 x 20 g
- Slotted masses with hook • Neodymium magnet • Pulley with stem
- Cylindrical masses • Nylon string • Air cushion

Hardware components.

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 and theoretical approach
- Moment of inertia, experimental approach and theoretical approach • Parallel axis theorem

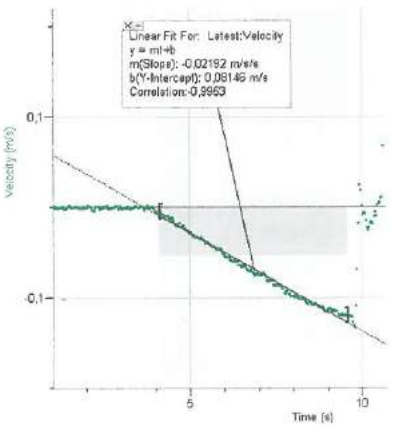
Disks for moment of inertia experiments.

Air blower set.

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.



$$I = mr^2$$

Moment of Inertia of a point mass.

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.

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

Centrifugal Force Apparatus

4142.70

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

Centrifugal Forces and "Earth's poles flattening" Apparatus.

Equipment needed

Vernier Photogate (code 2312.10)
Dual-Range Force Sensor (code 2311.10) – LabPro (code 2300.10)
Regulated DC Power Supply Unit (code 2409.20)

Specifications

Size: 16 x 16 x 45 cm – Weight: approx. 2.5 kg – Mounted on base

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

Main components

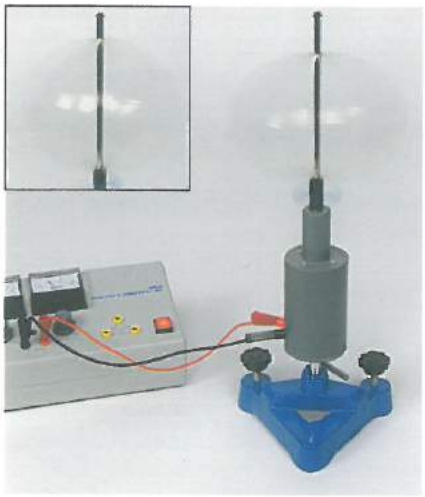
- "Earth's poles flattening" demonstrator
- Electric motor • Nylon string
- Rolling wire suspension
- Centrifugal force rotator
- Rods for experiment setup
- Squared bossheads • Bench clamp
- Base clamp

Centrifugal Force Apparatus components.

Laws and principles investigated

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

Earth's poles flattening demonstrator

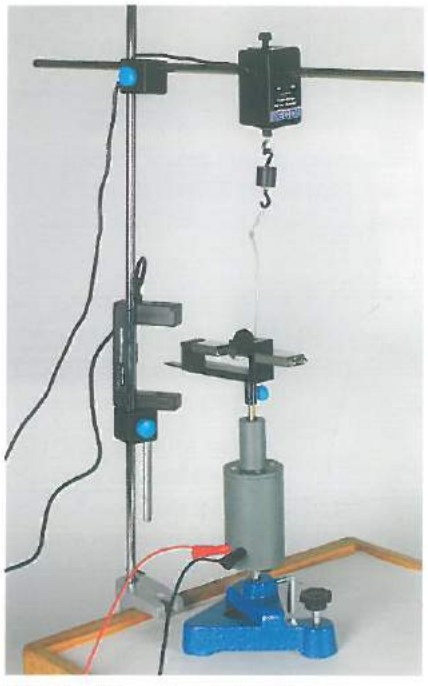


Observing the role of centrifugal force on Earth's shape.

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

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

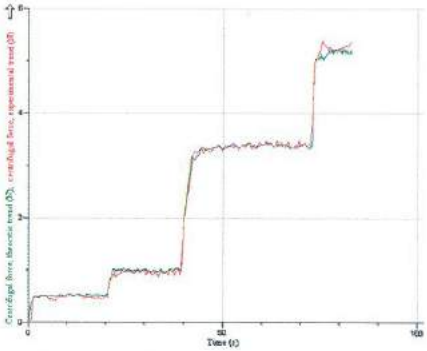
According to Newton's 3rd Law of Motion, for every action there is an equal and opposite reaction. In centripetal forces, the action is balanced by a reaction force and the centrifugal ("centre-fleeing") force. The two forces are equal in magnitude and opposite in direction.



Centrifugal Force Apparatus setup.

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.

Data of the centrifugal force.



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.

Torsion Balance

4170.00

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

Altay's Torsion Balance ready to work.

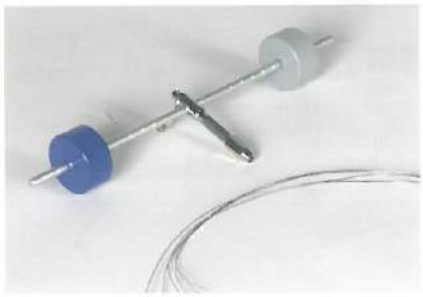
Equipment needed

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

Specifications

Size: 37 x 35 x 100 cm – Weight: approx. 2.5 kg

Precise and simple, the TEMA'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.



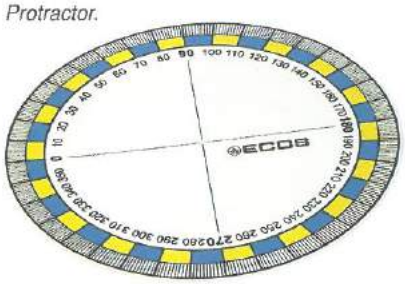
Balance arm with cylindrical weights housed in the wire clamp's plughole; metal wires of different diameters.

Reference index.

Main components

- Metal rod with terminal clamp to house a metal wire
- Clamp to block the metal wire, with hole to house the balance arm
- Balance arm • Two equal cylindrical weights with central plughole
- Metal wires of different diameters • Pan and weights • Reference index
- Nylon string • Protractor

Protractor.



Pan and weights.

Laws and principles investigated

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

Torsional modulus

The measurement of the torsional modulus of a metal wire

Place the torsional balance vertically to measure the torsional 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.

Setup for the dynamical measure of the torsional modulus.

Pellat Apparatus

4180.20

A simple experiment to study hydrostatic pressure

Specifications

Size: 24 x 28 x 55 cm – Weight: approx. 4.5 kg

Pellat Apparatus.

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.

Main components

- Base with support, capsule and tubes • Cylindrical shape vessel
- Conical shape vessel • Thin shape vessel

The apparatus is composed of a supporting panel on which a cylindrical support is used to hold the various shaped containers.
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.

Laws and principles investigated

- Hydrostatic pressure
- Communicating vessels principle

Pellat Apparatus components.

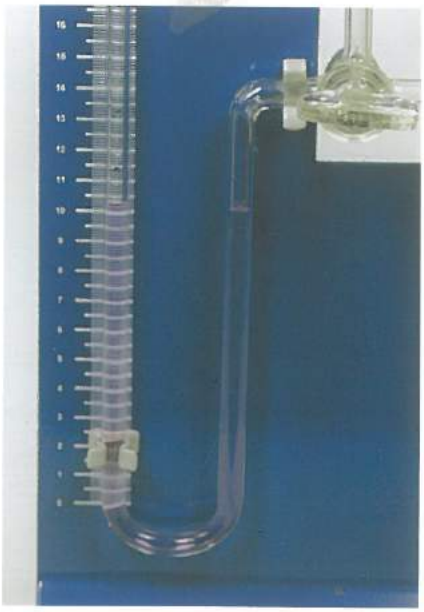
Hydrostatic pressure • Independence of the pressure on the shape of the vessel

With this easy to use apparatus, it is possible to demonstrate that the hydrostatic pressure on the bottom of a vessel does not depend on the shape of the vessel but only on the specific weight and on the level of the liquid.

The effect can be shown through a vessel whose bottom is the membrane of a manometer capsule.

Conical shape vessel mounted on Pellat Apparatus.

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.



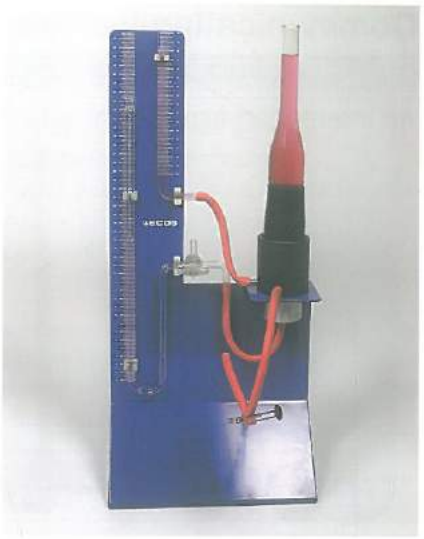
Balanced pressure in an empty vessel.

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.

Left: 28 cm water column.
Right: 13.5 cm water column pressure for the conical shape vessel.

By filling a different vessel up to the same level as the first, it can be observed that the pressure at the bottom of the membrane will still remain the same. A similar result will be seen with a third different vessel.

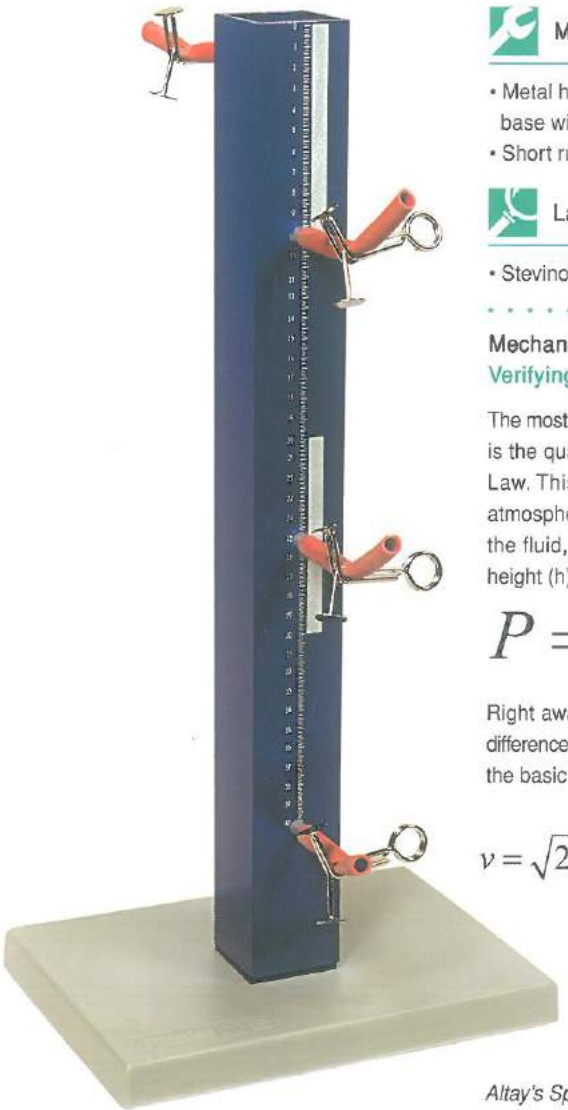
Thin shape vessel with 28 cm water height shows the same 13 cm pressure column height.



Spouting Jar

4180.42

As easy as that, get insights over the pressure in fluids



Main components

- Metal hollow column with scale, mounted on base with four apertures at different heights
- Short rubber tubes • Mohr clips

Laws and principles investigated

- Stevino's Law

Specifications

Size: 25 x 28 x 52 cm – Weight: approx.1.8 kg

Deeper inside everyday experience, the Spouting Jar apparatus takes students by hand into the laws governing pressure in fluids.
A metal column filled with water, spouts from rubber tubes placed at different height, showing the peculiar relation between the height of the aperture (which means the pressure of the liquid) and the length of the spout.

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:

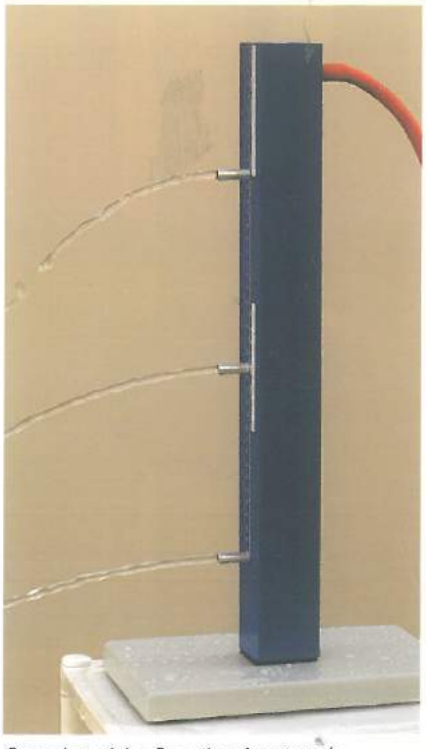
$$P = P_{atm} + \rho g h$$

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.

Altay's Spouting Jar.



Snapshot of the Spouting Jar at work.

Communicating Vessels

4180.60

An interesting experiment with connecting vessels

Communicating Vessels with coloured water.

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.

Specifications

Size: 20 x 18 x 20 cm – Weight: approx. 150 g
Mounted on base

Main components

- Set of four communicating borosilicate glass tubes of different size and form
- Stand to mount tube set

Laws and principles investigated

- Communicating vessels principle

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

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

Students peering at the principle of communicating vessels.

Capillary Tubes

4182.20

Exploring capillarity of various fluids

The Capillary Tubes apparatus

Specifications

Size: 20 x 18 x 20 cm
Weight: approx. 190 g
Mounted on base

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.

Main components

- Set of five interconnecting borosilicate glass tubes of different diameter
- Stand to mount tube set

Laws and principles investigated

- Capillarity • Jurin's Law

Capillarity · Narrow tubes and fluid behaviour

Capillary action is a physical effect caused by the interactions of a liquid with the walls of a thin tube. The capillary effect is a function of the ability of the liquid to wet a particular material.
It is due to surface tension by which the portion of the surface of a liquid coming in contact with a solid is elevated or depressed, depending on the adhesive or cohesive properties of the liquid.

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

Jurin's Law. $$h \cong \frac{2\tau}{\rho g r}$$

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

Boyle's Law Apparatus

4187.19

Get started with mechanics of fluids

Equipment needed	Specifications
Mercury (code 4207.55)	Size: 20 x 14 x 125 cm – Weight: approx. 4 kg

**The essential form of the apparatus gives a natural approach to the empirical basis of Boyle's Law.
It becomes a simple way to approach the experimental side of physics and to introduce at sight the concepts of vacuum, pressure, density, etc.**

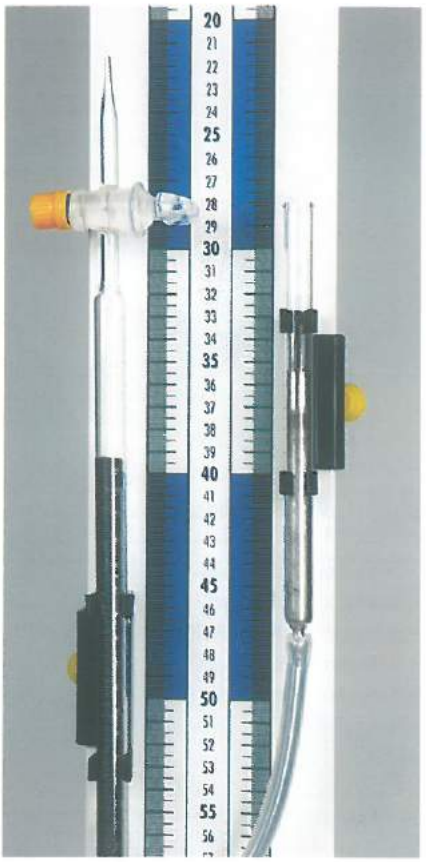
Boyle's Law Apparatus.

Main components

- Vertical support with lateral guides and dual-scale in mm • Pair of slides
- Glass tubular container with stopcock airtight, graduated • Gauge tube transparent and flexible
- Expansion container open at one end and fitted with an inlet at the other

Boyle-Mariotte Law

An experimental approach to this physical phenomena



Example showing the compression of gas.

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.

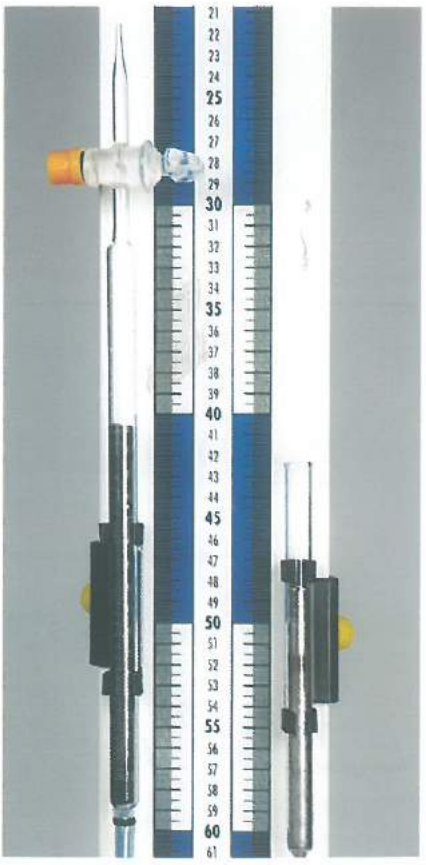
Laws and principles investigated

- Boyle's Law • Atmospheric pressure

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.



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.

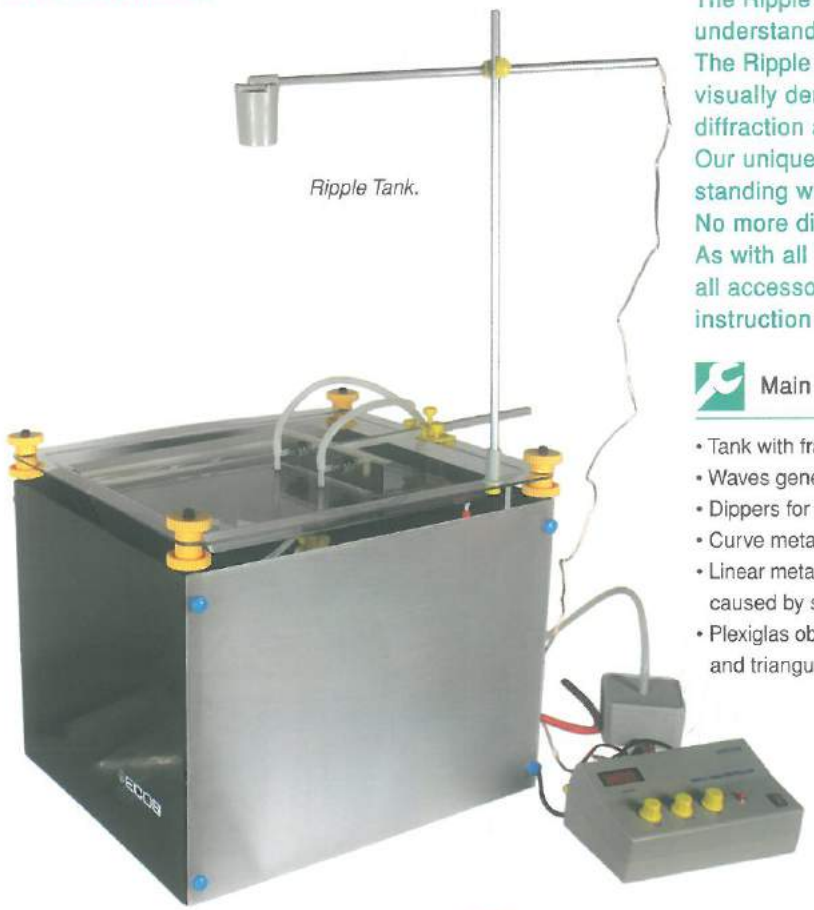
Ripple Tank

4311.80

New version of a very effective tool that helps students understand wave mechanics

Specifications

Size: 52 x 44 x 40 cm – Weight: approx. 6.5 kg

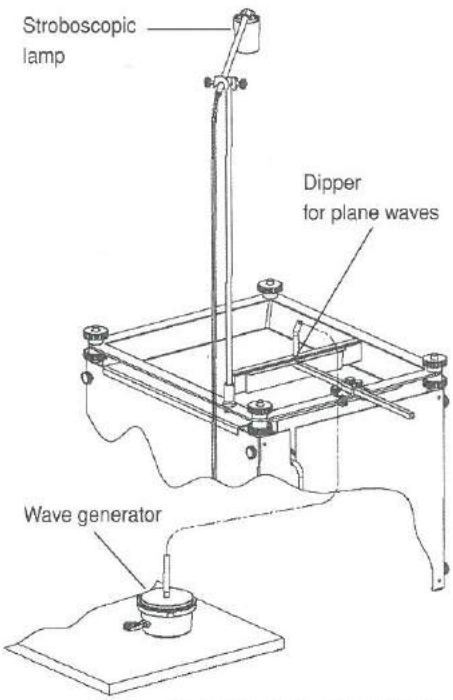


Ripple Tank.

The Ripple Tank is a very effective tool that helps students understand wave mechanics.
The Ripple Tank is also used to introduce, develop and visually demonstrate wave theory such as 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!
As with all Altay products, the Ripple Tank is supplied with all accessories, including connecting cables and instruction manual.

Main components

- Tank with frame and mirror • Ripple Tank controller, three-digit display
- Waves generator • Stroboscopic light with halogen lamp
- Dippers for plane and circular waves • Semicircular metal obstacle
- Curve metal obstacle • Metal right-angle obstacle
- Linear metal obstacles to produce diffraction phenomena or interference caused by single or double slot
- Plexiglas obstacles of different shape: biconcave, biconvex, rectangular and triangular



Ripple Tank mounting schema.

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

We use a unique pulsed air system to produce accurate and repeatable waves with our Ripple Tank. The electronic controller allows you to control the frequency of the pulses and hence the value of the wavelength.
The controller also coordinates the same pulsed air frequency to the stroboscope so that the waves appear to be static and therefore easily measurable. The system also includes a bright light source which is easily moveable to the side of the Ripple Tank.

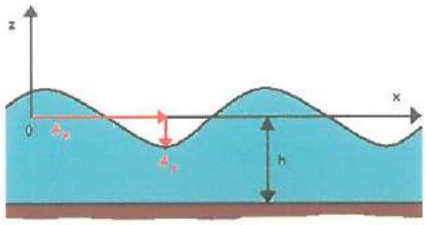
Ripple Tank Controller detail.

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.

Relationship between depth and phase velocity

Focus of a circular mirror.

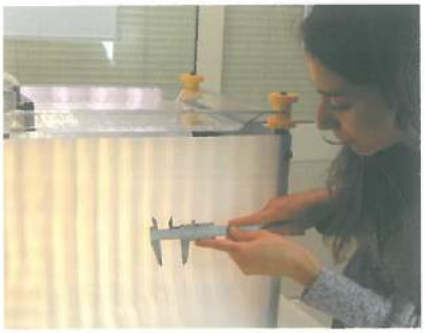


Wavelength

Measure the wavelength of a plane wave

With the Ripple Tank it is easy to teach students concepts such as wavelength, period, frequency, amplitude and so on. The screen is also very useful in taking direct measures of quantities. With a calliper, it is easy to measure the wavelength of a plane wave and verify the relation between other quantities such as period and frequency.

Student measuring the wavelength of a plane wave.



Spring Set

4315.15

Longitudinal and transversal waves

TEMA's Spring Set.

Specifications

Size: 37 x 24 x 12 cm – Weight: approx. 2 kg
Packing: ABS carry case with foam inserts
The set contains both springs that can also be sold separately

These springs are ideal for demonstrating longitudinal and transverse waves.

Main components

Wave Form Helix (Slinky) (code 4315.00), diameter 8 cm. Unstretched length 13 cm, may be stretched to approximately 5 m
Helix Spring (code 4315.02), diameter 2 cm. Unstretched length 1 m

Helix Spring.

Laws and principles investigated

• Logitudinal and transversal waves

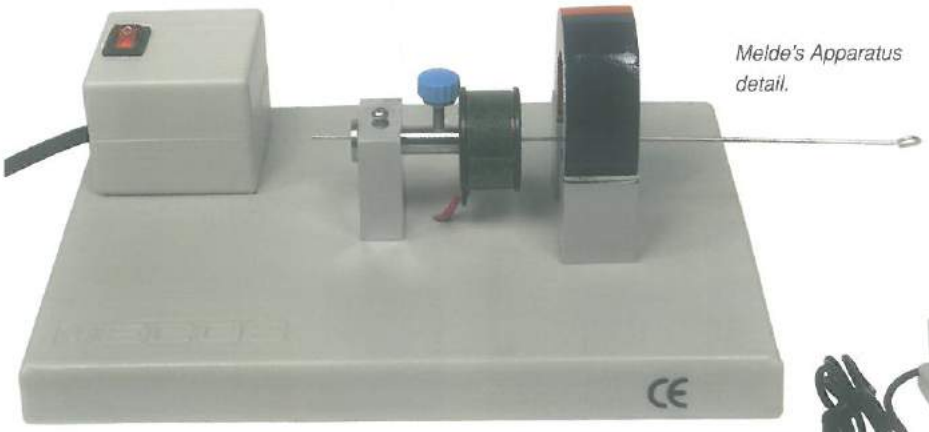
Waves · An introduction to a wide range of teaching involving longitudinal waves

TEMA's Spring Set allows teachers to literally introduce a hands on approach to the teaching of waves. The motion of the coil compressions of the springs resemble sound waves.
You can observe reflection and interference on the slinky created by students themseves.

Melde's Apparatus

4315.35

A simple experiment to study standing waves on a string

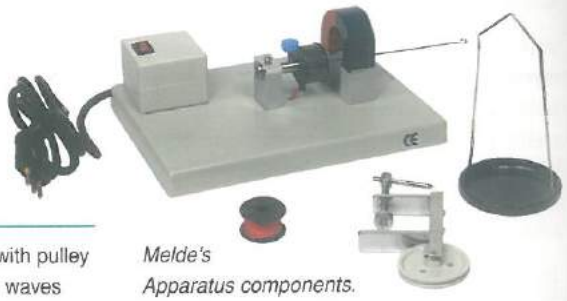


Melde's Apparatus detail.

Specifications

Size: 25 x 18 x 7 cm – Weight: approx. 1.6 kg

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.



Melde's Apparatus components.

Laws and principles investigated

- Standing waves on a string

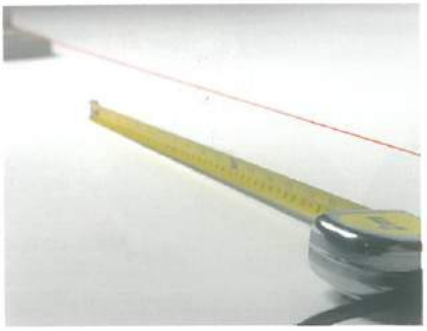
Main components

- Wave generator on base • Clamp with pulley
- Weight holder • String for standing waves

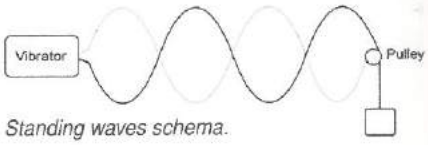
Standing waves

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.



Measuring a standing wave.



Standing waves schema.

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.

Three-Wire Sonometer

4316.05

Enquiring the laws of the vibrating string

Three-Wire Sonometer apparatus.

Specifications

Size: 67 x 10 x 10 cm – Weight: approx. 1.5 kg

Appealing and elegant, the Sonometer is a classical device developed in order to study vibrating strings.
With this apparatus it is possible to investigate the dependence of the pitch on the length, tension and thickness of a vibrating string.

Laws and principles investigated

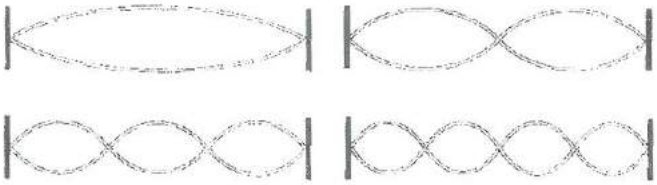
- Vibration frequency of a stretched string as a function of the length, tension and density of the string
- Frequency versus length • Frequency versus tension • Frequency versus mass per unit of length

Main components

- Wooden resonance box with graduated scales in millimetres
- Steel strings: two to be stretched on pegs; a third to be linked to dynamometer
- Dynamometer
- Movable bridges for adjustment of the length of the strings

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.

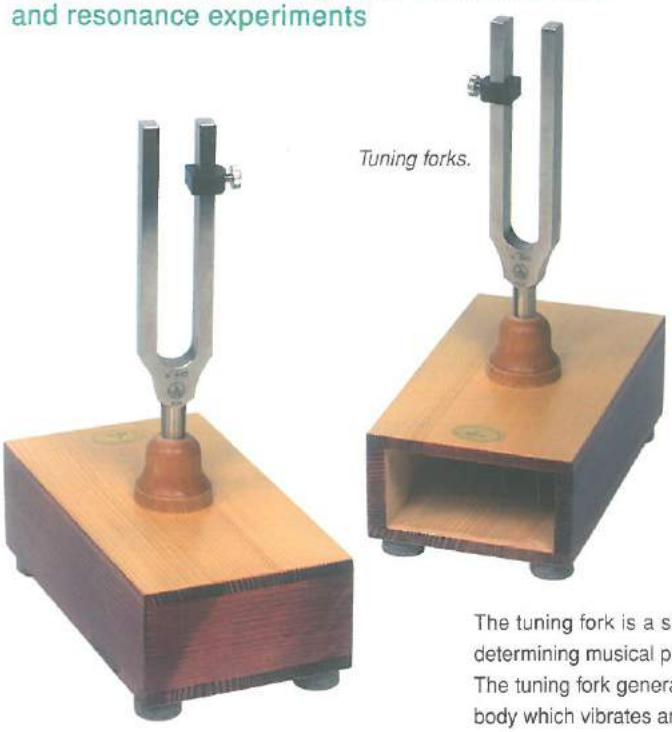


Examples of normal modes of a vibrating string.

Pair of LA_3 Tuning Forks

4317.40

A pair of mounted tuning forks for interference and resonance experiments



Tuning forks.

Specifications

Size: approx. 14 x 7 x 20 cm each – Weight: approx. 0.4 kg each

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.

Main components

- Pair of LA_3 Tuning Forks • Two resonance boxes for tuning forks
- Rubber mallet
- Pair of sliding masses on forks for minor adjustment of frequency

Laws and principles investigated

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

The tuning fork is a sound generator. It was invented by John Shore in 1711, and it is used for determining musical pitch and also in sound experiments.
The tuning fork generates a pure sound of a determined frequency. Each fork is a metallic elastic body which vibrates and then generates longitudinal elastic waves of acoustic frequencies.

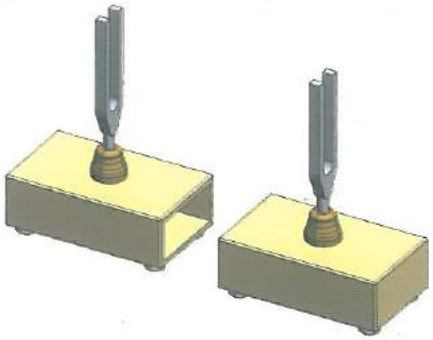
Pure tone · LA_3 sound and resonance

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

Tuning fork in use.

Resonance
Excitation of a tuning fork by resonance

You can vibrate a tuning fork without even touching it. By resonance.
This is done by striking another tuning fork facing the one you want to resonate.
You will notice that the maximum resonance is experienced when both the open resonant boxes face each other.



Setup for resonance experiment.

Set of Tuning Forks

4317.90

Set of Tuning Forks for a wide range of experiments

Specifications

Size: 25 x 21 x 7 cm – Weight: approx. 0.8 kg
Packing: ABS carry case with foam inserts

The TEMA 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 kHz and 512 kHz), allowing you to perform interesting experiments in harmonics.
Ideal for use with the LabPro software and data logging sound sensor to demonstrate beats.

Main components

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

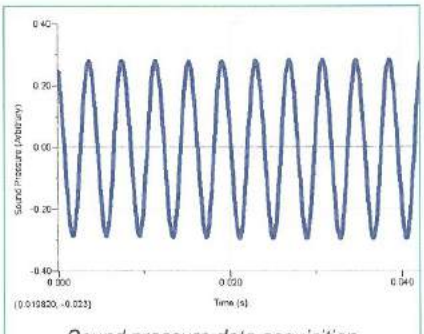
Laws and principles investigated

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

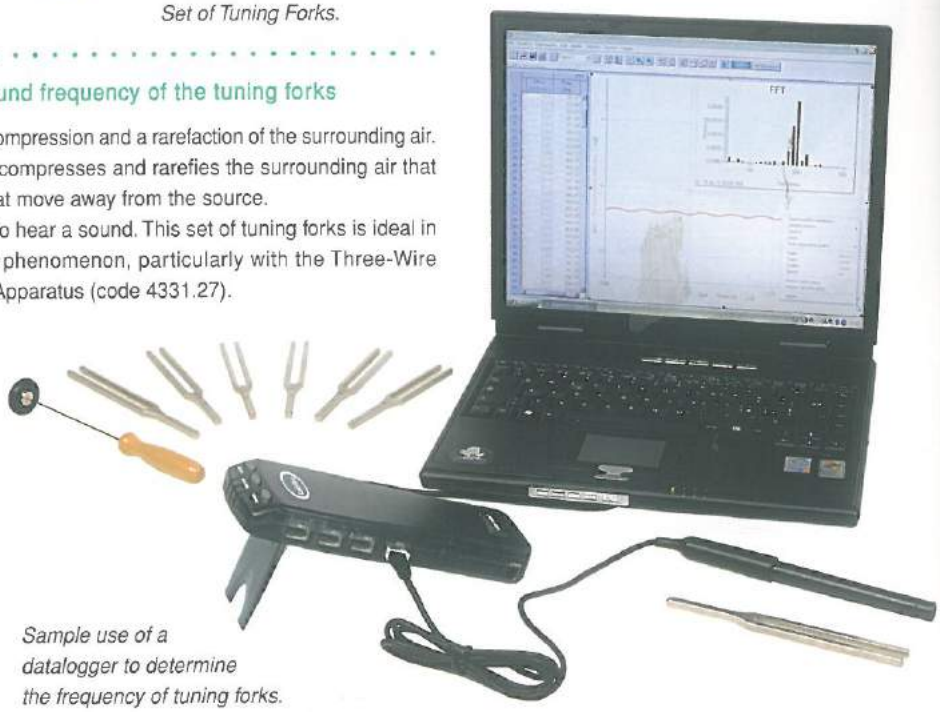
Set of Tuning Forks.

Resonance frequencies • Determine the sound frequency of the tuning forks

When tuning forks are vibrated, the forks create a compression and a rarefaction of the surrounding air. Periodically vibrating the tuning fork alternatively compresses and rarefies the surrounding air that transmits this in the form of longitudinal waves that move away from the source.
When these waves reach the ear, they cause us to hear a sound. This set of tuning forks is ideal in all the experiments useful to illustrate acoustic phenomenon, particularly with the Three-Wire Sonometer (code 4316.05), and the Resonance Apparatus (code 4331.27).



Sound pressure data acquisition.



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

The diaphragm of a microphone sensor records these variations by moving in response to the pressure changes. The diaphragm motion is then converted to an electrical signal.
Using a microphone and a computer interface, you can explore the properties of common sounds such as period, frequency and amplitude.
When two sound waves overlap, their air pressure variations will combine. For sound waves, this combination is additive. We say that sound follows the principle of linear superposition.
Beats are an example of superposition. Two sounds of nearly the same frequency will create a distinctive variation of sound amplitude, which we call beats. You can study this phenomenon with a microphone, lab interface, and computer.

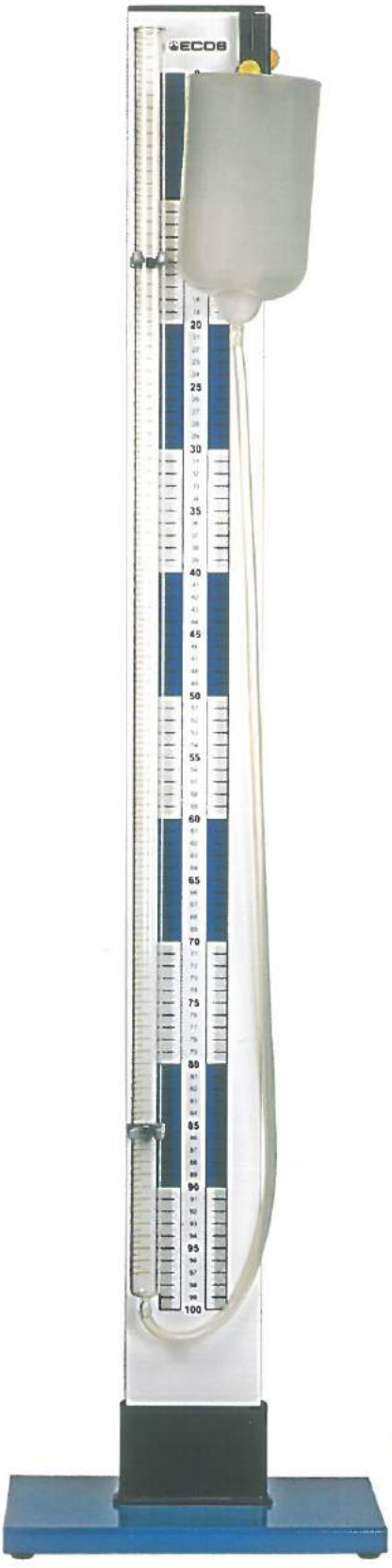
Resonance Apparatus

4331.27

Demonstrating standing waves

Equipment needed	Specifications
Set of Tuning forks (code 4317.90)	Size: 30 x 20 x 104 cm – Weight: approx. 3.2 kg Mounted on base

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



The Resonance Apparatus.

Main components

- Vertical bar with graduated 100 cm scale and pins to attach the glass tube • Metal base
- Levelling bulb (1000 ml) with rubber tube • Slide to hang the levelling bulb
- Vertical glass tube (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

The Resonance Apparatus ready to 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.

The resonance tube matching the wavelength of the incoming sound wave.

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.

Gunther Expansion Apparatus

4200.22

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

Gunther Expansion Apparatus.

Specifications

Size: 62 x 8 x 12 cm
Weight: approx. 2.2 kg

Equipment needed

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

Main components

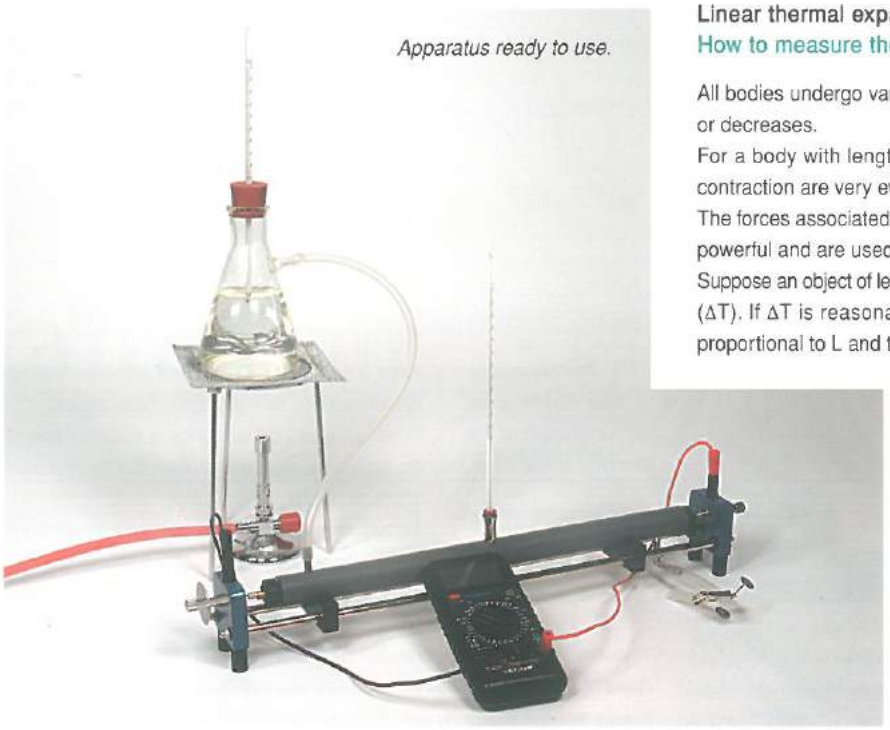
- Gunther Expansion Apparatus
- Metal rods (brass, aluminium, iron)
- Thermometer (-10 to 110°C)

Laws and principles investigated

- Linear thermal expansion

This is an ideal apparatus for determinating the coefficient of the linear expansion of a solid.
The apparatus comprises of a double metal plastic jacket containing the rods which will be raised to a temperature of 100°C. A micrometer screw gauge is mounted at one end and will show any expansion of the rods.

We make temperature measurement simple, yet accurate.
We directly measure the temperature of each tube with a mercury thermometer.
A digital multimeter can be used together with the micrometer screw gauge.
Comes complete with one brass, one aluminium and one iron rod of length 50 cm approx, mounted in the double jacket.



Apparatus ready to 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 α 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.

Bimetal Strip with Electric Contact

4200.80

Simple demonstrator for thermal expansion

Specifications

Size: 10 x 10 x 12 cm – Weight: approx. 150 g
Mounted on base, with electrical plugs for electric contacts

Bimetal strip detail.

A simple device that shows how we can use two different metals joined together to produce a thermostat.
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.

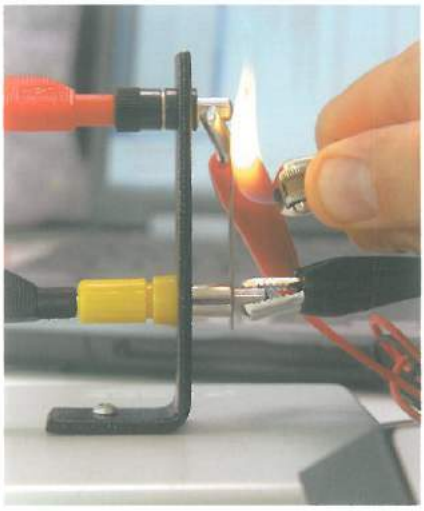
Laws and principles investigated

- Thermal expansion
- Demonstraton model of thermostat

Thermal expansion
Demonstration of a Bimetal Strip in action

Many of today's thermostats are based on the differential expansion of two different metals (brass and iron, for example), which was discovered in the 18th century.

Differential expansion causes the metals to change shape when heated. This change in shape can then be used to a throw a switch, for example. 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 complete 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.



Bimetal strip in use.

Mixing Calorimeter

4230.60

Ideal apparatus for simple experiments in thermodynamics

Specifications

Size: 12 x 20 cm (dia. x height)
Weight: approx. 250 g

Mixing Calorimeter.

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

Main components

- Copper calorimeter • Felt cover
- Lid with stirrer and fixture for the thermometer
- Thermometer

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.

Laws and principles investigated

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

Joule's Law Unit for Calorimeter

4230.65

Joule's Law: electricity and thermodynamics

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

Joule's Law Unit for Calorimeter.

Specifications

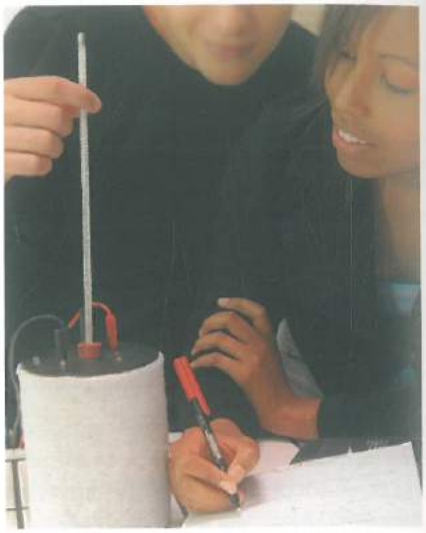
Specifically developed for our Mixing Calorimeter
Resistances: 1, 2, 3 Ω
4 mm jacks for power supply

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

Equipment needed

Mixing Calorimeter (code 4230.60)
Regulated DC Power Supply Unit (code 2409.20)



Joule's Law Unit setup with the Calorimeter.

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

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

$$Q = I^2 Rt$$

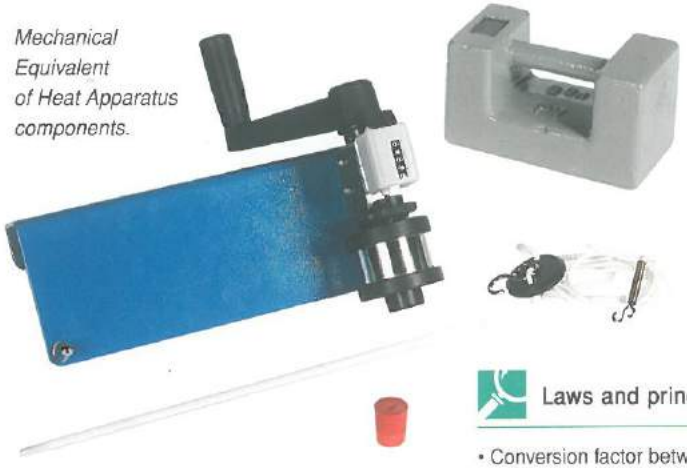
Joule's Law.

Mechanical Equivalent of Heat Apparatus

4235.10

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

Mechanical Equivalent of Heat Apparatus components.



Specifications

Size: 26 x 22 x 20 cm – Inclusive of clamp for table mounting

The apparatus is a simple and accurate demonstration of how to turn mechanical energy into heat. Using the rotation-counter and a falling mass it is possible, using a thermometer, to calculate the mechanical effect of friction and the increase in temperature of the calorimeter.

Main components

- Base with crank, mechanical counter, calorimeter and rubber stopper for the insertion of the thermometer
- Pin with chord and spring • 5 kg weight • Thermometer

Mechanical Equivalent of Heat Apparatus in use.

Laws and principles investigated

- Conversion factor between joules and calories

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 calorimeter 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.

Stroboscope

2238.10

Light from a timing source

Altay's Stroboscope.

Stroboscope with frequency selector.

Specifications

Size: 20 x 12 x 14 cm – Frequency range: 1 ÷ 300 Hz – External input for trigger

A Stroboscope is a pulsed lamp which is used to observe rapidly moving phenomena, such a vibrating string or waves in a Ripple Tank.
If the frequency of "flashes" from the Stroboscope matches the frequency of the object being observed, it causes the eye to see the image as having been frozen at that matched frequency. Hence, useful measurements can be made and observations made easy.

Laws and principles investigated

- Frequency determination in various contexts

Slow down motion
Decomposition of colours

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

Strobo light over the Newton's Disk.

Crooke's Radiometer

4215.20

Investigating the energy and impulse of an electromagnetic wave

Altay's Crooke's Radiometer.

Invented by Sir William Crooke, the vanes in the highly effective radiometer rotate when exposed to solar radiation.
The cause for this rotation can open up much debate for which students should be encouraged to develop their own explanations. Some will state that the device relies upon the difference in absorption of impulse between the black and metal vanes. Others may think there is a difference in temperature of the vanes. This device has been designed with black vanes that absorb electro-magnetic radiation and reflective metal vanes. Students need also remember that black painted sides get warmer than metallic ones.

Specifications

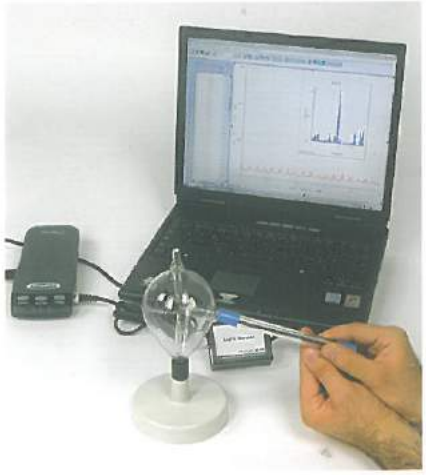
Size: 10 x 15 cm (dia. x height)
Weight: approx. 250 g – Mounted on base

Laws and principles investigated

- Energy conversion

Black body · Heating up the vanes

The correct solution of the puzzle 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 molecule recoil is what causes the device to spin.
The other proposal involving photon absorption by the black vane and reflection by the metal side is physically correct, but negligible with respect to the main effect described above.
With a light sensor, it is also possible to measure the frequency of rotation and calculate the angular speed of the radiometer.



Investigate light reflection using a light sensor.

Optical Bench with Accessories

4417.50

A complete set for exploring geometrical optics

Specifications

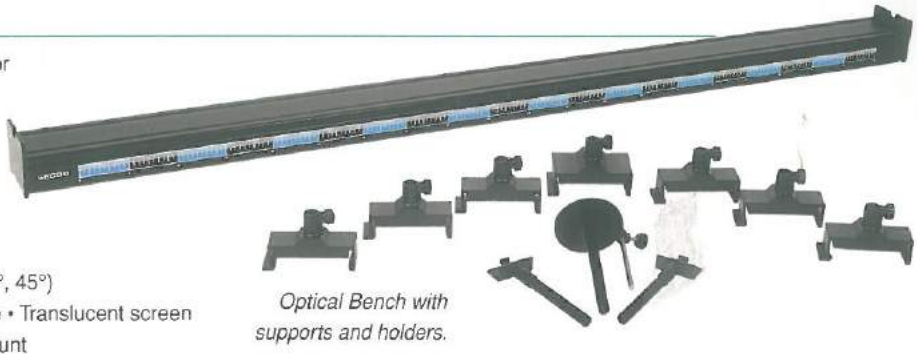
Optical Bench: length 110 cm

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

Optical Bench with Accessories.

Main components

- Optical bench • Slider for holders and projector
- Slides and diaphragm holders
- Set of seven diaphragms • Iris diaphragm
- Adjustable slit diaphragm
- Projector with 12 V lamp and spare lamp
- Transformer 12 V 2.5 A
- Lamp holder, single and 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 • Grease spot photometer
- Pair of polaroid filters, mounted
- Set of mounted biconvex lenses: f = +50, +100, +150,+ 200, +300, +500 mm
- Set of mounted biconcave lenses: f = -50, -100, -150, -200, -300, -500 mm



Optical Bench with supports and holders.

Lenses with lens holders.

Set of diaphragms.

Two colour metal screen, translucent screen and plane mirror.

Iris diaphragm, adjustable slit diaphragm and mirror.

Projector with transformer, cables and lamp holders.

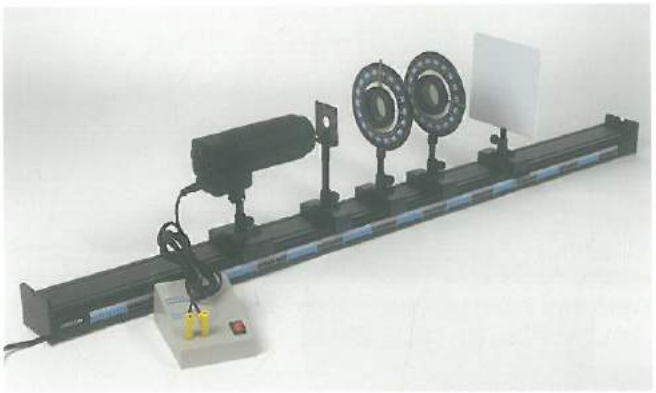
Laws and principles investigated

- 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
- 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
- Photometry • Prism • Rotation of light

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.



Polarization experiment setup.

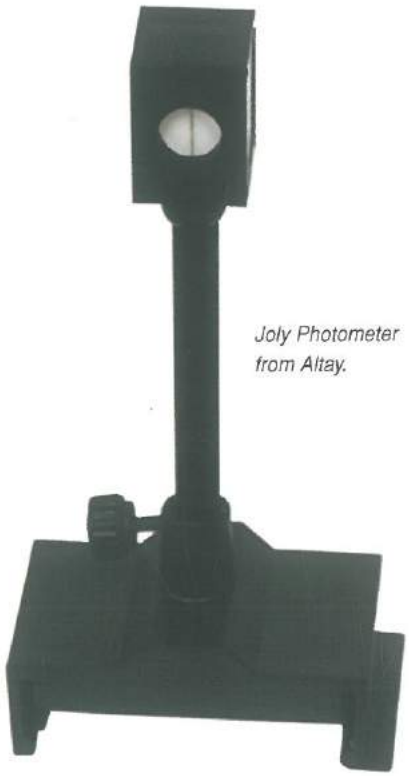
A polarizing filter, such as a pair of polarizing sunglasses, can be used to observe this by rotating the filter while looking through. At certain angles, the reflected light will be reduced or eliminated.
Polarizing filters remove light polarized at 90° to the filter's polarization axis. If two polarizers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

Joly Photometer

4422.01

A comparative light sensor

Simple in its arrangement, Joly Photometer allows for comparisons of light intensities. Two blocks of translucent material separated by a sheet of opaque foil constitute the kernel of this appealing device.



Joly Photometer from Altay.

Laws and principles investigated

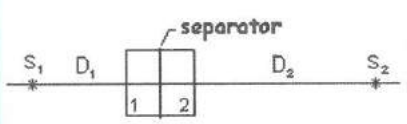
- Comparison between brightness of two light sources
- Inverse square distance law for light intensity

Light intensity

Verify the inverse square distance law for light intensity

Place the head of Altay's Joly Photometer between two sources S_1 and S_2 of different brightness as shown in the scheme. Move the light sources until the two blocks of Joly Photometer appear equally bright. Now, verify the inverse square distance law of luminosity.

Scheme of the experiment (not to scale)



Joly Photometer

Specifications

Size: 2.5 x 2.5 x 2.5 cm – Mounted on stem

Students learning the inverse square distance law for light intensities.

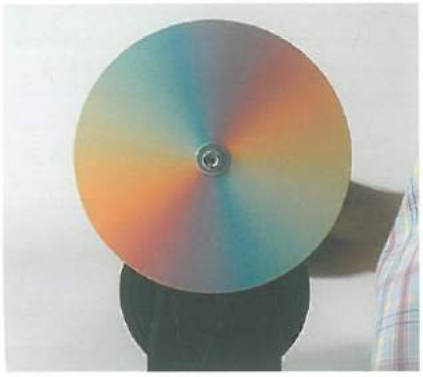
Newton's Disk

4453.22

The human perception of colours

Newton's Disk.

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



Rotating disk at low speed.

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.

Specifications

Size: 20 x 30 x 12 cm – Weight: approx. 1 kg
Mounted on base

Laws and principles investigated

• Colour mixing • Human perception of colours

Colour mixing

By rotating the disk all colours mix together becoming white

Newton's Disk turns white at a higher rotation.

Spectrometer

4455.02

Studying the spectral lines of a light source

Altay's Spectrometer with accessories.

Specifications

Size: 44 x 30 x 30 cm in wooden box – Weight: approx. 12 kg

Available 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)

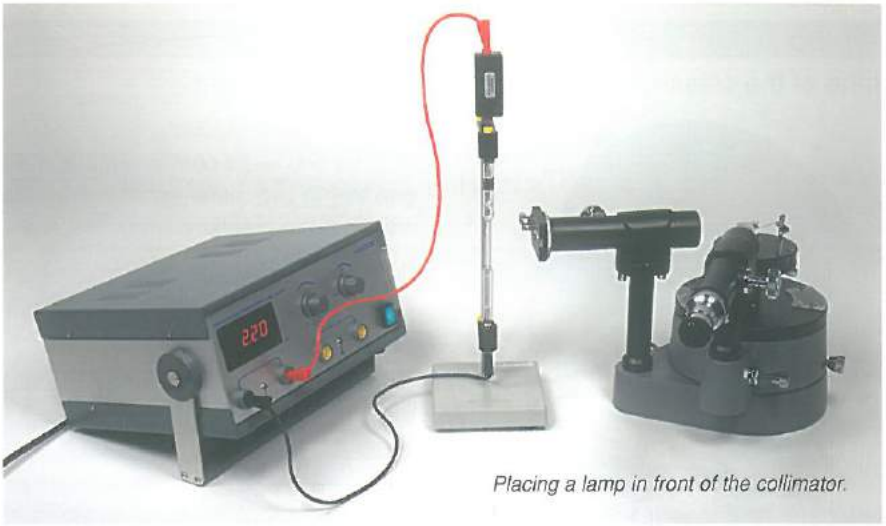
The Spectrometer is used to study the spectral lines of a light source. Easy to use and robust, this instrument is particularly suitable for classrooms. Altay's Spectrometer allows you to detect the spectral lines with precision and to measure the corresponding wavelength.

Main components

- High quality telescope with 15x eyepiece and cross hair graticule
- Collimator made from high quality optics • Quality prism
- Diffraction grating • Prism clamp
- Diffraction grating holder
- Eyeglass for reading of angles
- Tommy bar for adjustment of optical axis
- Study base for good optical alignment
- Precise rotating platform

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

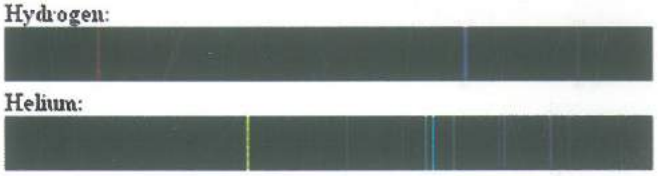


Placing a lamp in front of the collimator.

Spectral Lines

Measuring the wavelength of the hydrogen spectra

The spectrometer is an ideal instrument for analysing the spectral lines of a light source. In order to perform the experiment, set the position of the sodium lamp so that the collimator is properly aligned.
The diffraction grating is then placed in its holder, allowing you to observe the spectral lines of sodium.
The full spectra can be seen by rotating the telescope. By knowing the diffraction angle, we can then work out the wavelength of the light.



Hydrogen and Helium emission spectra.

Spectrum Tubes

4470.10 - 50

Excitation of the Hydrogen in the tube produces light

Hydrogen Spectrum Tube on Spectrum Tube Holder.

Specifications

All items are sold separately

Spectrum Tubes Holder with Ballast Resistance (code 4470.50)
Size: 12 x 12 x 36 cm – Weight: approx. 260 g

Equipment needed

Regulated 5 kV Power Supply Unit (code 2407.01)

Gas tubes

Size: 1 x 10 x 23 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)

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

Laws and principles investigated

• Light from excited energy levels • Monochromatic light

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.

Wimshurst Machine

4622.20

One of the classic electrostatic generator experiment

Specifications

Size: 40 x 24 x 43 cm – Weight: approx. 4.4 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.

The Wimshurst Machine ready to run.

Wimshurst Machine at work.

Laws and principles investigated

• Electrostatic charge • Electrical sparks

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.

Van de Graaff Generator

4623.20

Get excited with the Van de Graaff Generator

Van de Graaff components.

Specifications

Size: 30 x 20 x 77 cm – Weight: approx. 4.4 kg

The Van de Graaff Generator is considered an important and powerful apparatus to perform electricity experiments. Its great appeal and dramaticity attracts students into the amazing world of physics. Historically developed to accelerate particles in high energy physics experiments, our Van de Graaff Generator has been redesigned to perform demonstrations and experiments in schools.

Main components

- Base with rotating belt, motor and controls • Conductor sphere
- Metal discharge sphere • Head of hair • Needle head
- S-shaped bar with end-point spikes
- Wheel with handle to run manually the Van de Graaff Generator
- Power supply • Spare rubber belt

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

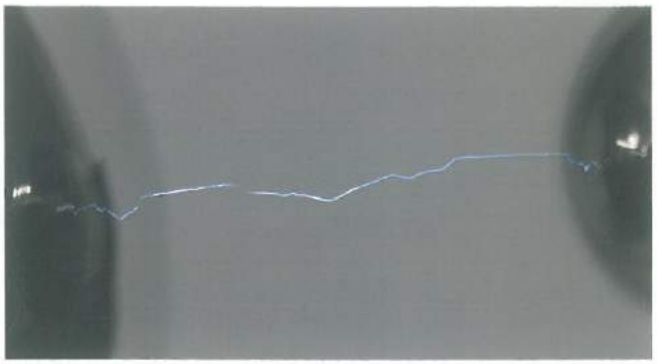
Laws and principles investigated

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

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.



Detail of the spark of several thousands volts.

Pith Ball Electroscope

4625.00

Specifications

Size: 11 x 13 x 26 cm – Weight: approx. 100 g

High impact electrostatic force experiment

The Pith Ball Electroscope is a simple instrument for demonstrating electrostatic force. With some simple rods of different materials such as perspex, PVC or glass and a piece wool or silk surface, you can charge one of the spheres in the electroscope. After, the spheres will have different charges and will repel each other.

Pith Ball Electroscope in detail.

Laws and principles investigated

- Positive and negative charges
- Electrostatic repulsion and attraction

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.

Gold Leaf Electroscope

4625.50

A classical instrument for measure static charges

Altay's Gold Leaf Electroscope.

Main components

- Electroscope mounted on base
- Inserted insulated leaf support with top metal disk
- Plug for ground • Gold leaf plus spare

Simple and functional, Altay's Gold 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 golden 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 golden leaf.

Laws and principles investigated

- Electrostatic charge measure

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 golden leaf and the vertical rod.

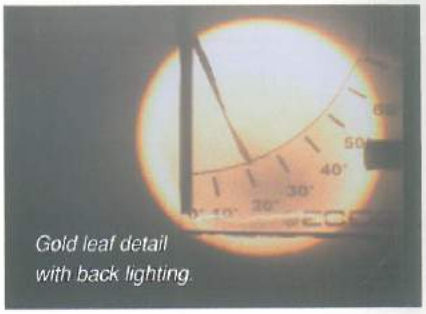
Specifications

Size: 20 x 15 x 20 cm – Weight: approx. 1 kg
Mounted on base

Also available
Gold Leaf Electroscope, Flask Types (code 4625.09)

Specifications
Size: 10 x 20 cm (dia. x height)
Weight: approx. 200 g

Gold Leaf Electroscope, Flask Type.



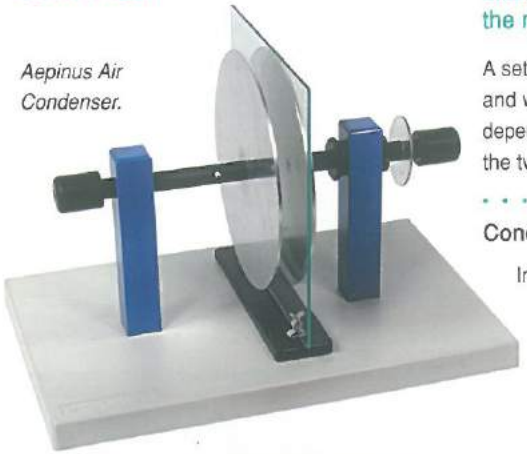
Gold leaf detail with back lighting.

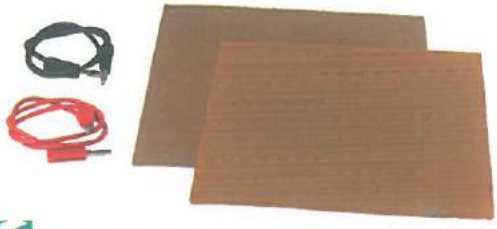
Aepinus Air Condenser

4628.32

A demonstration model of a condenser

Aepinus Air Condenser.





Main components

- Aepinus Air Condenser on base • Wooden surface • Bakelite surface
- Glass surface • Holder for materials

A condenser is a device that allows the storage of energy in the electric field created between a pair of conductors on which electric charges of equal magnitude, but opposite sign, have been placed. With our Aepinus Air Condenser, it is possible to show the dependence on capacity of a parallel plate condenser and the distance between the plates and the nature of the medium between them.

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

Specifications

Size: 34 x 20 x 25 cm – Weight: approx. 3 kg

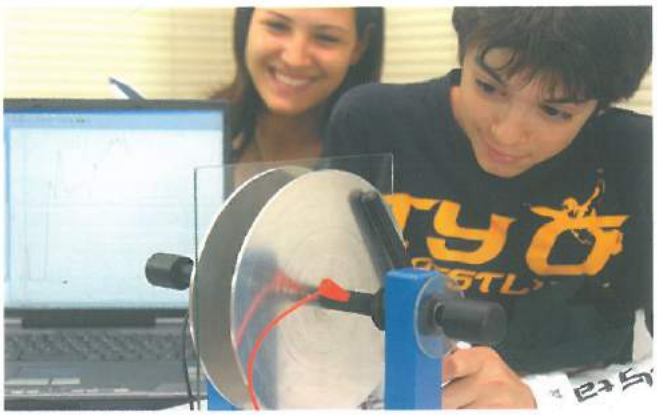
Laws and principles investigated

- Plane face condenser • Dielectric effect

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

Different shape magnets for a wide number of magnetism experiments in laboratories

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.

Specifications

All items can be bought separately

Laws and principles investigated

• Magnetic poles • Magnetic field • Lines of force

Magnetic Rubber Sheet

4610.60

Set of 12 rubber sheets, two pieces each of red, yellow, blue, green, black and white.

Specifications
Size: 30 x 5 cm each

Coloured Chart Magnets

4610.70

Set of 6 discs. One each of red, yellow, blue, green, black and white.

Specifications
Size: 3.5 cm dia. each – Plastic coated

Cylindrical Magnets

4611.16

Cylindrical magnets, supplied in pairs.

Specifications
Material: ALNICO – Size: 1.2 x 5 cm (dia. x length)
Also available:
Size: 1 x 3 cm (dia. x length) (code 4611.17)
Size: 0.8 x 2.5 cm (dia. x length) (code 4611.18)
Size: 0.6 x 2 cm (dia. x length) (code 4611.19)

Plastic Cased Bar Magnets

4611.40

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

Specifications
Size: 8 x 2.2 x 1 cm

Chrome Steel Bar Magnets

4611.50

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

Specifications
Size: 5 x 1 x 0.5 cm
Also available:
Size: 10 x 1 x 0.5 cm (code 4611.51)
Size: 15 x 1.5 x 0.5 cm (code 4611.52)

Bar Magnets

4611.55

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

Specifications
Material: ALNI – Size: 5 x 1.2 x 0.6 cm
Also available:
Material: ALNI
Size: 7.5 x 1.2 x 0.6 cm (code 4611.56)
Size: 10 x 1.2 x 0.6 cm (code 4611.57)
Material: ALNICO5
Size: 2 x 1 x 0.5 cm (code 4611.60)
Size: 4 x 1.2 x 0.5 cm (code 4611.61)
Size: 6 x 1.5 x 0.5 cm (code 4611.62)
Material: ALNICO
Size: 5 x 1.5 x 1 cm (code 4611.65)
Size: 7.5 x 1.5 x 1 cm (code 4611.66)

Mighty Magnet

4611.69

Very strong magnet with long steel pole pieces and a keeper.
Ideal for simple electric motor construction or re-magnetising other magnets.

Specifications
Size: 11 x 7.5 x 4 cm

Major Magnet

4611.70

Very high power magnet with keeper. Ideal for flux density measurement.

Specifications
Material: ALNICO5 – Size: 11 x 10 x 5 cm

Cast U-Shaped Magnet

4611.75

Painted red, with keeper.

Specifications
Material: ALNICO
Pole gap: 1.5 cm – Size: 2 x 2 x 0.75 cm
Also available:
Pole gap 2 cm – Size: 2.5 x 2.5 x 0.95 cm (code 4611.76)
Pole gap 2.3 cm – Size: 3 x 3 x 1.1 cm (code 4611.77)

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: 2.5 x 0.5 cm (dia. x height)
Also available:
Size: 1 x 0.8 cm (dia. x height) (code 4611.83)
Size: 2 x 1 cm (dia. x height) (code 4611.85)

U-Shaped Magnet

4611.71

Strongly magnetized, with keeper.

Specifications
Size: 6 x 5 x 2.5 cm

Chrome Steel U-Shaped Magnet

4611.78

Red and plated, with keeper.

Specifications
Size: 10 x 1.6 x 0.6 cm
Also available:
Size: 14 x 2 x 1 cm (code 4611.79)

Button Magnet

4611.90

These strong isotopic magnets have a central hole.
They can be used up to 500 °C.
Supplied in red and comes with keeper.

Specifications
Size: approx. 1.25 x 0.4 cm (dia. x bore)
Also available:
Approx. 2 x 0.5 cm (dia. x bore) (code 4611.91)
Approx. 2.5 x 0.5 cm (dia. x bore) (code 4611.92)
Approx. 3 x 0.7 cm (dia. x bore) (code 4611.93)

Ferrite Magnet

4612.09

Magnetised through thickness.

Specifications
Size: 5 x 1.9 x 0.6 cm

Horseshoe Flat Magnet

4611.72

Painted, with keeper, in plastic case.

Specifications
Material: chrome steel – Size: 10 x 5 x 0.5 cm

Horseshoe Magnet

4611.81

With keeper, painted red.

Specifications
Material: ALNICO – Size: 3 x 3 x 1 cm

Ring Magnet

4612.03

Annular magnets with face poles.

Specifications
Size: 2.4 x 0.7 x 0.5 cm
Also available:
Size: 3.2 x 1.8 x 0.5 cm (code 4612.04)
Size: 3.6 x 1.8 x 0.8 cm (code 4612.05)
Size: 6 x 3 x 1 cm (code 4612.06)
Size: 7 x 3.2 x 1 cm (code 4612.07)

Magnetic Needle on Stand

4613.80

A simple magnetic needle compass

Specifications

Needle: 10 cm length – Support rod: 11 cm length – Mounted on base: 6 cm dia.

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.

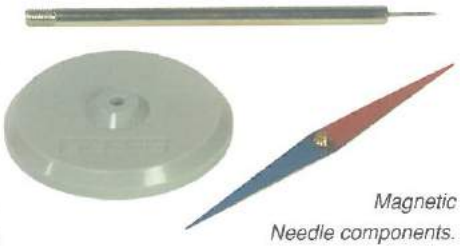
Magnetic Needle on Stand.

Main components

- Magnetic needle • Plastic base
- Metallic pillar with carbon steel point

Laws and principles investigated

- Earth magnetic field • North and cardinal points



Magnetic Needle components.

The North • To determine the position of cardinal points

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

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

The simplest compass consists of a magnetised pointer that aligns itself accurately with Earth's magnetic field.
In our Magnetic Needle, you will find a simple compass useful to determine the position of the cardinal points of every location.
The red side points to North (0°), the blue to South (180°). Earth's rotation defines the orientation of East (90°) and West (270°).

Demonstration Compass

4614.50

Study the cardinal points with a compass

Demonstration 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.

Specifications

Size: 16 x 3 cm (dia. x height)
Magnetic needle: 10 cm length

Main components

- Compass base with silk printed cardinal points
- Magnetic needle

Laws and principles investigated

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

Demonstration Compass unmounted.

The cardinal points • How to read the compass

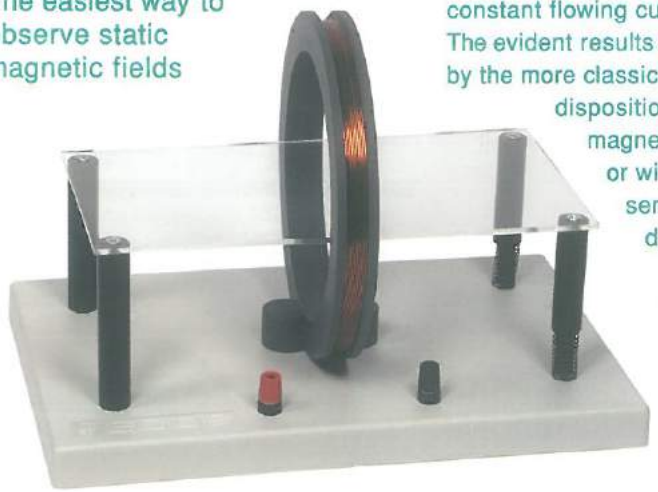
Compass rose example.

A compass or "wind rose" is a figure that displays the orientation of the cardinal directions: North, South, East and West on a map or nautical chart. Today the use of a compass rose is used in almost all navigational systems, including nautical charts, NDB and VOR systems and in some GPS systems.
Placing our Demonstration Compass on a table the magnetic needle orientates itself with Earth's magnetic field.
The red part of the needle points to North; this way all other cardinal points are immediately defined.

Circular Coil

4640.50

The easiest way to observe static magnetic fields



Circular Coil.

This equipment has been developed for students' demonstrations on static magnetic fields generated by a constant flowing current.
The evident results can be visualised by the more classical iron filings' disposition along the magnetic lines of a force or with a magnetic field sensor and a datalogger.

Teacher demonstrating how the Circular Coil works.

Specifications

Size: 30 x 20 x 20 cm – Weight: approx. 1.2 kg

Equipment needed

Low Tension Power Supply Unit (code 2408.00)
Iron Filings (code 4612.12)

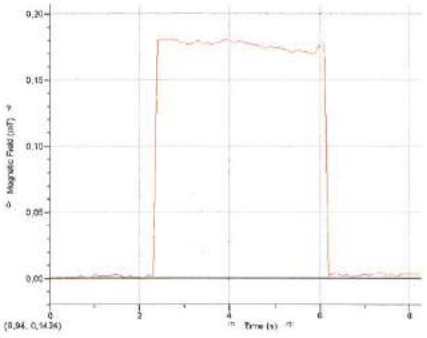
Laws and principles investigated

- Magnetic field by electric current

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

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

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



Magnetic field data acquisition.

U-Shaped Electromagnet

4652.10

Magnetic and electric fields

Altay's U-Shaped Electromagnet.

Main components

- Electromagnet isolated to prevent electric shock
- Keeper with hook

Specifications

Size: 10 x 12 x 4 cm – Weight: approx. 350 g
Resistance: approx. 30 Ω – Impedance at 50 Hz: approx. 50 Ω without keeper

Equipment needed

Regulated DC Power Supply Unit (code 2409.20) – Iron Filings (code 4612.12)

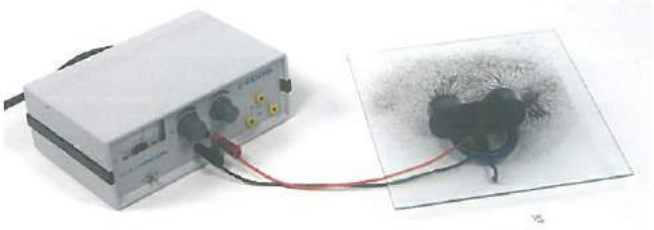
Specifically designed to perform experiments of electromagnetism, Altay's U-Shaped Electromagnet encourages students to learn the relationship between electricity and magnetism.

Laws and principles investigated

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

Electricity and magnetic fields · Visualize the magnetic lines of force

The electromagnet is used in many electric devices such as: electric bells, relays, circuit breakers, loudspeakers and microphones. Strong magnetic fields can be achieved by coiling a wire around a piece of soft iron.
The soft iron becomes a magnet itself when the current begins to flow, and makes the magnetic field stronger.

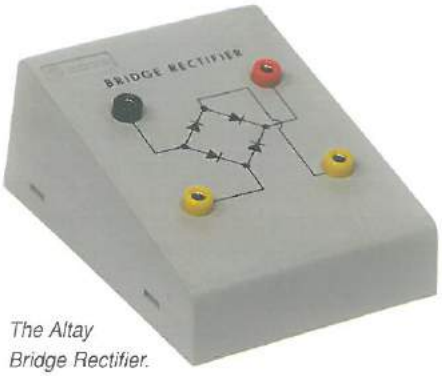


U-Shaped Electromagnet at work.

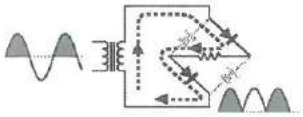
Bridge Rectifier

2404.13

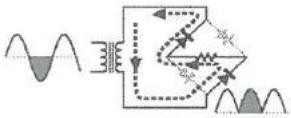
The Altay Bridge Rectifier transforms alternate current (AC) in direct current (DC)



The Altay Bridge Rectifier.



Positive current flow.



Negative current flow.

The Altay Bridge Rectifier consists of four diodes connected in a bridge circuit. The most common application of this circuit is the conversion of alternating current (AC) input into direct current (DC) output. The unit has a circuit diagram printed so that student may gain an appreciation of the importance of diodes and how they can rectify alternating current to direct current.

Specifications

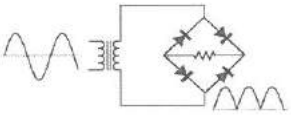
Size: 13.5 x 9 x 5.5 cm – Weight: approx. 150 g

Laws and principles investigated

• AC-DC Convertion • Diode principle

AC – DC Converter · How to transform an alternate current in direct current

A bridge rectifier makes use of four diodes in a bridge arrangement to achieve full-wave rectification. This is a widely used configuration, both with individual diodes wired as shown and single component bridges where the diode bridge is wired internally.



Full wave rectification schema.

For both positive and negative swings of the transformer, there is a forward path through the diode bridge. Both conduction paths cause current to flow in the same direction through the load resistor, achieving full-wave rectification.
By simply placing a capacitor in parallel to the output of the bridge rectifier, it is possible to stabilize the tension of the DC current.

While one set of diodes is forward biased, the other set is reverse biased and effectively eliminated from the circuit.

As with all our products, it is easy to set up a configuration to acquire data directly on the computer.

Bridge Rectifier ready to be used with GoLink and a Differential Voltage Probe.

Capacitance Box

4690.00

A didactic solution for students to handle capacitances at site

Capacitance Box detail.

Capacitances in series.

Specifications

Size: 135 x 90 x 55 mm – Weight: approx. 150 g
11-position switch – 4 mm sockets
Max. voltage: 50 V – Accuracy 10%
Capacitance: 1 - 2.2 - 4.7 - 10 - 22 - 47 - 100 - 220 - 470 - 1000 nF.

Also available

Capacitance: 1 - 2.2 - 4.7 - 10 - 22 - 47 - 100 - 220 - 470 - 1000 µF (code 4690.02)
Capacitance: 100 pF - 470 pF - 1 nF - 4.7 nF - 10 nF - 47 nF - 100 nF - 1 µF - 4.7 µF - 10 µF (code 4690.04)

Altay Capacitance Boxes are designed to be sturdy and are also very useful in laboratories. The strong ABS case prevents damage and is printed with large easy to read capacitance value to facilitate experimenting in a circuit without having to disconnect.

Laws and principles investigated

• Capacitor laws

Capacitances in series and in parallel
Verify the laws of capacitances in circuits

Capacitors are different from resistors connected in series. Capacitors in series can be shown as:

$$C_{eq} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2}}$$

C_{eq} in series mounting.

Two or more capacitors are rarely deliberately connected in series in real circuits, but it can be useful to connect capacitors in parallel to obtain a very large capacitance, for example, to smooth a power supply.

Capacitances in parallel.

Capacitances connected in parallel offer an equivalent resistance equal to the sum of the two. In this case, is also easy to setup the experiment.

$$C_{eq} = C_1 + C_2$$

C_{eq} in parallel mounting.

Decade Resistance Box

4693.10 - 50

An easy to use, multiple value resistances with 4 mm jacks.

Resistance Boxes.

Laws and principles investigated

- Resistance laws

Specifications

Size: 13.5 x 9 x 5.5 cm – Weight: approx. 150 g – 11 position switch
4 mm sockets – Max voltage: 50 V – Power permitted: 1 W
Decade Resistance Box: 1 Ω ÷ 10 Ω, accuracy 2% (code 4693.10)
Decade Resistance Box: 10 Ω ÷ 100 Ω, accuracy 2% (code 4693.20)
Decade Resistance Box: 100 Ω ÷ 1 kΩ, accuracy 2% (code 4693.30)
Decade Resistance Box: 1 kΩ ÷ 10 kΩ, accuracy 2% (code 4693.40)
Decade Resistance Box: 10 kΩ ÷ 100 kΩ, accuracy 2% (code 4693.50)

The Altay Decade Resistance Boxes are a robust solution in any electronics laboratory and ideal for testing circuits with different resistances.
The high impact angled plastic housing case allows an easy reading of resistance values and easy changing of resistance values without having to remove them from the circuit.

Resistance in series and in parallel • Ohm's Law and its concequences

The most fundamental law of electrical circuits is known as Ohm's Law:
"To make a current flow through a resistance there must be a voltage across that resistance. Ohm's Law shows the relationship between the voltage (V), current (I) and resistance (R)"

$$V = IR$$ *Ohm's Law.*

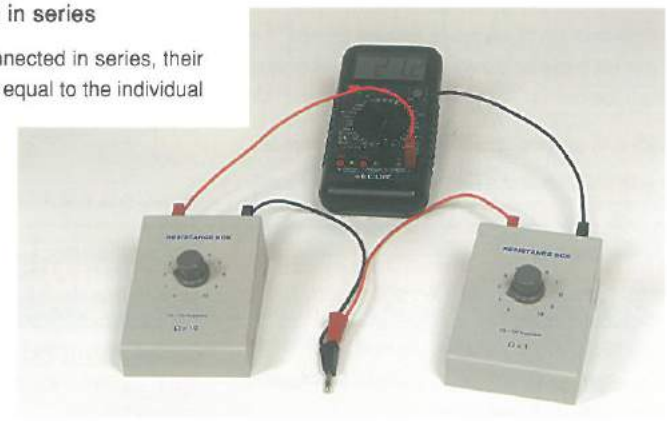
Using Ohm's Law, we can look at how a circuit differs as to whether it is in series or parallel.

Resistors connected in series

When resistors are connected in series, their combined resistance is equal to the individual resistances added together.

$$R_{eq} = R_1 + R_2$$

R_{eq} *in series.*



Resistance boxes in series.

Resistors connected in parallel

Resistance boxes in parallel.

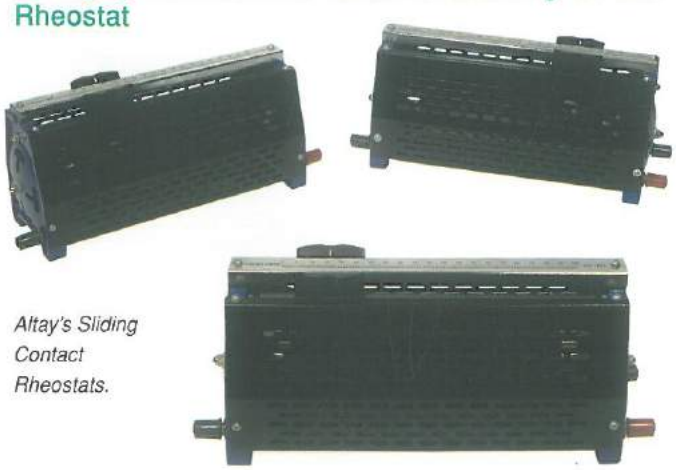
When resistors are connected in parallel, their combined resistance is less than any of the individual resistances. There is a special equation for the combined resistance of two resistors R_1 and R_2.

$$R_{eq} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$$ R_{eq} *in parallel.*

Sliding Contact Rheostat

4694.11 - 61

Changing the resistance value with a Sliding Contact Rheostat



Altay's Sliding Contact Rheostats.

Specifications

Size: 30 x 10 x 15 cm – Weight: approx. 2.5 kg
Sliding Contact Rheostat, 2.9 Ω, max 9 A (code 4694.11)
Sliding Contact Rheostat, 10 Ω, max 5 A (code 4694.21)
Sliding Contact Rheostat, 50 Ω, max 2.2 A (code 4694.31)
Sliding Contact Rheostat, 120 Ω, max 1.4 A (code 4694.41)
Sliding Contact Rheostat, 300 Ω, max 0.9 A (code 4694.51)
Sliding Contact Rheostat, 1400 Ω, max 0.4 A (code 4694.61)

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.

Main components

- Wire input on a ceramic tube
- Oxidised wire to give a perfect insulation • Graduated cursor scale
- Three sockets for connection for a fixed resistance, variable resistance, or a potentiometer

Laws and principles investigated

- Variable resistance

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.

Rheostat used as a fixed resistance.

Connecting the black and red plugs to the circuit, the rheostat works as a variable resistance.

Rheostat used as a variable resistance.

With a more complex circuit schema is possible to realise a potentiometer.

Rheostat used as a potentiometer.

Potentiometer Bridge

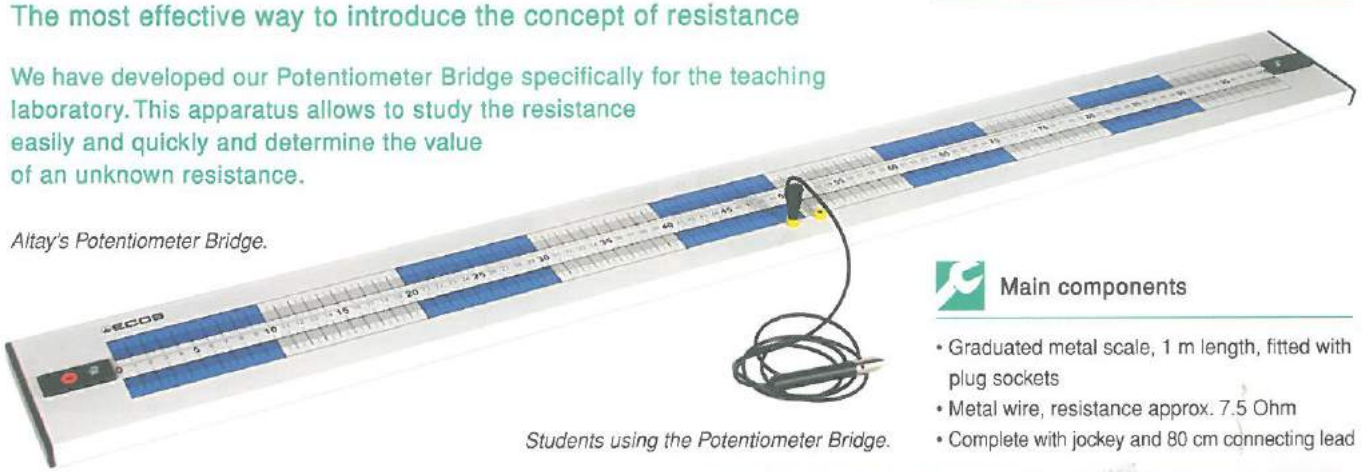
4697.00

The most effective way to introduce the concept of resistance

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.

Specifications

Size: 110 x 12 x 3 cm – Weight: approx. 1.6 kg



Altay's Potentiometer Bridge.

Students using the Potentiometer Bridge.

Main components

- Graduated metal scale, 1 m length, fitted with plug sockets
- Metal wire, resistance approx. 7.5 Ohm
- Complete with jockey and 80 cm connecting lead

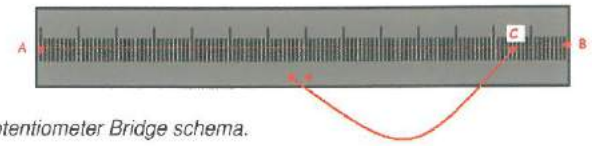
Laws and principles investigated

- Resistance dependence from geometrical quantities

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.

Demonstration Transformer

4729.00

Demonstration of the voltage transformation in an alternate current

Demonstration Transformer components.

Specifications

Size: 20 x 15 x 20 cm – Weight: approx. 10 kg – Power output: 2 A max.

Equipment needed

Digital Multimeter (code 2275.10)

With our Demonstration Transformer, students will learn how to change the voltage of an alternate current at a certain frequency to a different value.
Ideal for use in many experiments such as plotting a hysteresis of a ferro-magnet.

Main components

- Laminated iron U-core, with locking system • Laminated iron base
- Main coil, 2400 turns • Interchangeable secondary coil, 65 turns
- Interchangeable secondary coil, 130 turns • Plastic base with coil support

Laws and principles investigated

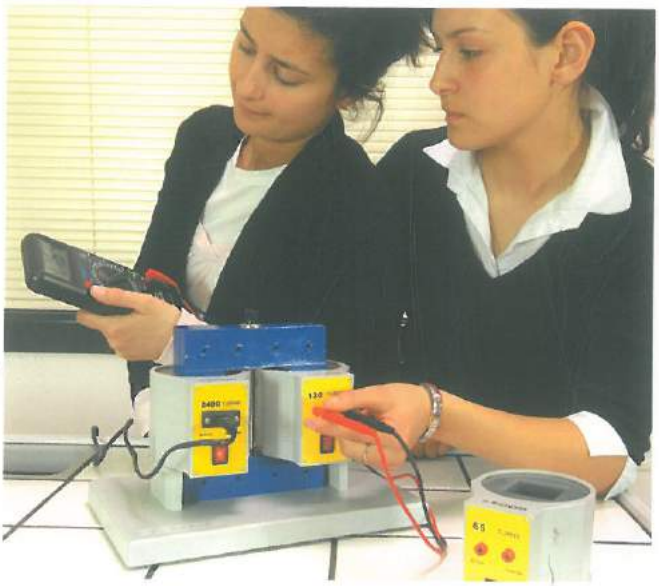
- Voltage transformation • Current transformation
- Resistance in an ideal transformer • Magnetic hysteresis

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.

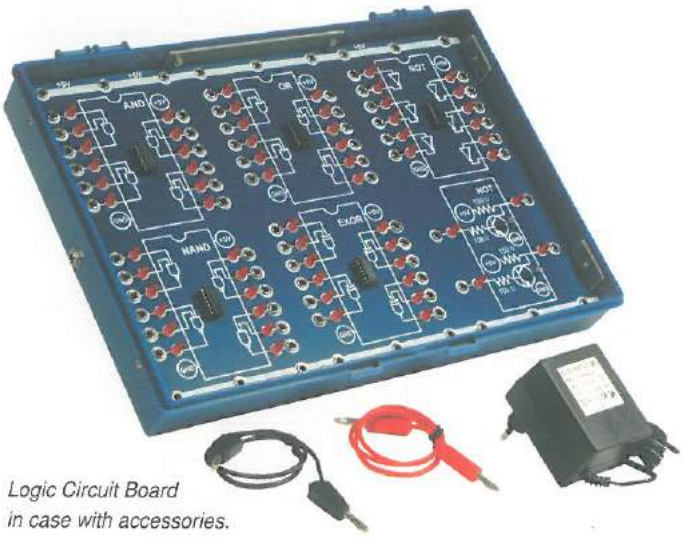


Students realizing a voltage transformation.

Logic Circuit Board

4781.00

Easy to use digital circuits project and testing board



Logic Circuit Board in case with accessories.

Specifications

Size: 35 x 25 x 6 cm – Weight: approx. 1.2 kg
Packing: plastic case with transparent cover

Equipment needed

Digital Multimeter (code 2275.10)

The Logic Circuit Board is a complete solution for the study of logic gates.
A logic gate is an arrangement of controlled switches used to calculate operations using Boolean logic in digital circuits. The board features AND, NAND, OR, EXOR and two different types of NOT gates.
The kit is supplied in sturdy plastic storage case with power supply and connection cables.

Main components

- Four AND Gates • Four OR Gates • Four NAND Gates
- Four EXOR Gates • Six NOT Gates • Two NOT Gates NPN-Si Type
- High Level (5 V) line power • Low Level (0 V) line ground • Power supply
- Connecting leads

Laws and principles investigated

• Logic gates • Truth table • Boolean algebra

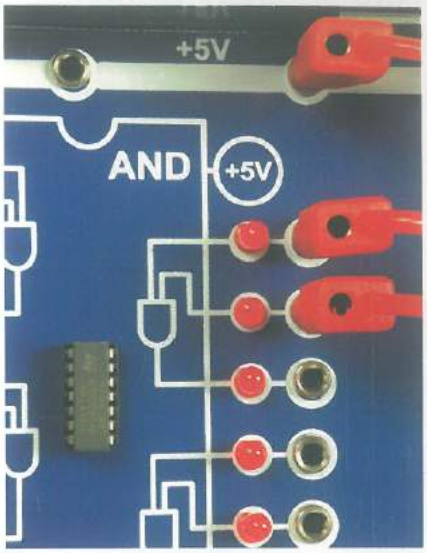
Boolean algebra · How to realise logic circuits in a easy way

The three types logic gates are the AND, OR and NOT gates. Using the array of gates, we can demonstrate any boolean equation.
The kit also includes NAND, NOR, XOR and XNOR gates for convenience.

A	B	A AND B
1	1	1
1	0	0
0	1	0
0	0	0

Truth table of the AND gate.

The board is an ideal base to demonstrate and introduce students to truth tables.
After compiling the truth table, students can then verify the result on the Altay Logic Circuit Board.

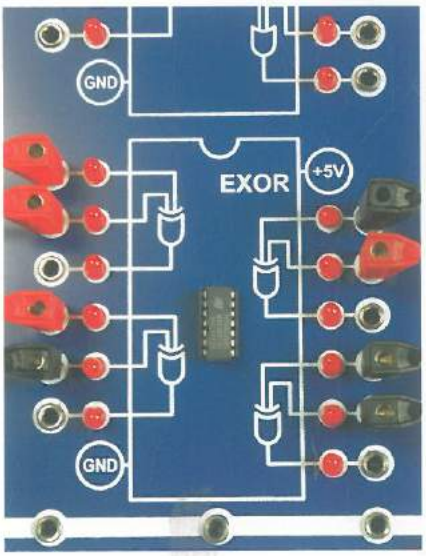


Demonstration shows how an AND gate goes high when the inputs are both high.

A	B	A EXOR B
1	1	0
1	0	1
0	1	1
0	0	0

Truth table of the EXOR Gate.

The EXOR gate (for 'EXclusive OR' gate) is a logic gate that gives an output of '1' when only one of its inputs is '1'. It is one of the most difficult for students to understand.
With the Altay Logic Circuit Board, it is made easy!



A Truth table of the EXOR Gate explained on the Altay Logic Circuit Board.

Students can easily verify a Truth Table for a high and low level input to the EXOR gate.

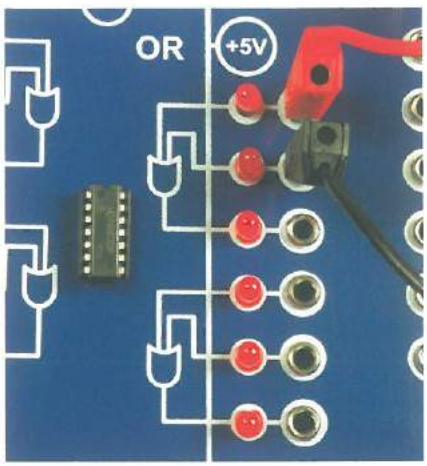
The Altay Logic Board has many inputs for high and low values; all the gates can be used in series or parallel to mount more complex circuits. This feature allows students to test particular boolean equations such as De Morgan's Laws. By using De Morgan's Theorem, an AND gate can be turned into an OR gate by inverting the sense of the logic at its inputs and outputs

De Morgan's Laws (in Boolean formal logic notation).

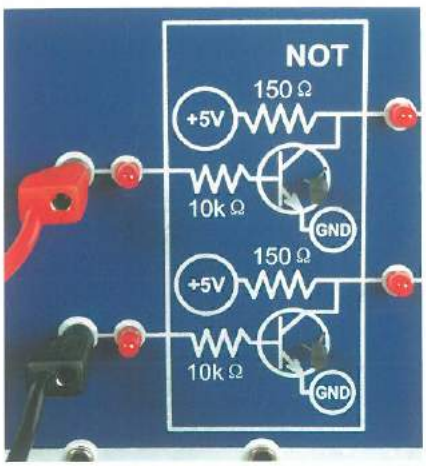
$$\neg(P \wedge Q) = (\neg P) \vee (\neg Q)$$

$$\neg(P \vee Q) = (\neg P) \wedge (\neg Q)$$

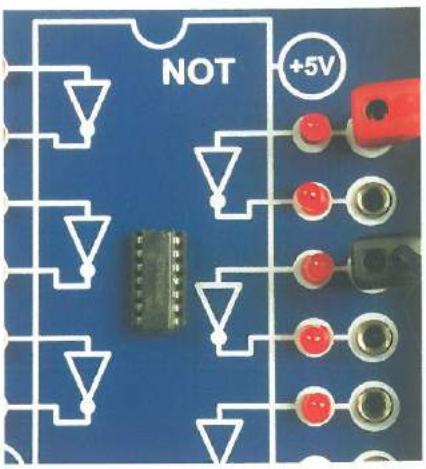
Other examples of gates using the Altay Logic Board



The OR Gate is high if one input is high and the other is low.



NOT Gate (NPN-Si Type).



NOT Gate (integrated type).

Radioactivity Bench

4832.00

An easy to set up apparatus for radioactivity experiments

Altay's Radioactivity Bench.

Specifications

Radioactivity Bench: 35 cm length
Geiger Müller Counter: size 20 x 12 x 7 cm

With our Radioactivity Bench it is easy to measure the number of radioactive particles emitted by alfa, beta and gamma sources.
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.

Main components

- Radioactivity Bench
- Alfa, beta and gamma sources
- Metallic screens of different material
- Particle detector • GM Counter
- Holders for radioactive sources and screens

Radioactivity Bench with holders for sources and screens.

Laws and principles investigated

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

Radioactive sources and metallic screens.

GM Counter with particle detector.

Radioactive sources and effect of metal screens

Determine radioactive decay of alfa, beta and gamma sources and verify the effect of metal screens to stop the radioactivity

With our Radioactivity Bench it is easy to measure the radioactive decay of the different sources supplied. By setting up the time interval to a specified value, it is easy to measure the radioactive activity in becqerel (Bq), the SI unit for measuring radioactive decay.

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 and numbers on the order of gigabecquerels are commonly seen.

With the different metal screens supplied, it is also possible to determine the effect of placing surfaces of different material, for example lead, between the radioactive source and the detector.
This way, it is possible to verify the behaviour of various radioactive source type in case of presence of different metal screen and understand the construction principles behind the bunkers.

Effect of lead screen.

Datalogger & Sensors

TEMA INTERNATIONAL

LabPro

2300.10

Get Started with Datalogging: Data Collection Technology

LabPro interface.

The Vernier LabPro offers data logging in a new level of affordability and flexibility.
The LabPro is very versatile as it can be used directly with a USB or Serial Port on your computer and has four digital and two analogue inputs.
LabPro can be used directly with a computer (using the award winning LoggerPro software)
or with a Texas Instruments graphing calculator, Palm OS® PDA*, or as a stand-alone data collector.
To collect data, simply connect the LabPro to your computer or hand-held device, plug in one of our sensors, and start the data-collection program. The program automatically detects which sensors are connected.
This datalogger has been classroom tested by hundreds of thousands of students around the world.

Compatibility

- Windows or Macintosh OS, serial or USB port, with Logger Pro software (sold separately)
- TI handhelds: TI-73, TI-82, TI-83, TI-83 Plus, TI-83 Plus Silver Edition, TI-84 Plus, TI-84 Plus Silver Edition, TI-86, TI-89, TI-92, TI-92 Plus, Voyage 200
- Palm® Handhelds: Palm T|X, Tungsten E2, T5, T3, C, W, T2, T, Zire 71, m515, m130, m125, m500, i705, and many legacy, Palm, and Visor handhelds
- Sony Handhelds: PEG-TJ25, TJ35, TJ27, TJ37
- Garmin® iQue™ 3600, 3200

Six data collection channels

- Four analogue channels for over 40 different sensors, for physics, chemistry, environmental science, mathematics, biology and physiology
- Two digital channels (DIG/SONIC 1, DIG/SONIC 2) for motion detectors, photogates, radiation monitors and rotary motion sensors
- Samples up to 50,000 readings per second • 12-bit A/D conversion
- Internally stores 12,000 data points
- Four analogue input channels (CH1÷CH4)
- Analogue Output, 1 channel (CH4), ±3 volts, 100 mA (with function generator)

Datalogger with motion detector used to acquire collision data with the Altay Mechanics Upgrade 1.

Easily and immediate field data acquisition to the computer.

Main components

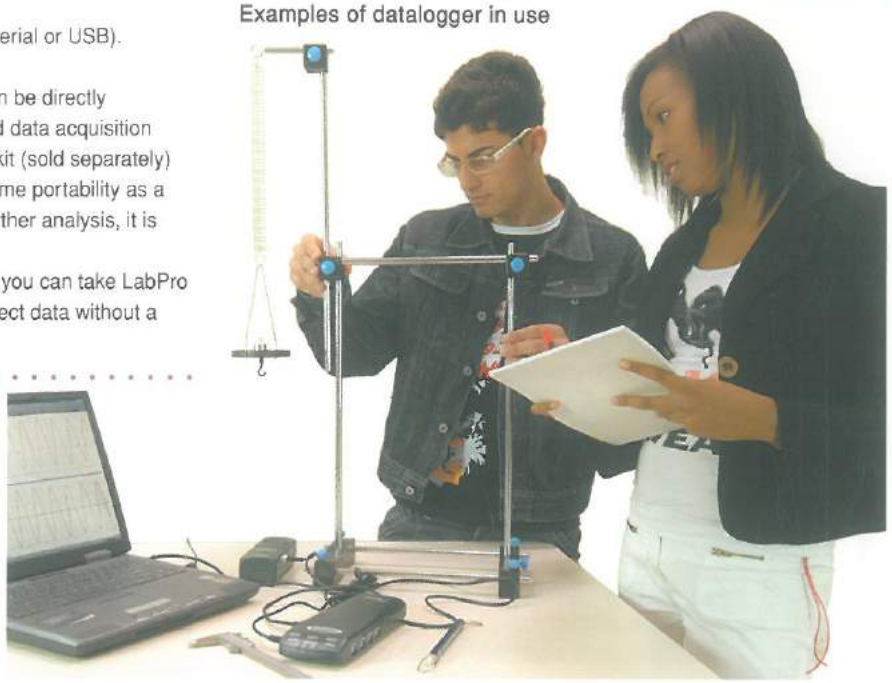
- LabPro Interface • Voltage Probe
- Computer cables (USB & serial)
- Calculator cradles
- DataMate calculator program
- Calculator link cable • User's manual
- AC power supply

Interfaces

The datalogger can be easily connected to:

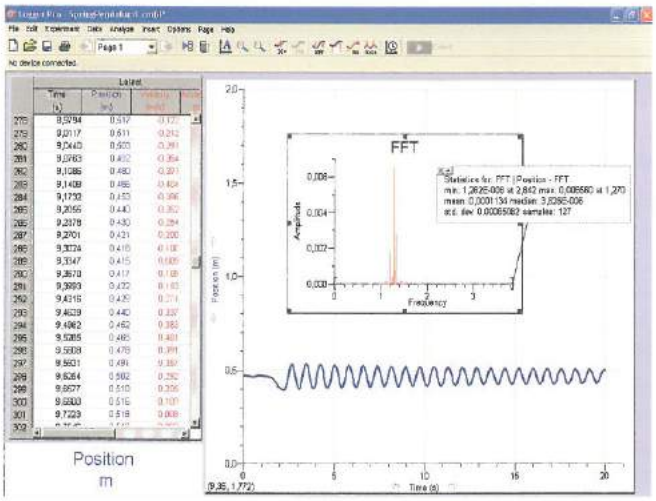
- Computers: Windows or Macintosh computers (serial or USB). Using the LabPro3 software (sold separately)
- Texas Instruments Handhelds: the datalogger can be directly connected to many TI graphic calculators for field data acquisition
- Palm® Handhelds: with the Palm data collection kit (sold separately) and a Palm Powered™ handheld, you get the same portability as a calculator on the highly popular Palm OS. For further analysis, it is always possible to uploading data to a computer
- As a Stand-Alone Data Logger: in remote mode, you can take LabPro to an amusement park or a local stream and collect data without a computer or handheld attached

Examples of datalogger in use



Mechanics experiments with datalogger.

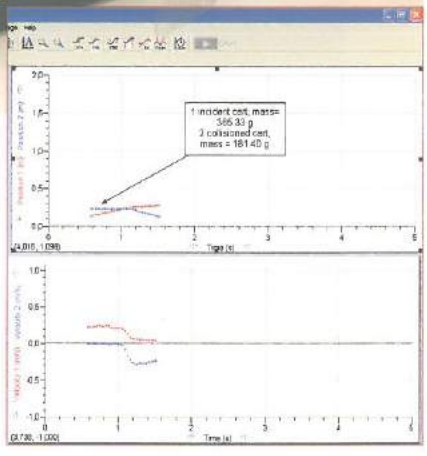
The Motion Sensor is ideal for most Kinematics Experiments. Using LoggerPro software and the Altay Mechanics System 1, we can use the powerful LoggerPro software to easily determine the elastic constant of a spring.
This is done by using the FFT (Fast Fourier Transform function in real time).



Spring pendulum experiment using LoggerPro data logging software.

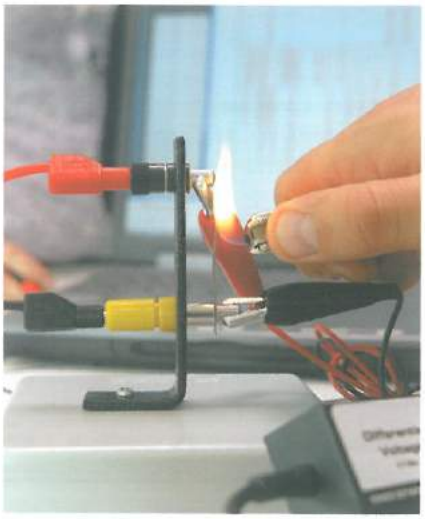
The Motion Sensor can be also used in collision experiments to acquire data of elastic and inelastic collisions in real time with incredible accuracy.

Investigating collisions using a datalogger.



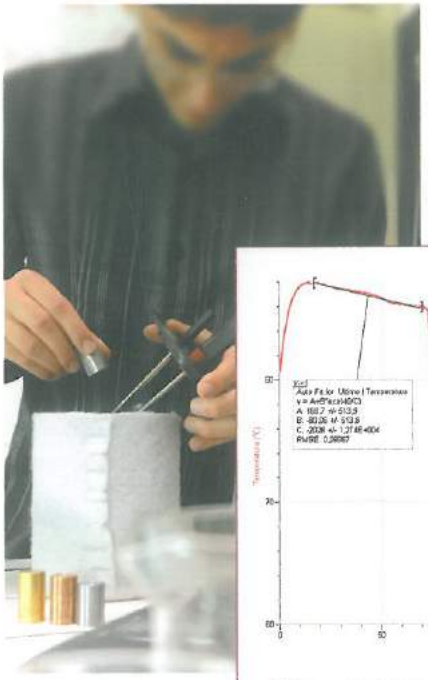
Collision graphs with the datalogger and motion sensors.

With the datalogger and software it is easy to study collision between carts. It is very easy to set up an experiment by combining two motion sensors to acquire position, velocity and acceleration data for two carts in real time. Using LoggerPro, it is possible to graph simultaneously the positions of the two carts and see what happens during the collision in real time.

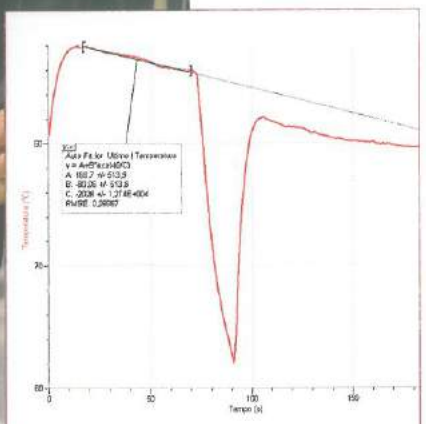


A Differential Voltage Sensor can be used together with the Bimetal Strip and a Stainless Steel Temperature Probe to determine the instantaneous temperature of the circuit when it opens.

Using the Bimetal Strip and the Differential Voltage Probe.



Calorimeter and Stainless Steel Temperature Probe.

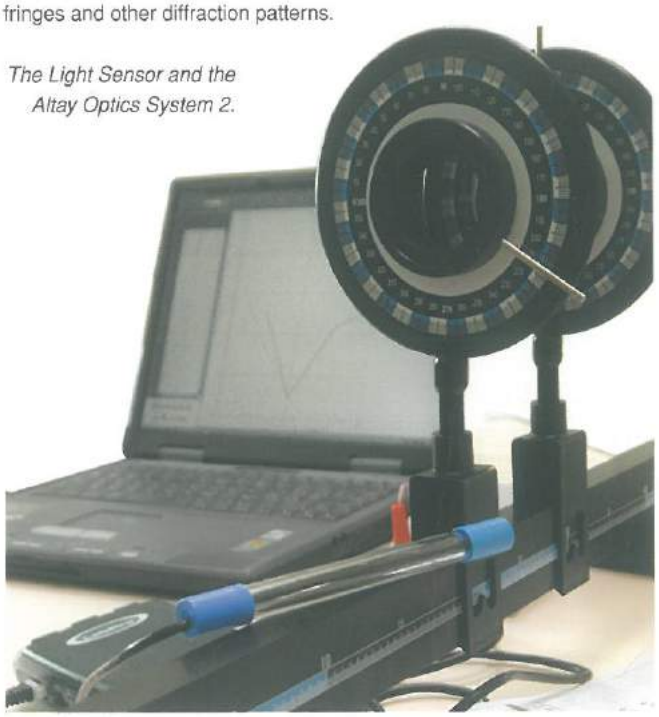


With a calorimeter and a temperature probe is easy to acquire data and determine the specific heat of materials.

Copper specific heat measurement.

The Light Sensor is ideal for use with the Altay Optics Systems 1 and 2 for accurate data on a very wide range of experiments.
Using a Light Sensor we can acquire extremely accurate interference fringes and other diffraction patterns.

The Light Sensor and the Altay Optics System 2.



Wireless Dynamics Sensor System

2300.20

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

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/s² (±5 g)
  Resolution 0.04 m/s²
- Altimeter: Altitude Change Range ±200 m – Resolution 1 m
- Force Sensor, custom load cell provides accurate, repeatable results
- Altimeter, record changes in altitude for roller-coaster physics
- 3-Axis Accelerometer, three orthogonally mounted sensors let you 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 Powered™ handhelds, manual entry, movies and more
- Easily export data and graphs from LoggerPro to Microsoft® Word documents or Excel spreadsheets. Students can even use the multiple page feature to write lab reports in LoggerPro
- LoggerPro will be your students' favourite graphing program. Our generous LoggerPro site license allows your students to continue working with lab data on their home computers
- LoggerPro includes over 1,000 experiment files

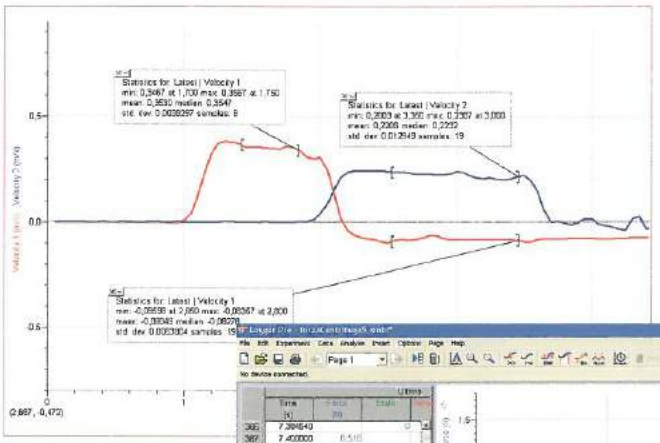
Specifications

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

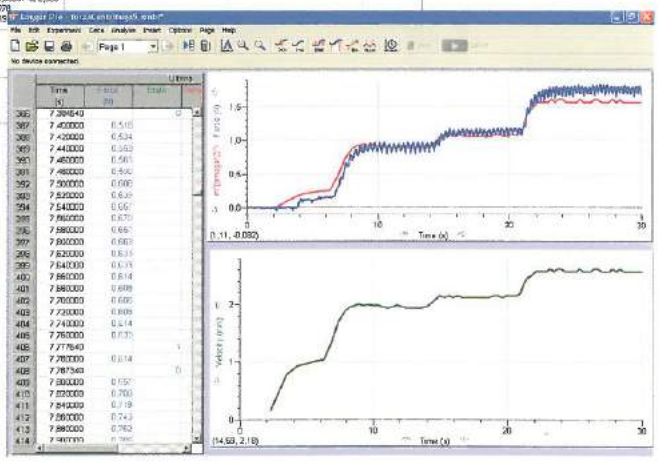
Analysis tools

- 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

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!



Elastic collision between two carts plotted in LoggerPro software.



Centrifugal forces apparatus data plotted in multiple graphs.

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).

Compatibility

- LabPro
- GolTemp • GolLink • GolMotion
- 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

Physics Data Logging Packages

2300.61 - 63

Three levels of data logging for different levels of study

We offer three levels of data logging bundles for physics.
All bundles are ideal for use with Altay apparati. We offer Starter, Standard and Deluxe Bundles aimed at different levels of study.

Combine the award winning Vernier software and the largest range of sensors in the world with our high quality and affordable physics apparatus.
The bundles include all you need to perform a wide variety of experiments.

Concepts such as velocity, acceleration, Newton's Laws, and momentum will be more clearly understood by your students using both data logging and physics apparatus.

Starter Bundle detail.

Starter Bundle (code 2300.61)

The ideal starter package for data logging in physics. The bundle consists of a LabPro Interface with a voltage sensor, motion detector, dual-range force sensor and microphone.

Main components

LabPro Interface	(code 2300.10)	Dual-Range Force Sensor	(code 2311.10)
Voltage Probe	(code 2313.30)	Microphone	(code 2313.60)
Motion Detector	(code 2310.10)		

Standard Bundle (code 2300.62)

Great companion for the study of Kinematics experiments including motion and momentum. Also included is a sound sensor for determination of sound wave experiments plus a light sensor for optics.
We also include the Low-g Accelerometer so that students can gain an understanding into g forces.

Main components

LabPro Interface	(code 2300.10)	Picket Fence	(code 2312.11)
Voltage Probe	(code 2313.30)	Light Sensor	(code 2315.10)
Motion Detector	(code 2310.10)	Low-g Accelerometer	(code 2311.21)
Dual-Range Force Sensor	(code 2311.10)	Vernier Photogate	(code 2312.10)
Microphone	(code 2313.60)	Ultra Pulley Attachment	(code 2312.12)

Deluxe Bundle (code 2300.63)

Our advanced bundle allows for over fifty different experiments in kinematics, optics, electricity, magnetism, thermodynamics and much more.

Main components

LabPro Interface	(code 2300.10)	Vernier Photogate	(code 2312.10)
Voltage Probe	(code 2313.30)	Ultra Pulley Attachment	(code 2312.12)
Motion Detector	(code 2310.10)	Magnetic Field Sensor	(code 2313.50)
Dual-Range Force Sensor	(code 2311.10)	Differential Voltage Probe	(code 2313.40)
Microphone	(code 2313.60)	Current Probe	(code 2313.20)
Picket Fence	(code 2312.11)	Stainless Steel	
Light Sensor	(code 2315.10)	Temperature Probe	(code 2314.20)
Low-g Accelerometer	(code 2311.21)		

Motion Detector

2310.10

The most versatile instrument for dynamics experiments

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.

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

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/s²
Typical Accuracy: ±1 m/s²
Also available:
Low-g Accelerometer (code 2311.21)
Range: -50 ÷ +50 m/s²
Typical Accuracy: ±0.1 m/s²

Barometer

2311.30

Ideal for use it for environmental monitoring

The Barometer can be used for barometric pressure in weather studies or for lab experiments involving pressures close to normal air pressure.

Specifications

Ranges: 25.0 ÷ 31.5 in. Hg, 0.80 ÷ 1.05 atm, 81 ÷ 106 kPa, 608 ÷ 798 mm Hg
12-bit Resolution
(LabPro, Go!Link): 0.003 in. Hg
10-bit Resolution
(CBL, CBL 2): 0.01 in. Hg

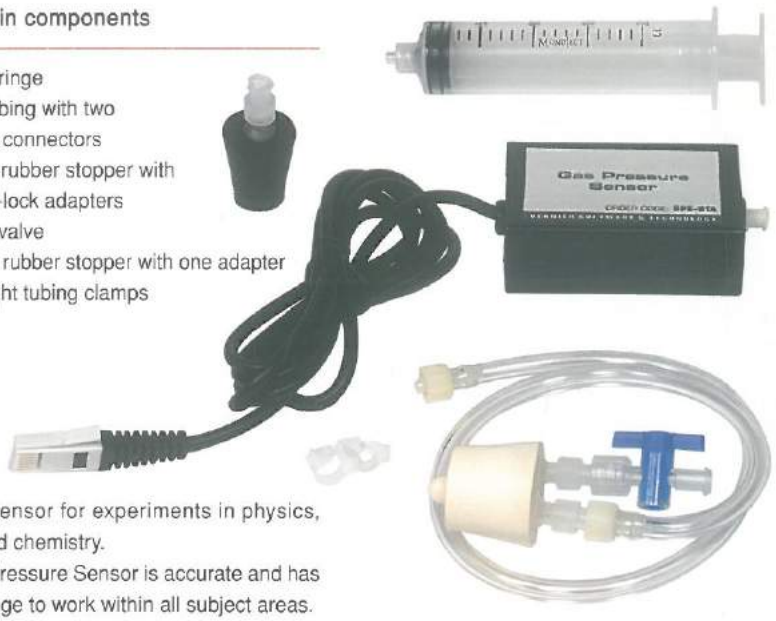
Gas Pressure Sensor

2311.40

A complete kit for your pressure-temperature experiments

Main 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



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)

Vernier 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

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

Current Probe

2313.20

A practical sensor for current measurements

Use the Current Probe to measure currents in low-voltage AC and DC circuits.
With a range of ±0.6 A, this probe is ideal for use in most battery and bulb circuits.
Use it with a voltage probe to explore Ohm's Law, phase relationships in reactive components and much more.
Use multiple sensors to explore series and parallel circuits.
Can also be used in electrochemistry experiments.

Specifications
Range: -0.6 ÷ +0.6 A

Voltage Probe

2313.30

A simple sensor for tension measurements

This Voltage Probe is included with each Vernier LabPro and TI CBL 2.
It can be used to measure the potential in direct-current or alternating current circuits. In chemistry, physical science or middle school science classes, the Voltage Probe can be used to measure voltages developed in a variety of electrochemical (voltaic) cells.

Specifications
Range: -10 ÷ +10 V
12-bit Resolution (LabPro): 0.005 V (5 mV)
10-bit Resolution (CBL, CBL 2): 0.020 V (20 mV)

Magnetic Field Sensor

2313.50

Ideal sensor for magnetic field measurements

Specifications
Low Sensitivity: -6.4 ÷ +6.4 mT
High Sensitivity: -0.32 ÷ +0.32 mT

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.

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.

Instrumentation Amplifier

2313.80

Sensor to amplify chart recorder and many other instruments

The Instrumentation Amplifier monitors voltages from 20 mV to 1 V (DC or AC).
It has several switch settings to allow you to select the best gain. It is typically used to amplify the chart recorder or analogue output of any instrument (such as a Gas Chromatograph).

Thermocouple

2314.10

Sensor for temperature measurements

This sensor uses type-K thermocouple wire to measure temperatures over the range of -200 to 1,400°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

Stainless Steel Temperature Probe

2314.20

Rugged sensor for temperature measurements

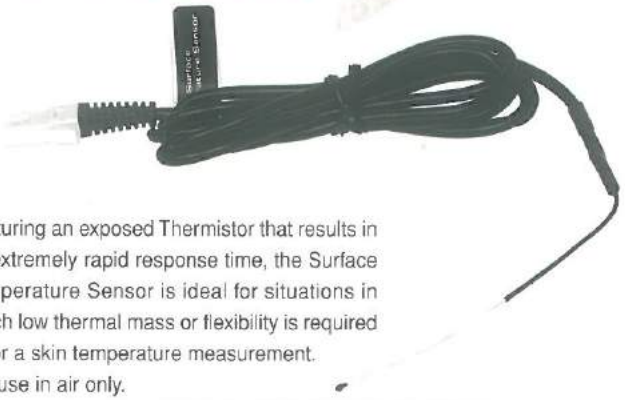
This rugged and durable temperature probe has a sealed stainless steel shaft and tip that can be used in organic liquids, salt solutions, acids and bases.

Specifications
Range: -40 ÷ 130°C
12-bit Resolution (LabPro, GoILink): 0.17°C (-40 ÷ 0°C), 0.03°C (0 ÷ 40°C), 0.1°C (40 ÷ 100°C), 0.25°C (100 ÷ 135°C)
10-bit Resolution (CBL, CBL 2): 0.68°C (-40 ÷ 0°C), 0.12°C (0 ÷ 40°C), 0.4°C (40 ÷ 100°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, GoILink): 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).

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, GoILink): 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, GoILink): 0.3 mW/m2
10-bit Resolution (CBL, CBL 2): 1 mW/m2

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

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.

Go!Motion

2320.10

Easy to use and can connect direct to a USB port

Go!Motion is the next-generation motion detector from Vernier. Go!Motion connects directly to a computer's USB port, eliminating the need for a data-collection interface.
Go!Motion comes bundled with free LoggerLite software, which supports data collection on Windows or Macintosh computers.

- Teach important concepts in physics and physical science, such as position, velocity and acceleration
- Engage your students with hands-on activities
- Study the motion of a ball tossed in the air or a cart on a ramp
- Study the motion of a student walking, a toy car and much more... without an additional interface!

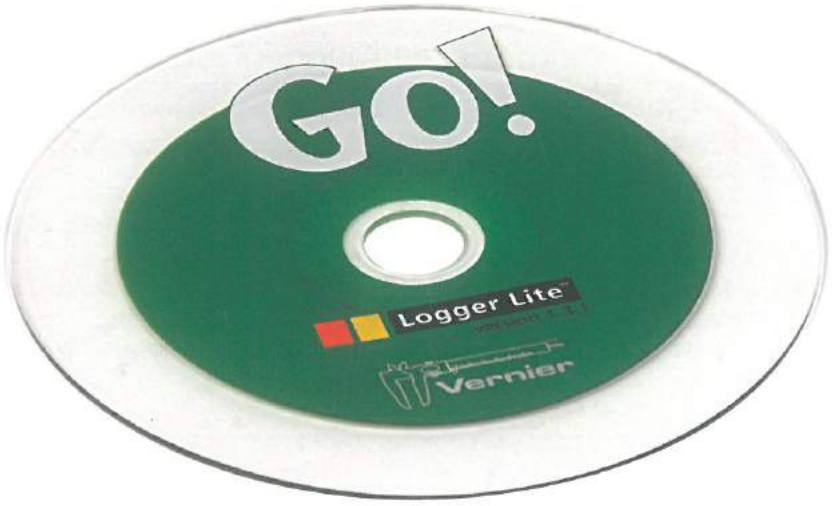
Specifications
Sensitivity switch lets you customise settings to your experiment – Objects can be as close as 15 cm and as far away as 6 m

Go!Temp

2320.20

USB temperature sensor

Go!Temp plugs directly into the USB port of your Windows or Macintosh computer's USB port without the need for an additional interface.
This rugged, stainless-steel temperature probe will engage your students in hands-on science as they explore temperature investigations. Collect temperature data on your computer with our award-winning USB temperature sensor!



Logger Lite software, included in Go! sensors for a quick datalogging.

Go!Link

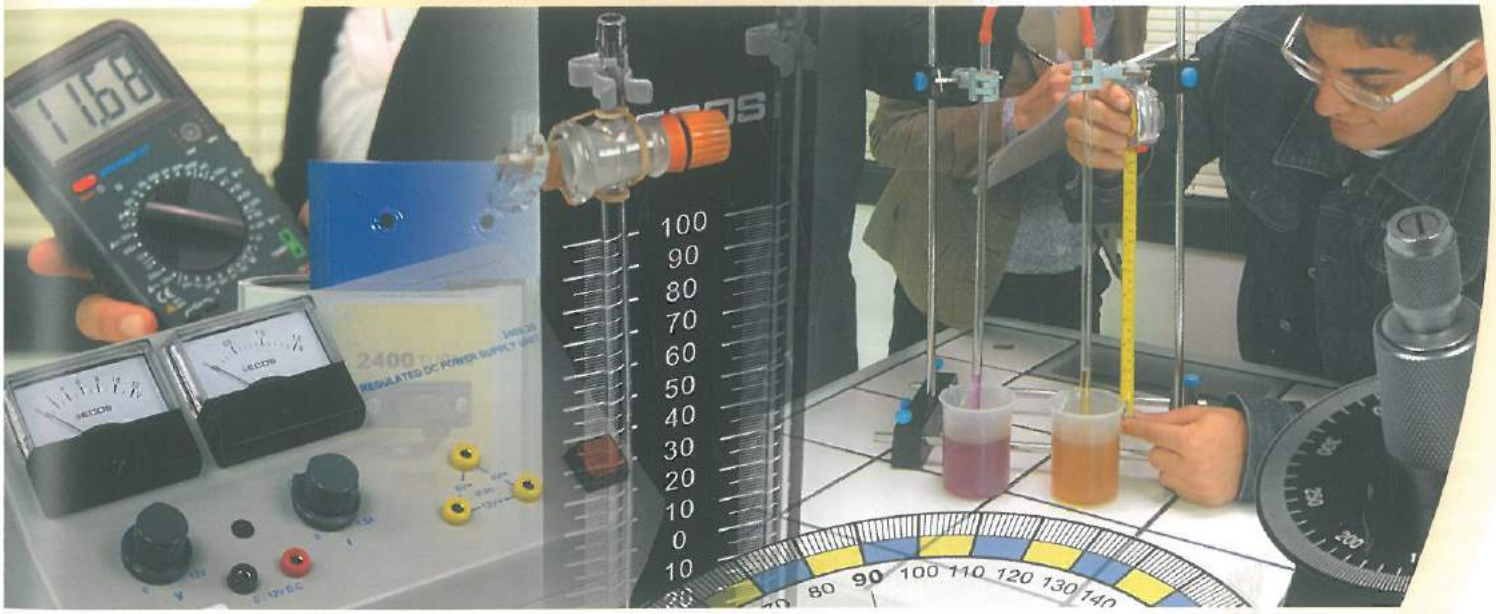
2320.30

Easy to connect and collect data

A quick and affordable way to get started with data-collection technology.
This single-channel USB interface is used by students to perform their own engineering experiments on or off campus. Students can use a Go!Link instead of a textbook for their course on sensors and data acquisition. Use our LabVIEW drivers or LoggerPro software for data collection and analysis. Sensors can be automatically recognized and calibrations automatically loaded. Dozens of experiments from our popular lab books may be conducted using Go!Link.
Connect any one of the sensors to your computer and collect data such as light, pH, and more!

Specifications
Single-channel interface connects any one of 42 Vernier sensors to your Windows or Macintosh computer USB port

Physics Accessories



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. The code refers to the category.

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

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 ÷ 160 mm – Sensitivity: 0.05 mm

Micrometer Dial Gauge

2214.00

Length comparator

The Micrometer Dial Gauge allows precise measurements 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

Vernier Caliper

2213.10

The original accurate measuring tool!

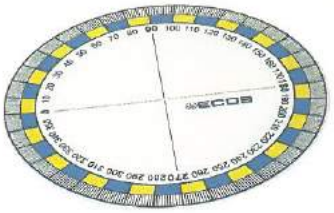
The Vernier Caliper is an extremely precise measuring instrument; the reading error is 0.05 mm.
The Vernier Caliper is easy to use and is very similar to a slide rule. You simply move the sliding scale against the fixed and as the graduations match up and align, this is your reading!

Specifications
Range: 0 ÷ 160 mm – Sensitivity: 0.05 mm

Goniometric Circle

2216.10

Angle measurement instrument



ECOS Goniometric Circle is an useful device for measure angles. The yellow - blue scale facilitates the measure. For example, this instrument is used in Mechanics System 1 for the parallelogram of forces experiment.

Specifications
Range: 0 ÷ 360° – Sensitivity: 1°

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

Ohaus Dial-O-Gram® Balance

2218.00

Mechanical balance

Features include:
- Two graduated, notched beams with centre indicating sliding poise
- Undivided tare beam with sliding poise
- Magnetic damping
- Zero adjust compensator equipped for specific gravity weighing – 1/2" hole in base for lab rod, provision for suspending sample below platform
- Die cast aluminium box and beam.

Ideal for school laboratories, the convenience and speed of a direct reading dial calibrated 10 g x 0.1 g, makes this balance one of the most popular in schools worldwide.
The Dial-O-Gram® Balance provides the convenience of a top loading balance with the durability and versatility to accommodate a range of lab applications. All models have a tare beam to allow containers up to 225 g to be weighed accurately. The Dial-O-Gram® Balance combines the versatility of even arm balance and the speed and convenience of a dial reading of up to 100 g.

Specifications
Capacity: with optional attachment weight set, 2,610 g; without, 610 g – Sensitivity: 0.1 g
Graduations: centre beam 500 g x 100 g; rear beam 100 g x 10 g; dial 10 g x 0.1 g – Tare: 225 g

Ohaus Cent-O-Gram® Balance

2218.10

All day use mechanical balance

The Ohaus Cent-O-Gram® Balance is a favorite in classrooms and industries worldwide.
The Cent-O-Gram® Balance offers high precision and remarkable value. The three-point base, special floating bearing principle and beam design eliminates the need for level adjustment. Zeroing is quickly achieved by means of a zero adjust knob at the end of the beam. With aluminum pressure castings for the base and beam assembly, agate bearings, steel knife-edges, and stainless steel pan, everything about the Cent-O-Gram® Balance ensures a high standard of quality.

Specifications
Capacity: 311 g – Sensitivity: 0.01 g
Graduations: front beam 1 g x 0.01 g; second beam 10 g x 1 g; third beam 100 g x 10 g; rear beam 200 g x 100 g

Electronic Balance

2219.10

Economical, frequent use balance

An electronic balance is always necessary in a laboratory. This balance includes tare facility and automatic switch-off after five minutes of non-use in battery mode.

Specifications
Capacity: 2 kg – Sensitivity: 2 g

Ohaus Triple Beam Balance

2218.20

Classical mechanical balance

Whether you're weighing solids, liquids, powders or even animals, an Ohaus Triple Beam balance is well-equipped to handle the job.
This series provides the convenience of a top loading balance with the durability and versatility to accommodate a range of lab applications. The Triple Beam Balance Series is known world wide for its durability and versatility to accommodate a range of lab applications.
Main characteristics are: removable stainless steel pan, three notched and tiered beams with centre reading and spring loaded zero adjust compensator.

Specifications
Capacity: with optional attachment weight set, 2,610 g; without 610 g – Sensitivity: 0.1 g
Graduations: front beam 10 g x 0.1 g; second beam 500 g x 100 g; rear beam 100 g x 10 g
Platform size: 6 x 0.8 cm (dia. x depth)

Sensitive Electronic Balance

2219.51

Higher accuracy balance

A high quality electronic balance for school laboratory usage.
Simple to use and calibrate, simply apply the desired calibrated weight to the balance, tare to zero by pressing the TARE-key and start taking the measures you need.

Specifications
Capacity: 400 g – Sensitivity: 0.1 g

Also available:
Capacity 200 g, sensitivity 0.01 g (code 2219.50)
Capacity 1 kg, sensitivity 0.1 g (code 2219.52)

Ohaus Scout® Pro Balance

2219.60

Top quality balance

Accurate and immediate weight measures in laboratory, industrial or education applications, the Ohaus Scout Pro continues the tradition set by the Ohaus Scout and Scout II products.
Featuring easy-to-use two-button operation, a high-contrast LCD display, multiple weighing units, four application modes, and the option of either RS232 or USB connectivity, the Scout Pro is the high quality portable balance for daily use.

Specifications
Capacity: 200 g – Sensitivity: 0.01 g

Also available:
Capacity 400 g – Sensitivity 0.01 g (code 2219.61)
Capacity 400 g – Sensitivity 0.1 g (code 2219.62)
Capacity 600 g – Sensitivity 0.1 g (code 2219.63)
Capacity 2 kg – Sensitivity 0.1 g (code 2219.64)
Capacity 4 kg – Sensitivity 0.1 g (code 2219.65)
Capacity 6 kg – Sensitivity 0.1 g (code 2219.66)

Hydrostatic Balance

2220.42

Laboratory school balance

A Hydrostatic Balance is a balance for weighing substances in water. This balance allows us to determine the specific gravities of any substance.
The Hydrostatic Balance is supplied with two types of pans, one to hold masses and another for hanging materials in water.
A beaker and a full set of masses is also supplied.

Precision Mass Set

2220.60

Precision Mass Sets

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)

U-Tube Manometer

2242.20

A manometer made from a glass U-tube, with a valve attached to a metric scale plate mounted on a secure base.
The measured pressure is applied to one side of the tube whilst the reference pressure (which may be atmospheric) is applied to the other.
The difference in liquid level represents the applied pressure.

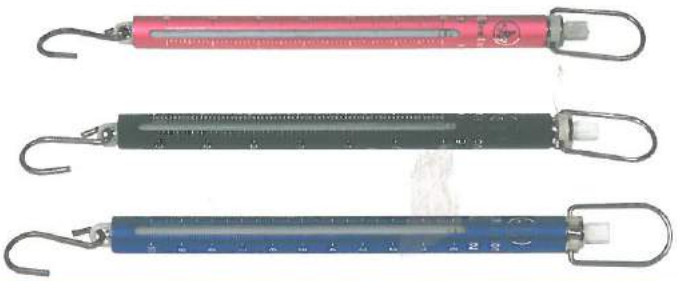
Specifications
Range: 0 ÷ 100 mm – Sensitivity: 1 mm
Available also without valve (code 2242.10)

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) – Range: 3 N (code 4110.03) – Range: 6 N (code 4110.05) – Range: 10 N (code 4110.07)
For additional ranges, please contact our sales department

Tubular Spring Balances (Plastic)

4110.20 - 24

Dynamometer

A range of spring balances constructed with high quality and attractive clear plastic case, with load hook and suspension ring.
Each balance is dual scaled in Newtons and grams, with zero adjustment and protection against over load.
Available in different ranges and colour coded for convenience.

Specifications
Range: 1 N (code 4110.20) – Range: 2.5 N (code 4110.21) – Range: 5 N (code 4110.22) – Range: 10 N (code 4110.23) – Range: 20 N (code 4110.24)
For additional ranges, please contact our sales department

Stopwatch

2231.25

A simple to use, analogue stopwatch. The Hamilton stopwatch is useful in laboratory experiments.

Specifications
Range: 0 ÷ 60 min – Accuracy: 1 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

Digital Chronometer

2231.52

Handy to use LCD stopwatch with single memory function.

Specifications
Accuracy: 0.01 sec

Photogate

2232.52

Photogate to be used with the Electronic Digital Timer (code 2232.50).
(Comes with Varec magnet for an easy setup).

Reflection Photogate

2232.54

The Altay photogate is designed to be used with Altay Track for dynamics experiments.
It has a 6mm hole and pins to be fixed on track.
The photogate can be used with the Electronic Digital Timer (code 2232.50).

Electronic Digital Timer

2232.50

For dynamics experiments

Designed as a portable smart timer for kinematics experiments, the accuracy is crystal controlled giving 0.01% accuracy for timing experiments. Timer system can be used with up to two photo-gates, or additional inputs from a GM Tube, Time of Flight accessory, pulley systems and so on. The Timer is easy to set up and can measure speed and acceleration as well as time.

Specifications
- Two function modes: measurement of the time interval between two pulses (determination of average velocity) or the duration of a pulse (determination of instantaneous velocity)
- Two input gates • Three timing ranges: 1/10 s (up to 999.9 s), 1/100 s (up to 99.99 s), 1/1000 s (up to 9.999 s)
- Large (20 mm) four digit display with over range indicator • Automatic or manual reset feature
- Two start mode: chronometer and simultaneous electromagnet release or only electromagnet release
- Auxiliary 12 V DC power supply unit for use with release electromagnet • Input: 220 V, 50 - 60 Hz
- Dimensions: 20 x 12 x 7.5 cm

Large Display

2236.50

The Altay Large LED Display is very useful in classroom experiments. This four digit, 10 cm height display has good visibility even from the back of classroom.
Ready to use, with bases and suspension cord.
To be used with the Electronic Digital Timer (code 2232.50).

Specifications
Power Supply: AC Adaptor (supplied) – Connection cable (supplied) to connect Electronic Digital Timer (code 2232.50)

Electronic Oscillation Counter

2237.12

The Electronic Oscillation Counter can be used with the Electronic Digital Timer (code 2232.50). You can control oscillations for pendulum experiments, allowing you to easily measure the mean oscillation period of a pendulum.

Specifications
Range: 0 ÷ 100 periods – Manual stop function
Automatic stop function after: 1, 2, 5, 10, 20, 50, 100 oscillations – Power Supply: Digital Electronic Timer (code 2232.50)

Mounted Electric Meters

2264.00

A complete set of ammeters and voltmeters for every necessity in measuring electrical quantities on low voltage circuits (max 50 V). Based on a moving coil, this instrument allows an easy read of the measure value.
The ABS plastic boxes are of practical use in laboratory and the 4 mm sockets allow an easy mount to circuits with simple connection wires.
The code refers to the category, please contact our sales department.

Main ranges are 0 ÷ 1 A, 0 ÷ 1 V, 0 ÷ 5 A, 0 ÷ 5 V, 0 ÷ 15 A, 0 ÷ 15 V
Available all in AC and DC modes.

Specifications
Dimensions: 13.5 x 10 x 5.5 cm – Plugs: 4 mm sockets

Analogue Multimeter

2274.10

Analogue Multimeter, perfect for laboratory use.

Specifications
Ranges:
DC Volts: 0 ÷ 0,6 V, 3 V, 12 V, 60 V, 300 V, 1 kV, ±3%
AC Volts: 0 ÷ 12 V, 30 V, 120 V, 300 V, 1 kV, ±4%
Resistance: 0 ÷ 50 MΩ, ±3
Transistor check: NPN or PNP

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

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.

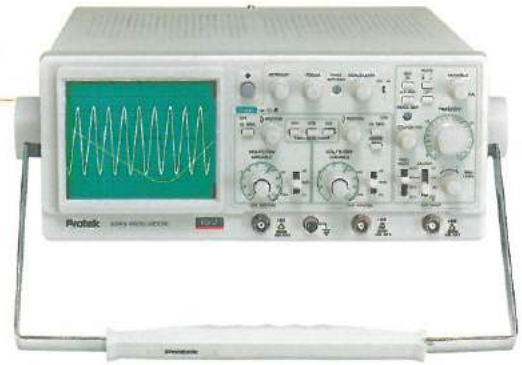
Specifications
Ranges: 20 mT, 200 mT, 2,000 mT

Oscilloscope

2280.70

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
- 20 Mhz max operating frequency
- Two Channels, Four Traces
- X5 Magnifier
- X-Y Operation

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

Mercury Thermometer

2240.10 - 50

Measure temperature (-10° to + 110° and over)

This thermometer consists of mercury in a glass tube.
Calibrated marks on the tube allow the temperature to be read by the length of the mercury within the tube, which varies directly with temperature.
All thermometers are supplied with a plastic case in many different ranges.

Specifications

Range: -10°C ÷ +50°C	Accuracy: 1°C	(code 2240.10)
Range: -10°C ÷ +110°C	Accuracy: 1°C	(code 2240.15)
Range: -10°C ÷ +150°C	Accuracy: 1°C	(code 2240.20)
Range: -10°C ÷ +250°C	Accuracy: 1°C	(code 2240.25)
Range: -10°C ÷ +420°C	Accuracy: 1°C	(code 2240.28)
Range: -10°C ÷ +50°C	Accuracy: 0.1°C	(code 2240.30)
Range: -10°C ÷ +110°C	Accuracy: 0.1°C	(code 2240.37)
Range: -5°C ÷ +5°C	Accuracy: 0.05°C	(code 2240.50)

For other types available, please call our sales department.

Maximum and Minimum Thermometer

2241.32

Ideal for study of outdoor temperatures over time

A simple thermometer for measuring temperatures of both maximum and minimum levels over a period of time. Mounted on a plastic base, with max/min indicators and a reset push button.

Specifications
Range: -40°C ÷ +50°C

Geiger Müller Counter

2236.00

A simple radiation measuring instrument

The ECOS 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
- Automatic stop after 10 and 60 sec intervals or manual stop
- x1, x2, x3, x4, x5 acquisition time multipliers

Hygrometer

2243.21

Ideal for measuring environmental humidity

A simple instrument to determine relative humidity.

Specifications
Range: 0 ÷ 100% – Sensitivity: 1%

Function Generator

2290.10

Advanced functions generator for circuit tests

Specifications
Input: 220 V, 50 Hz
Output: Frequency Range: 0.01 ÷ 10 Mhz
Amplitude Range: 10 Vpp 50 Ω
Output Impedance: 50 Ω ± 10%

Complete datasheet available on request

This Function Generator is a crucial part of any electronics lab for testing circuits.
This unit offers a complete solution in generating sine, triangle, square, ramp and pulse signals.

Features include: gate and trigger outputs, burst waveform outputs, sweep functions, VCG inputs, GCV functions, AM modulations, frequency counters and much more.

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

Transformer (12 V)

2403.14

AC Transformer for multiple applications

This general purpose 12 V AC Transformer is useful in many applications in schools, as supply unit for lamps, circuits and so on. Enclosed in a sturdy ABS box, it has 4 mm sockets for connections, an on-off switch and fuse for high current protection.

Specifications
Input: 220 V AC 50 Hz
Output: 12 V AC 2.5 A Max
Also available: Input: 110 V AC, 60 Hz (code 2403.24)

Multitap Transformer

2403.50

A general purpose laboratory transformer

This transformer is very useful in physics, electricity and electronics laboratories for multiple outputs at different voltages.

Specifications
Input: 220 V, 50 Hz
Outputs: 0, 4, 6, 9, 12 V AC
Current output 2 A Max
In plastic case, with on-off switch, 4mm output sockets, fuse and cables

Regulated 5 kV Power Supply Unit

2407.01

Designed for power supply to spectrum lamps

This power supply unit has been specially designed as a power source for spectrum lamps and discharge tubes.
It supplies high tension up to 5 kV, or even more if used in combination with a controlled AC-DC converter.
Both the LT and HT outputs are floating and the current from the HT output is limited to safe levels by the unit.

Specifications
Input: 220 V, 50 Hz – Output ranges: HT 0 ÷ 5 kV DC, 3 mA, continuously variable
LT 6 V AC, insulated from 5 kV – Electronic with 1 A fuse protection – Comes complete with high tension cables

Low Tension Power Supply Unit

2408.00

Low tension laboratory power supply unit

This unit supplies the voltages most commonly used in laboratories.
In the front panel you can find a current or tension regulator, 4 mm plugs for variable AC, DC and fixed AC outputs, voltmeter and ammeter for output current and tension measures.

Specifications
Input: 220 V, 50 Hz – Output ranges: 0 ÷ 30 V DC, 10 A, continuously adjustable
0 ÷ 22 V AC, 10 A, continuously adjustable
6 V, 5 A AC, fixed
Protection: Magnetothermic circuit breaker – 1.5 A fuse for variable outputs 6.3 A fuse for fixed outputs

Regulated DC Power Supply Unit

2409.20

Stabilised current and tension in labs

Specially designed for use in physics and electronics labs, this power supply unit has 1.5 A Max current stabilised output. Voltage and current are displayed on the two dial indicators.
The front panel contains outputs for circuits and electromagnets.

Specifications
DC Output: Range: 0 ÷ 12 V, 0 ÷ 1.5 A – AC Output: Range: 6 V, 12 V – 4 mm sockets outputs
Housed in box with on-off switch and fuse – Also available with large four digit LED display instead of analogue meters

Universal Retort Stand

5404.00

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.
Note: This item is available in different dimensions and materials.

Laboratory Jack

5406.30

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.
A large easy-grip adjustment knob allows for smooth and fast adjustment of the platform height.
The base is equipped with four anti-slip feet.
This item is available in aluminium, steel and stainless steel with different sizes, the code refers to the category.

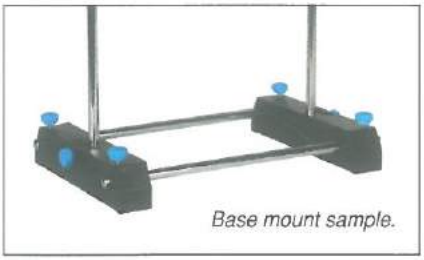
Universal Base

5405.70

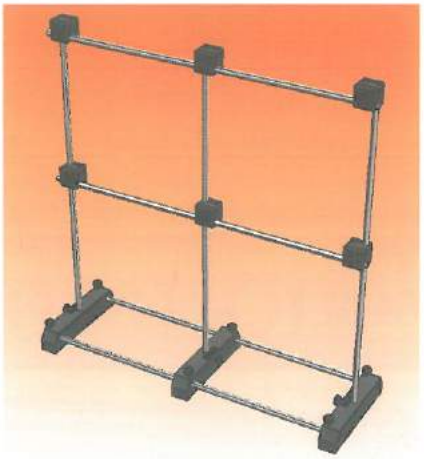
Universal base designed for a wide variety of uses

Single base.

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.



Base mount sample.



Example of universal bases mounted as a lattice.

Bench Clamp

5402.05

Baked-on enamel finished pressed steel, with two holes and a central knob-screw to secure rods up to 12 mm in diameter.
The clamp can also be mounted on benches.

G Clamp

5402.20

A series of robust iron frames of the highest quality are suitable for use as clamping bolts with adjustable clamps to suit different applications.
This item is available in different sizes and openings, for example: 50, 75, 100, 125, 150 and 200 mm. The code refers to the category.

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.

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.

Connecting Leads

2522.00

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. The code refers to the category.

Rods

5408.00

Different diameters, lengths, materials and types of supporting rods with rounded or threaded ends.

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.
This item is available in different diameters, lengths, materials and types, including rounded ends, threaded ends and with threaded holes. The code refers to the category.

Mercury

4207.55

Used with the U-Tube manometer for measuring pressure. Mercury is needed in many laboratory experiments.
WARNING: Handle with care and always secure container to avoid spills and evaporation. Mercury vapour is toxic, carry out experiments with adequate ventilation in order to avoid human exposure.

Specifications
Weight: 500 g

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 m^3/h
Pressure limit: 10 ÷ 30 Pa
Noise: ≤ 65 dB
Size: 27 x 11 x 22 cm
Weight: approx. 7.5 kg

Iron Filings

4612.12

Iron Filings are essential to every magnetic experiment.

Specifications
Weight: 300 g

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.

TEMA INTERNATIONAL

Jim Ohaus
New Business
Developer Manager

"TEMA brand stands for Innovation, Value and Customer Orientation."

TEMA INTERNATIONAL

Vernier International

TEMA International and Vernier International partner together to offer a complete range of high quality physics equipment along with innovative data gathering solutions.

WQC

ISO 9001
Certified Company
n° registered Q.01.330

TEMA INTERNATIONAL

featuring:
ECOS PHYSICS
by Altay Scientific