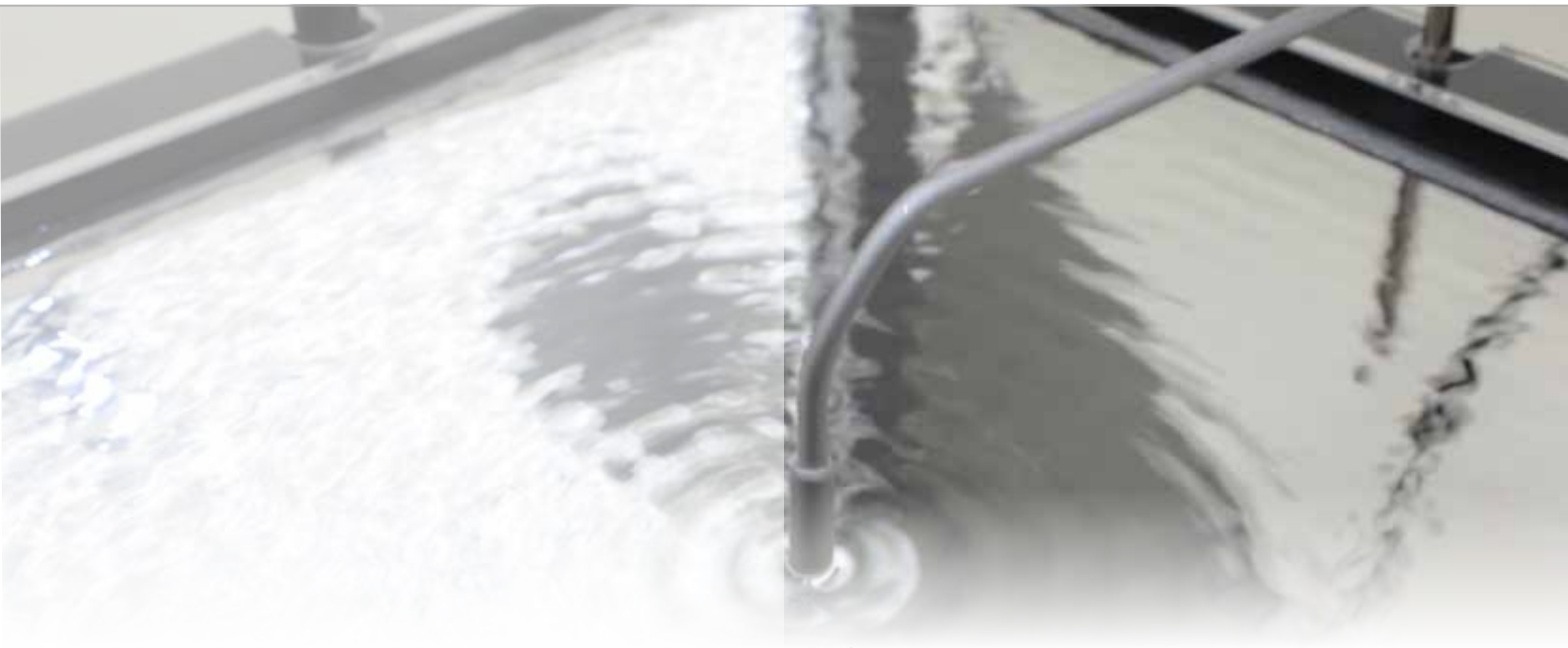
OPTIKA®
SCIENCE
ITALY

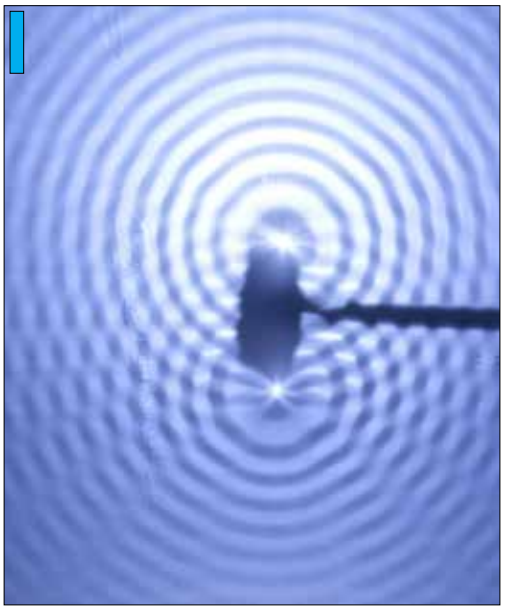


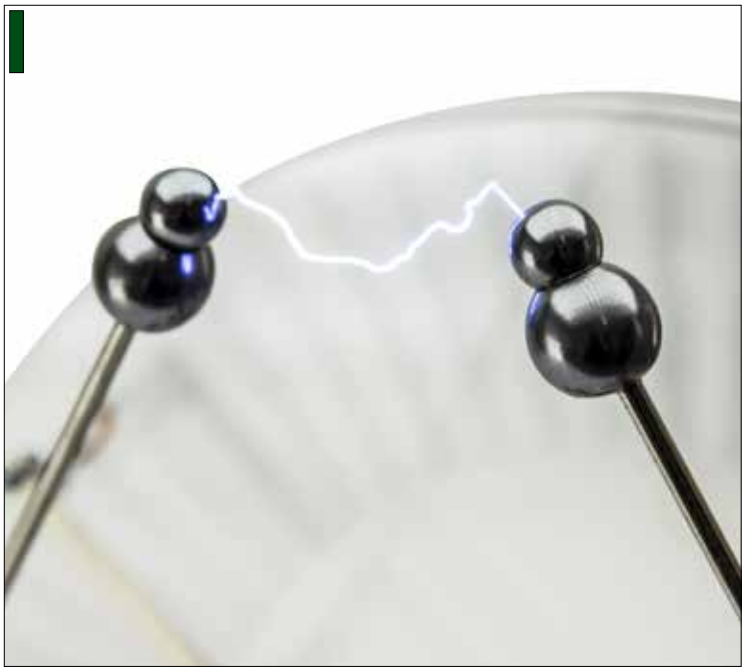
"I hear, I forget
I see, I remember
I do, I understand"

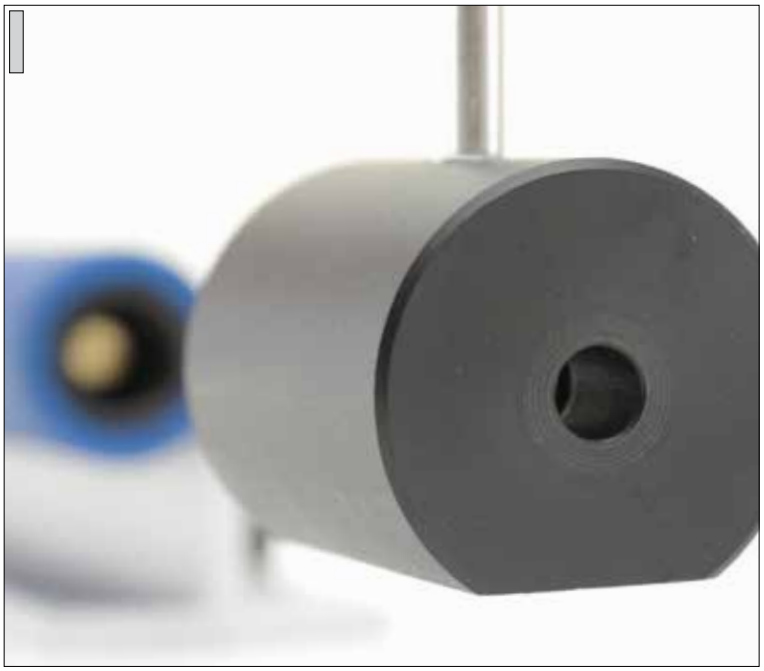
Physics and Science Education

Mechanics - Vacuum and gases - Waves - Heat - Optics
Electricity And Magnetism - Atomic Physics - Online Physics

Physics and Science Education







Topics

Warning

OPTIKA has been committed to design and manufacture products and solutions that meet demands of customers.
The company also takes constant efforts to develop new products and improve the old ones; for these reasons, specifications and appearance of the equipment shown in this catalogue are subject to change without any notice or obligation on the part of the manufacturer.
Contact our sales team if you have any questions about our products:
info@optikascience.com

OPTIKA®
ITALY

An Impressive History

1971

The company was founded by a physics teacher with great capabilities in combining design skills with teaching sensitivity.

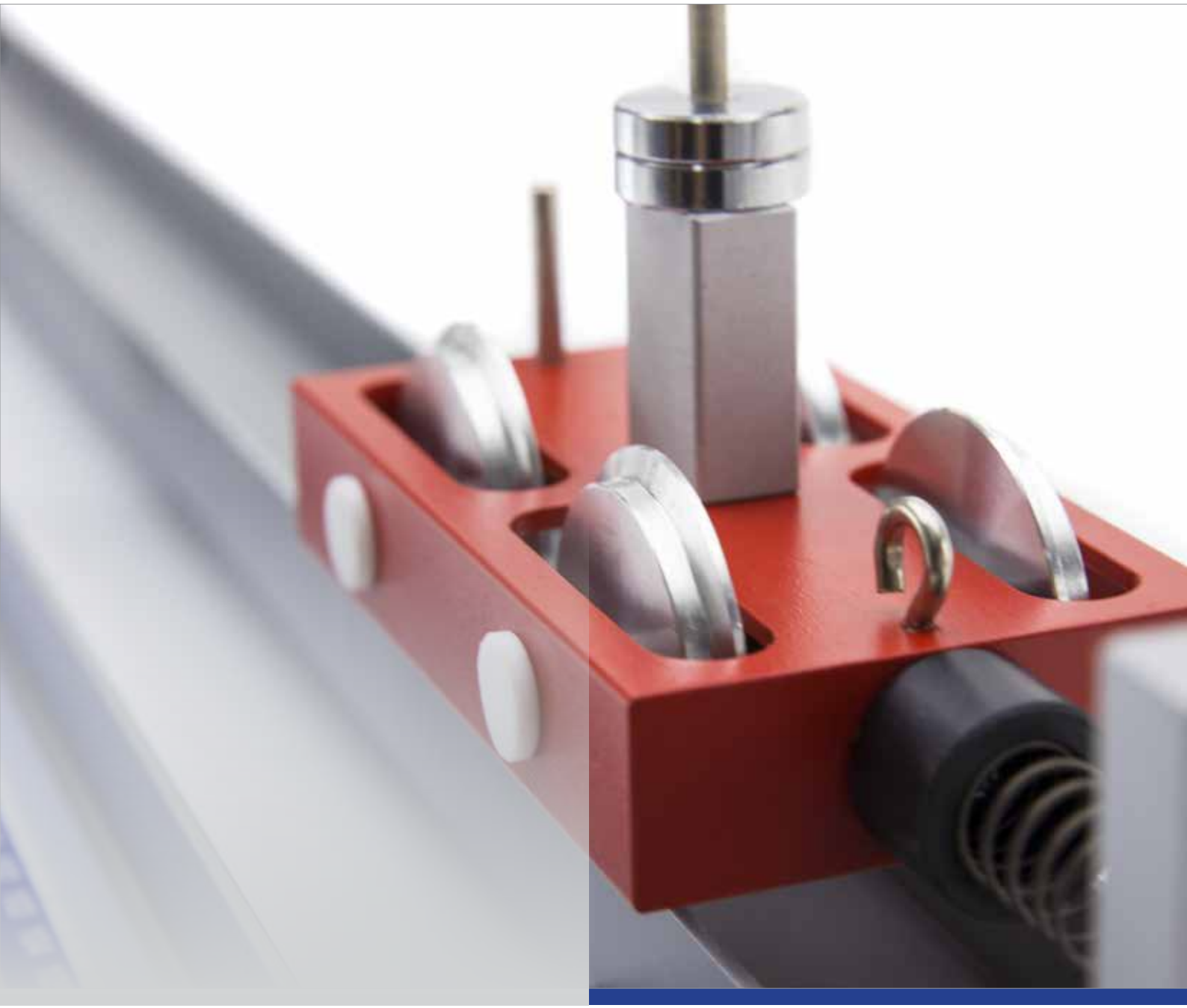
1990's

The second generation started to manufacture microscopes.The company is growing fast, passing from few employees to more than 60

Nowadays

OPTIKA is a leading manufacturer and supplier of scientific instruments for educational, laboratory, industrial and medical use.

Mechanics



"We cannot teach people anything; we can only help them discover it within themselves"

Galileo Galilei

A pulley is a wheel on an axle or shaft that is designed to support the movement and changes of direction of a taut cable or belt along its circumference; a lever is a machine consisting of a beam or rigid rod pivoted at a fixed hinge or fulcrum.

Equilibrium occurs when the resultant force acting on a point particle is zero (that is, the vector sum of all forces is zero). There are two kinds of equilibrium: static equilibrium and dynamic equilibrium.

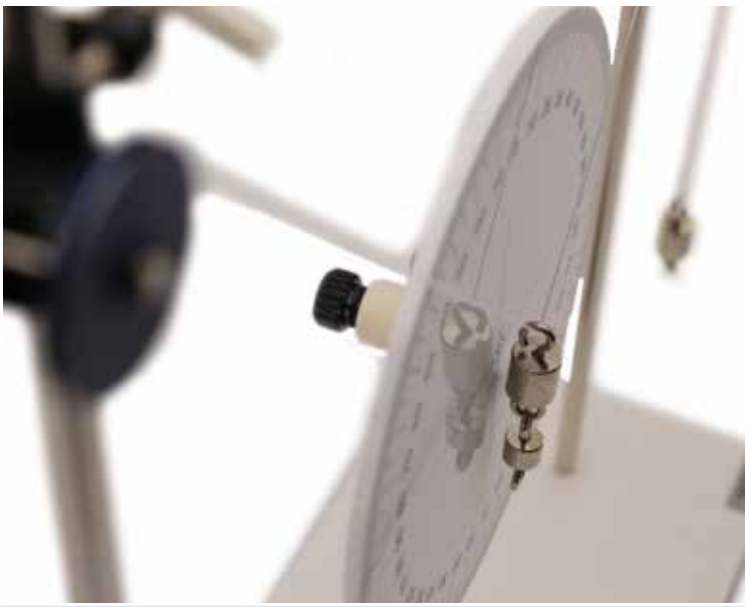
Device for the composition of forces

The device for the composition of forces allows the examination of the physical laws of concurrent forces composition – the parallelogram law and the parallel forces law.

■ **1032**

TOPICS

- *Parallel forces*
- *Opposite forces*
- *Forces composition*



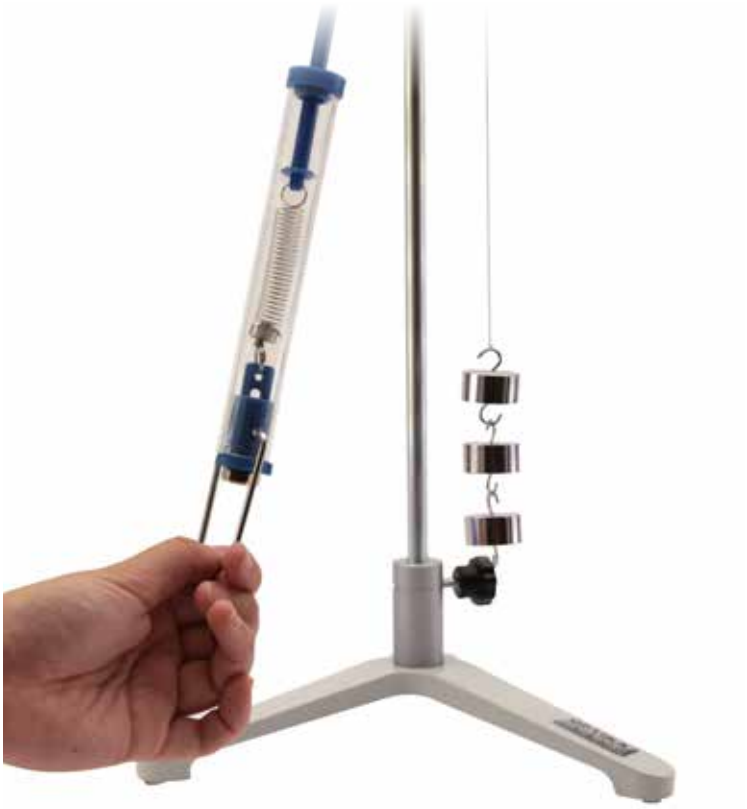
Levers and pulleys experiment kit

This kit provides the equipment needed to perform 12 experiments demonstrating the laws of equilibrium of forces and how levers and pulleys work.

■ **1341**

TOPICS

- *Spring scale: what it is and how it works*
- *Simple machines*
- *Levers and pulleys*



When a force is applied to a body which is not constrained, such body undergoes a translational motion. If the body is instead constrained around a pivot, any force F applied – whose straight line doesn't go through the pivot – causes a rotation of the body.

Rod for levers with stand

This device allows students to test the momenta equilibrium and thus to verify the working principle of levers.

■ **1354**

Momenta apparatus

This apparatus allows students to study the equilibrium of forces in rotational movements. It is composed of an aluminum disc rotating around a central pivot. Different weights can be hanged to the disc in different positions: if the sum of the clockwise momenta is equal to the sum of the anticlockwise momenta, the apparatus will be at rest.

■ **1167**

In physics, inclined plane means a particularly simple machine constituted by a flat surface arranged to form an angle greater than 0° and smaller than 90° with respect to the vertical.
The vertical is defined by the direction in which the force of gravity acts (which can be determined, for example, thanks to a plumb line).

Inclined plane

The inclined plane apparatus shows the physical law of forces in an easy and clear way.

■ **1171**

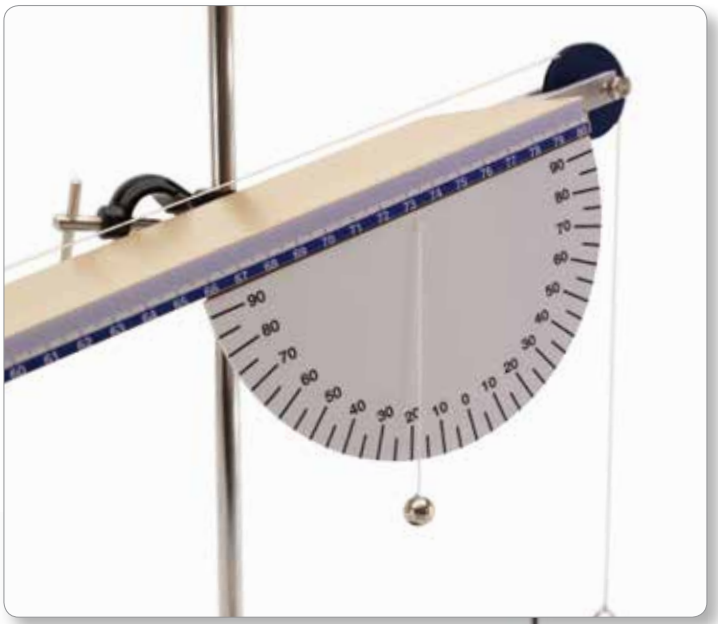
Friction inclined plane

The friction inclined plane allows students to study how forces act on an object moving along an inclined plane. Thanks to this kit it is also possible to calculate the coefficient of friction, a dimentionless scalar value which describes the ratio of the friction force between two bodies and the force pressing them together.

■ **1291**

TOPICS

- *Inclined plane*
- *Friction force and friction coefficient*



Equilibrium forces, momenta and machines

Thanks to this kit students are allowed to investigate equilibrium, momenta and machines: it contains all necessary devices and apparatus to perform up to 15 experiments.

■ **1123**

TOPICS

- *Composition of forces*
- *Hooke's law*
- *Momentum of a force*
- *Pulleys*
- *Inclined plane*

Experiments set for magnetic board

This equipment allows students to study easily how composition of forces works, what an inclined plane is and how friction acts on it. It contains all the necessary devices and apparatus to perform up to 20 experiments: thanks to the magnetic board (not included), it is possible to perform experiments directly from the teacher's desk.

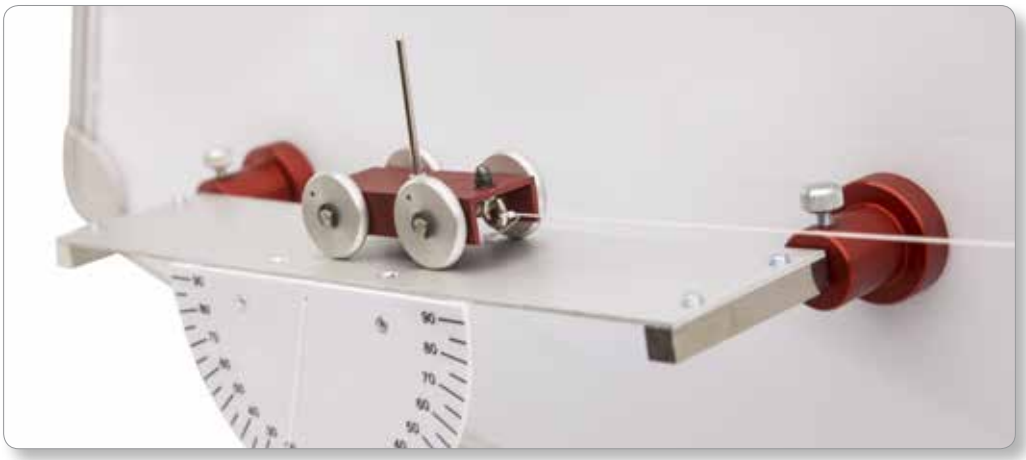
■ **1328**

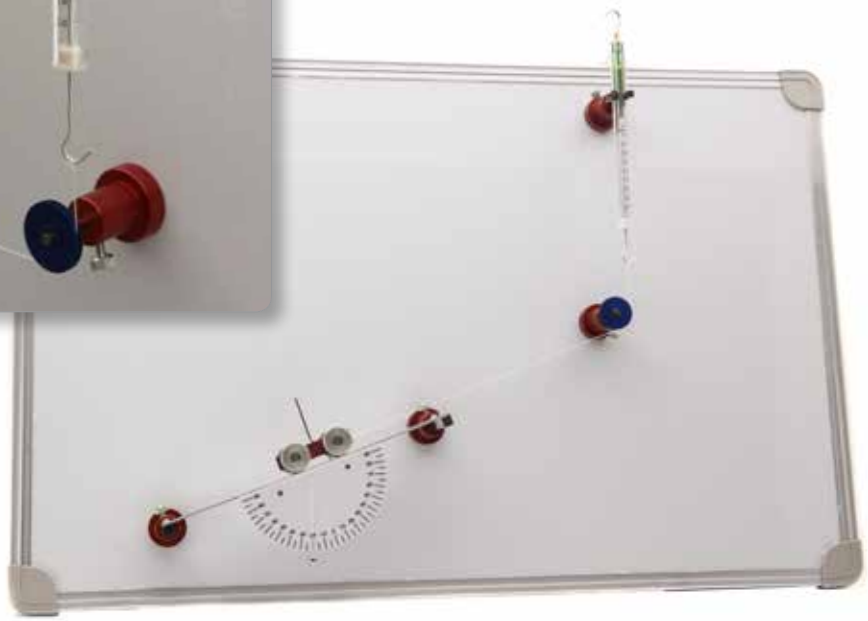
TOPICS

- *Composition of forces*
- *Elastic force*
- *Hooke's law*
- *Centre of gravity*
- *Force momentum*
- *Levers and pulleys*
- *Inclined plane*
- *Friction force*
- *Simple machines*

Accessory for "Experiments set for magnetic board"

■ **1329** Magnetic board 90x60cm





OPTIKA Spring scale

A spring scale or spring balance is a type of weighing scale. It consists of a spring fixed at one end, with a hook to attach an object at the other one. It obeys Hooke's Law, which states that the force needed to extend a spring by some distance from its rest position is proportional to that distance. Therefore the lines of the scale printed on the spring balance are equally spaced. A spring scale cannot measure mass, only weight.

Optika spring scales are made of a clear acrylic material to easily read the measured value: the upper section coloured according to the measurement range.

- **1193.1** 1N, division 0.01N
- **1256.1** 2N, division 0.02N
- **1257.1** 5N, division 0.05N
- **1258.1** 10N, division 0.1N
- **1259.1** 20N, division 0.2N

Hooke's Law Apparatus

This apparatus allows students to verify that, taking into account the experimental error, the lengthening of a spring is proportional to the intensity of the applied force.
The graduated scale has 1 mm divisions and the perfectly balanced weight-holder is provided with an index which can rotate to ensure a perfect alignment with the graduated scale.

- **1111**

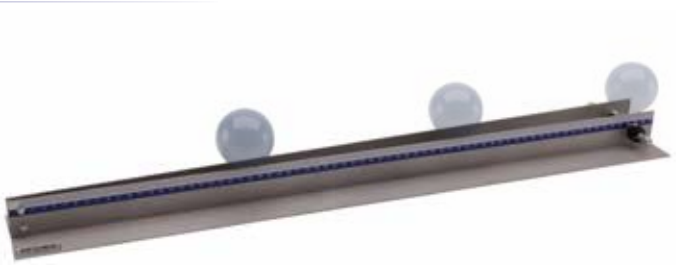
Mechanical paradox

This instrument is composed of a trapezoidal wood frame with two rails, on which are laid a pair of wooden cones joined at their bases. Placing the double cone on the bottom of the frame, it spontaneously starts to move upwards, thus giving the impression to not submit to the universal law of gravity. Because of this phenomenon, apparently contrary to common sense and, therefore, amazing, the device is often named as "mechanical paradox." The paradox is only apparent: the natural movement of a body depends on the movement of its center of gravity, which falls down naturally. In fact, since the tracks are far apart, the center of gravity of the double cone, placed on the rotation axis at the maximum diameter, does not go up when the entire body seems to proceed upwards, but conversely drops. Rolling, the double cone rests on the tracks at points closer to its two vertices.
Consequently, the distance of the centre of gravity with respect to the horizontal plane decreases as the cone goes up. The phenomenon has, therefore, nothing paradoxical, actually it is absolutely in accord with the laws of mechanics.

- **1079**

Does it go up or down?

A sphere moves spontaneously along a horizontal variable-gauge rail, and it always moves in the same direction. Which direction? And why? If the rail is inclined, the sphere does not always roll in the same direction. Why?
The explanation of these phenomena lies in the study of the position of the sphere's centre of gravity: a good amount of physics with such a simple device.



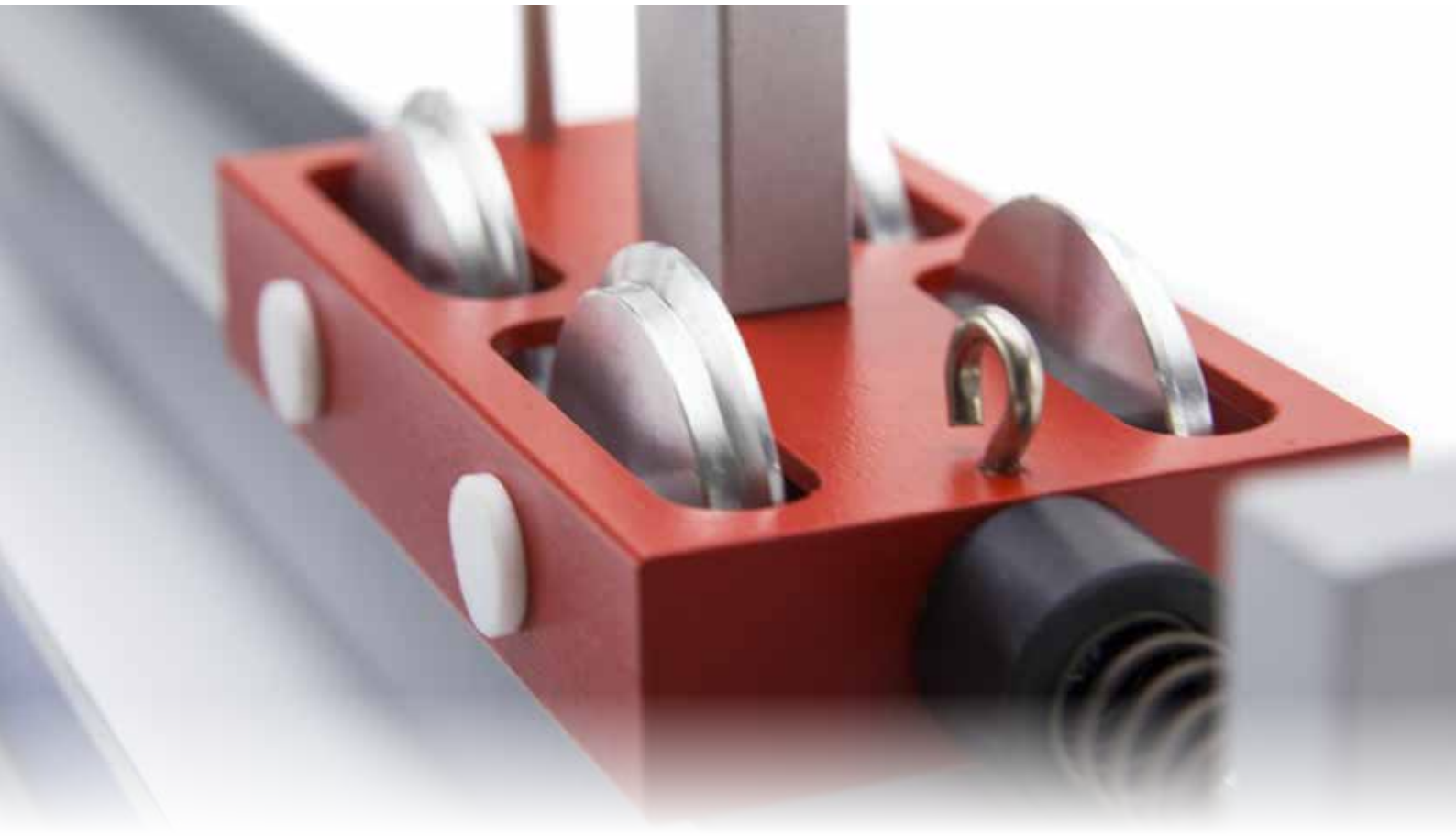
■ **1401**

Rotational Dynamics

It is a variable gauge track: the distance between the two rails of the track can be varied at the centre, screwing an external knob. The iron track should be placed perfectly horizontally: one of the two supports is provided with an adjustable foot.
If the track lies on a perfectly horizontal plane, why does the ball move "spontaneously" on the track without any initial pulse? The answer lays in the analysis of the position of the sphere's centre of gravity...

■ **1429**

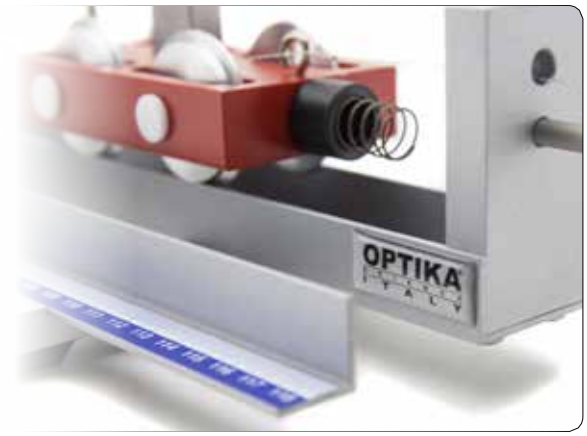
LOW FRICTION TRACK



Low friction track

Motion is subject to friction forces which can be reduced but not cancelled. Thanks to the low friction track students are able to perform experiments on kinetics and translational motion.

■ **1442**



Accessory for "Low friction track"

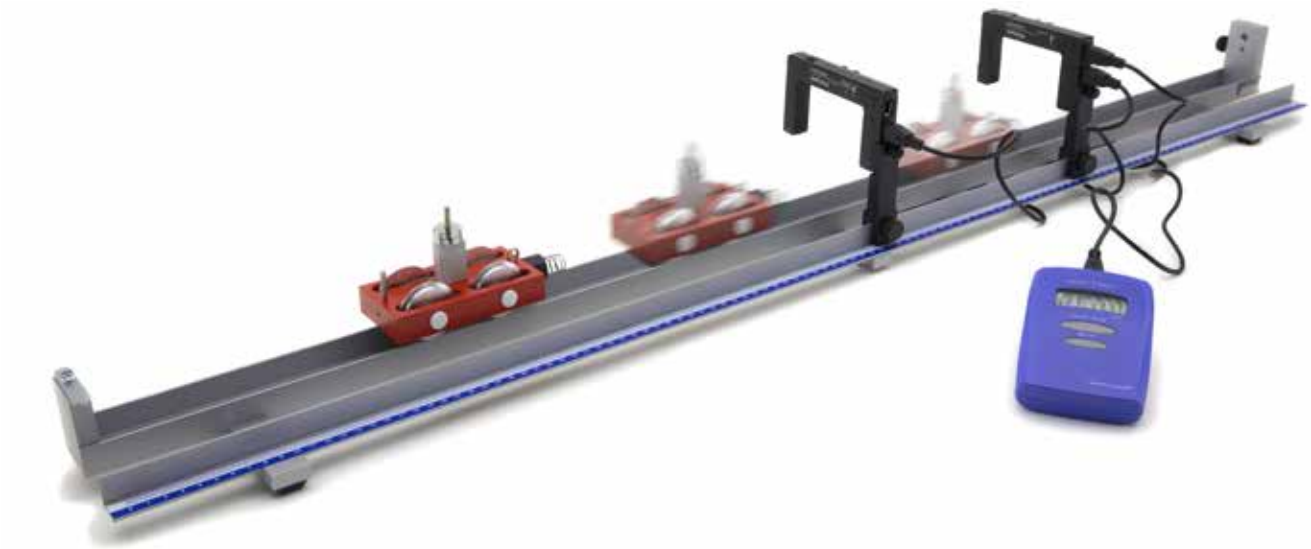
Optional timer system

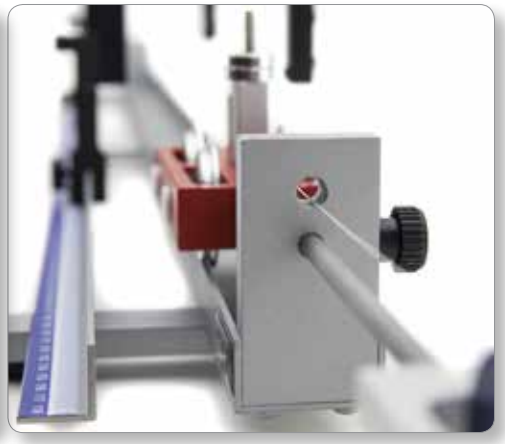
2 Photocells.
1 Timer.
Timer description:
- Readability: 0.001s
- 9V battery included
- 2 modes:
To measure darkening time
To measure the time elapsed between the darkening of the first photocell and that of the second one.

■ **9081**

TOPICS

- *Motion*
- *Motion is relative*
- *Reference systems*
- *Physical quantities defining motion*
- *Trajectory*
- *The instruments for the experimental study of motion*
- *Average speed*
- *Instantaneous speed*
- *Average acceleration*
- *Instantaneous acceleration*
- *Different types of motion*
- *Uniform rectilinear motion*
- *Uniformly accelerated rectilinear motion*
- *The principle of inertia*
- *The fundamental law of dynamics*
- *Friction force*





AIR TRACK SYSTEM

Air track system

Optika air tracks are made from the extrusion of a square aluminum tube.
Three available lenghts:

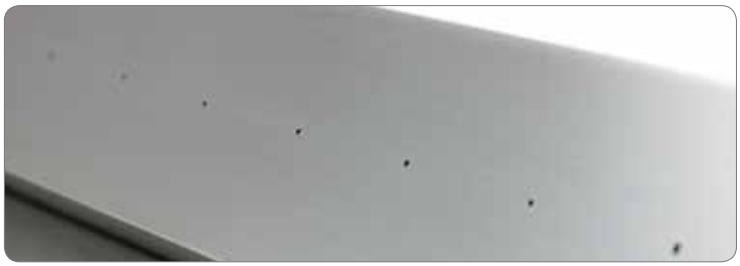
- **5588** - 1,5m
- **5589** - 1,9m
- **5590** - 2,0m

Each air track is provided with a side T-shaped aluminum profile on which photocell holders can slide.
On this profile a graduated scale is mounted for a clear reading of the photocell positions.
It is an essential instrument thanks to which students are able to practice with Newton's second law, uniform motion, uniformly accelerated motion, conservation law and collisions.

Track

Made of extruded aluminum square tube (50x50 mm).
3 feet (2 adjustable).

Working length	**5588 (1.5 m)**	**5589 (1.9 m)**	**5590 (2.0 m)**
Air holes	106	144	152
Hole diameter	1 mm	1 mm	1 mm
Spacing	26 mm	26 mm	26 mm
Millimeter scale	on one side	on one side	on one side



- **5588/5589/5590** These sets include 1 air track, 2 gliders and accessories, 2 photogate holders.

- **5450** Air blower.
- **5452** Timer (with 2 photogates ports)
- **5453** Photogate.
- **5454** Electromagnetic coil.
- **5455** Free fall apparatus expansion kit.
- **5456** RTL Kit (only for code 5588)

Timer

This timer is designed to perform time measurements using two photogates.
Functions available:

- Start/stop
- Count
- Calibration
- Collision
- Acceleration
- Gravity acceleration (free falling)
- Cycle

■ **5452**

Electromagnetic coil

Pushing electromagnetic coil button on the timer, students are able to interrupt the current to the coil output: in this way the glider is released.
Mini Jack plug.

■ **5454**

Photogate

This photogate works as a switch.
The infrared transmitter and receiver are mounted and aligned on a plastic fork.
Lead time: ~ 0.004 ms.

■ **5453**

Air blower

Optika air blower is silent and its speed can be continuously adjusted.
Provided with 1.5 m hose.

■ **5450**

Free fall apparatus expansion kit

The free falling apparatus allows students to study the free fall of a body getting accurate and reliable measurements.

■ **5455**

RTL Kit (only for code 5588)

Thanks to this kit, students are allowed to study dynamics using a Real Time Laboratory method.
This kit is suggested for 1.5 m Air Track (code 5588).

■ **5456**

Rotating platform

This instrument allows students to study, in a funny and easy way, inertial and non-inertial systems. They will be able to try on their skin all the effects of fictitious forces.
A great and wonderful instrument.

■ **1177**

TOPICS

- *Action and reaction principle*
- *Inertia momentum*
- *Conservation of angular momentum*
- *Non-inertial systems*
- *Centrifugal force*
- *Coriolis force*

Small manual rotating machine

The rotating machine is equipped with a metallic spindle for shafts of 6 mm diameter.

■ **1109**

Accessories for "Small manual rotating machine"

Centrifugal force device

When the machine rotates, the cylinder is subjected to the centrifugal force and presses the spring. The compression is directly proportional to the angular speed of the system and to the mass of the rotating cylinder.

■ **1081**

Coaxial cylinders

This coaxial cylinders device allows to verify some important aspects related to the centrifugal force in a simple way.
Since the mass of one cylinder is twice the other cylinder's mass, during the rotation the equilibrium is reached when the distances between each centre of gravity and the centre of rotation are inversely proportional to the masses.

■ **1092**

Elastic rings

They show that the centrifugal force increases as the distance from the rotation centre increases. During the use their shape becomes elliptical.

■ **1094**

Newton's disk

The white light is a polychromatic light which consists of the set of all colours. Such phenomenon can be shown thanks to Newton's Disk, a disk with coloured sections representing the colours of the rainbow. During the rotation, students can observe that it looks white.
This is due to the phenomenon of the persistence of the image on the retina.
The various colours reach the eye at time intervals shorter than a tenth of a second, hence they are not seen separately but rather overlap. As a consequence, the eye sees a sort of 'synthesis' represented by a white colouring.

■ **1097**

Device to measure the centrifugal force

The device to measure the centrifugal force is provided with a track on which runs a low friction glider. By rotating the device, using the rotary machine, it is possible to read the value of the centrifugal force on the spring scale placed on the rotation axis.

■ **1135**

Watt regulator

It was invented in 1788 by James Watt to control his steam engine where it regulates the injection of steam into the cylinders. It was used mostly on steam engines during the Steam Age in the 19th century. It is also found mounted on internal combustion engines and fueled turbines.
It is composed by two or more masses that rotate around a shaft. Due to the centrifugal force, these two masses move away from the rotational axis, but their movement is opposed by a spring system or by gravity through an articulated system.

■ **1093**

OPTIKA®

ELECTRICAL ROTATING PLATFORM

Optika rotating platform allows students not only to verify the relations between the fundamental quantities which characterize rotational motion, but also to perform experiments on an important topic: inertial and non-inertial systems. What is seen by an observer on an inertial system is different from what is seen by an observer on a non-inertial system. In this way students are allowed to understand which is the origin and which are the results of fictitious forces as the centrifugal force and Coriolis force.
Thanks to this platform, you are able to study a lot of fundamental topics as the effects of Coriolis force on solids and liquids and understand why a mathematical instrument as the cross product was so important.
By which magnitudes the centrifugal force depends on? Let's perform some experiences with OPTIKA rotating platform.

■ **1443**

TOPICS

1. *Centripetal force*
2. *A fictitious force: the centrifugal force*
3. *Lack of centripetal force: what happens?*
4. *Centrifugal forces in equilibrium*
5. *How to use centrifugal force to separate a mixture*
6. *How to use centrifugal force to dry linen*
7. *Centrifugal force and Earth shape*
8. *Watt's regulator*
9. *White light: Newton's Disk*
10. *Conical pendulum*
11. *Properties of conical pendulum*
12. *How to verify centripetal and centrifugal forces formula*
13. *Another fictitious force: Coriolis force*
14. *Coriolis force acting on a water jet*
15. *Coriolis force acting on a pendulum*
16. *Observer in a non-inertial system*
17. *How to verify Coriolis law with an experiment*
18. *When Coriolis force is zero*
19. *Foucault's pendulum*

Camera Kit

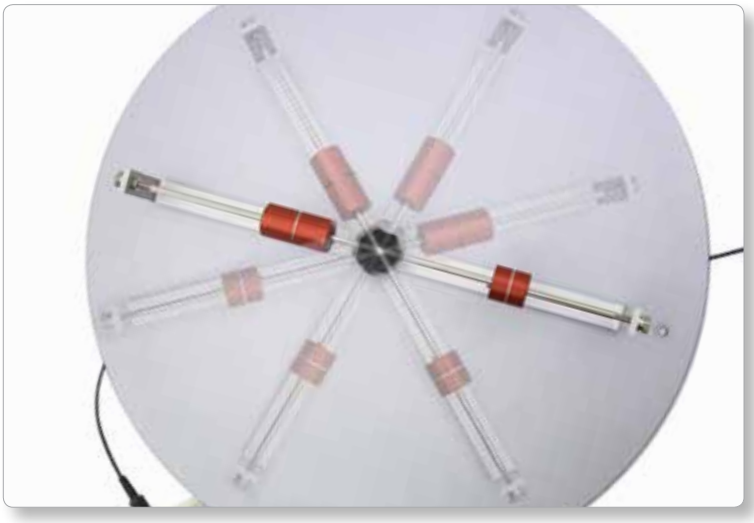
See the experiment as if you were on the non-inertial system.
This camera kit code 1455 allows you to make video with a smartphone: observe the experiment from another interesting point of view. This camera kit can be used with all the accessories of the rotating platform.

Warning: to be used only with velocity in LOW range.
The clamp shown in the photo is a smartphone support.
We recommend to use a smartphone provided by our company.
Please, contact our sales department for more information.

■ **1455**

Centrifugal forces in equilibrium

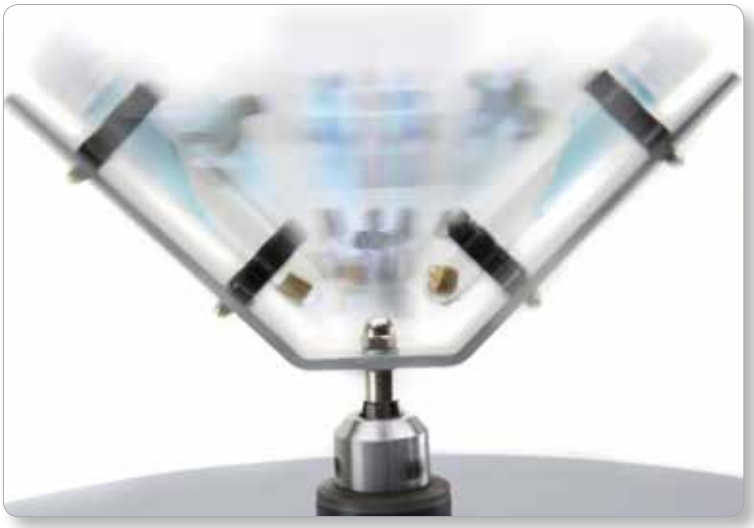
This apparatus is composed of two bodies: the first body has a mass that is double with respect to the second one.
After having switched on the rotating platform, if the two-bodies system remains in equilibrium during the rotation, it means that the two centrifugal forces, which have opposite directions, have equal modules.
Some food for thought: which is the equation that sets the equilibrium conditions of this system?



■ **1447**

Centrifugal force

As all the apparent forces, the centrifugal force produces dynamic effects entirely equivalent to those of the real forces.
In some cases, the presence of apparent forces can be detrimental: in huge electrical machines, such as alternators that rotate, the outer parts are stressed by huge centrifugal forces.
The centrifugal force must not be seen as only a detrimental force: it is used, for example, in industrial centrifugal machines.
These machines are used in various fields: to separate the particles in suspension in a liquid (such as milk centrifugation), to accelerate processes of filtration, precipitation and settling in industrial chemistry, to separate the liquid and solid phases of lubricating oils, etc.
In all these cases, it exploits the fact that, being the centrifugal force proportional to the mass of the rotating body, the particles, having equal volume, that have a greater mass are separated from those of lower mass.



■ **1082**

Conical pendulum

A conical pendulum is composed of a weight fixed on the end of string suspended from a pivot. It is similar to an ordinary pendulum: instead of hanging back and forth, the weight moves at a constant speed in a circle with the string tracing out a cone.
The conical pendulum was studied, for the first time, by the English scientist Robert Hooke around 1660 as a model for the orbital motion of planets.
In 1673, the Dutch scientist Christiaan Huygens calculated its period, using the concept of centrifugal force in his book Horologium Oscillatorium. Later it was used as the timekeeping element in a few mechanical clocks and other clockwork timing devices.

Taking in account the free body diagrams on the inertial and non-inertial reference system; knowing:
- The angular velocity
- The distance between the center of gravity of the pendulum from the hanging point
- The distance of the hanging point from the rotation axis

Thanks to a bit of trigonometry, students will able to calculate the centripetal acceleration.

■ **1450**

Accessories for "Electrical rotating platform"

1445 *Apparatus for centrifugal force*
1447 *Coaxial cylinders*
1082 *Apparatus with inclined test tubes*
1083 *Centrifuge*
1094 *Apparatus with elastic rings*
1093 *Watt's regulator*
1097 *Newton's Disk*
1459 *Bowl with dye (to be used with 1452 and 1458)*
1450 *Conical pendulum*
1451 *Apparatus for Coriolis force*
1452 *Apparatus for water jet*
1453 *Simple pendulum*
1455 *Camera kit (to be used with 1453)*
1458 *Apparatus for falling water*
1460 *Smartphone*

1445

1447

1082

1083

1097

1094

1093

1459

1450

1453 + 1455 + 1460

1451

1452

1458

The clamp shown in the photo is a smartphone support.
We recommend to use a smartphone provided by our company.
Please, contact our sales department for more information.

Technical balance

Dimensions:
Height: 33 cm
Base: 32 x 20 cm
Three adjustable feet

Provided with a weight box, from 10 mg up to 100g

■ **1433**

Accessories for "Technical balance"

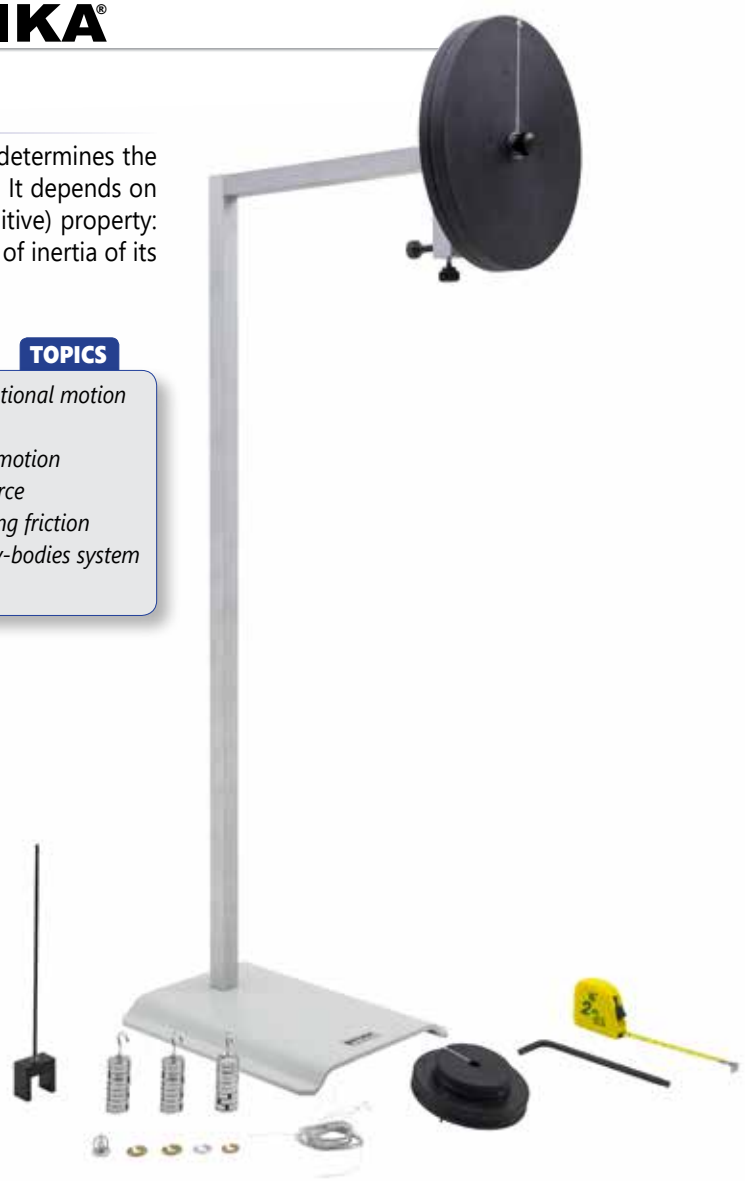
Bucket & cylinder Apparatus

Use this technical balance as an hydrostatic scale
Bucket (external measures): h = 60 mm; d = 41 mm
Cylinder: h = 50 mm; d = 30 mm
The Bucket and Cylinder Apparatus is used to verify the Archimedes Principle, or law of buoyancy.
Immersing the cylinder into a container of water, you can notice an apparent weight reduction: the upward buoyant force that is exerted on a body immersed in a fluid, whether fully or partially submerged, is equal to the weight of the fluid that the body displaces.

■ **1461**

Moment of inertia

The moment of inertia, also known as rotational inertia, of a rigid body determines the torque needed for a desired angular acceleration about a rotational axis. It depends on the body's mass distribution and the axis chosen. It is an extensive (additive) property: the moment of inertia of a composite system is the sum of the moments of inertia of its component subsystems, all taken about the same axis.



■ 1438

TOPICS

- *Translational and rotational motion*
- *Analogies between Translational and rotational motion*
- *Definition of some magnitudes regarding rotational motion*
- *How to evaluate torsional moment*
- *How to evaluate acceleration*
- *The fundamental law of rotational motion*
- *Moment of inertia*
- *Kinetic energy in rotational motion*
- *How to determine friction force*
- *Energy of the system including friction*
- *Moment of inertia in a many-bodies system*
- *Equilibrium of a rigid body*

Device to study rotational motion

Thanks to this kit, students are allowed to study some core topics involving circular motion. It should be used with a stopwatch (not supplied).
In physics, circular motion is a movement of an object along the circumference of a circle or a rotation along a circular path.
It can be uniform, with constant angular accelaration and constant speed, or non-uniform with a changing angular acceleration.

■ 8109

TOPICS

- *Uniform circular motion and harmonic motion*
- *Kinematics in circular motion*
- *Translational and rotational motion*
- *Dynamics in rotational motion*
- *Fundamental law of rotational motion*
- *Moment of inertia*
- *Kinetic energy in rotational motion*

ON-LINE equipment required not supplied

- *1 interface*
- *1 distance sensor*

Otherwise

- *1 USB distance sensor*

Simple pendulum

The Italian scientist Galileo Galilei was the first to study the pendulum's properties (1600).
It is a weight suspended by a pivot able to swing freely.
When a pendulum is displaced sideways from its equilibrium position, it is subject to a restoring force due to gravity that accelerates it back toward the equilibrium position.
When released, it oscillates about the equilibrium position, swinging back and forth.
A period is the time for one complete cycle: it depends on the length of the pendulum and on the amplitude of the pendulum's swing.

■ **1272**

Variable inclination pendulum

The variable inclination pendulum demonstrates that the period of a simple pendulum depends only on its length and on the gravitational acceleration.
The latter can be varied from 0 to 1 g, varying the inclination of the oscillation plane.
The oscillating disk is placed on a plank with air bearings which needs to be used with an air blower (code 5450, to be purchased separately).
The period of the pendulum can be measured with a stopwatch or with a photogate connected to a digital timer - both items must be purchased separately.

■ **1350**

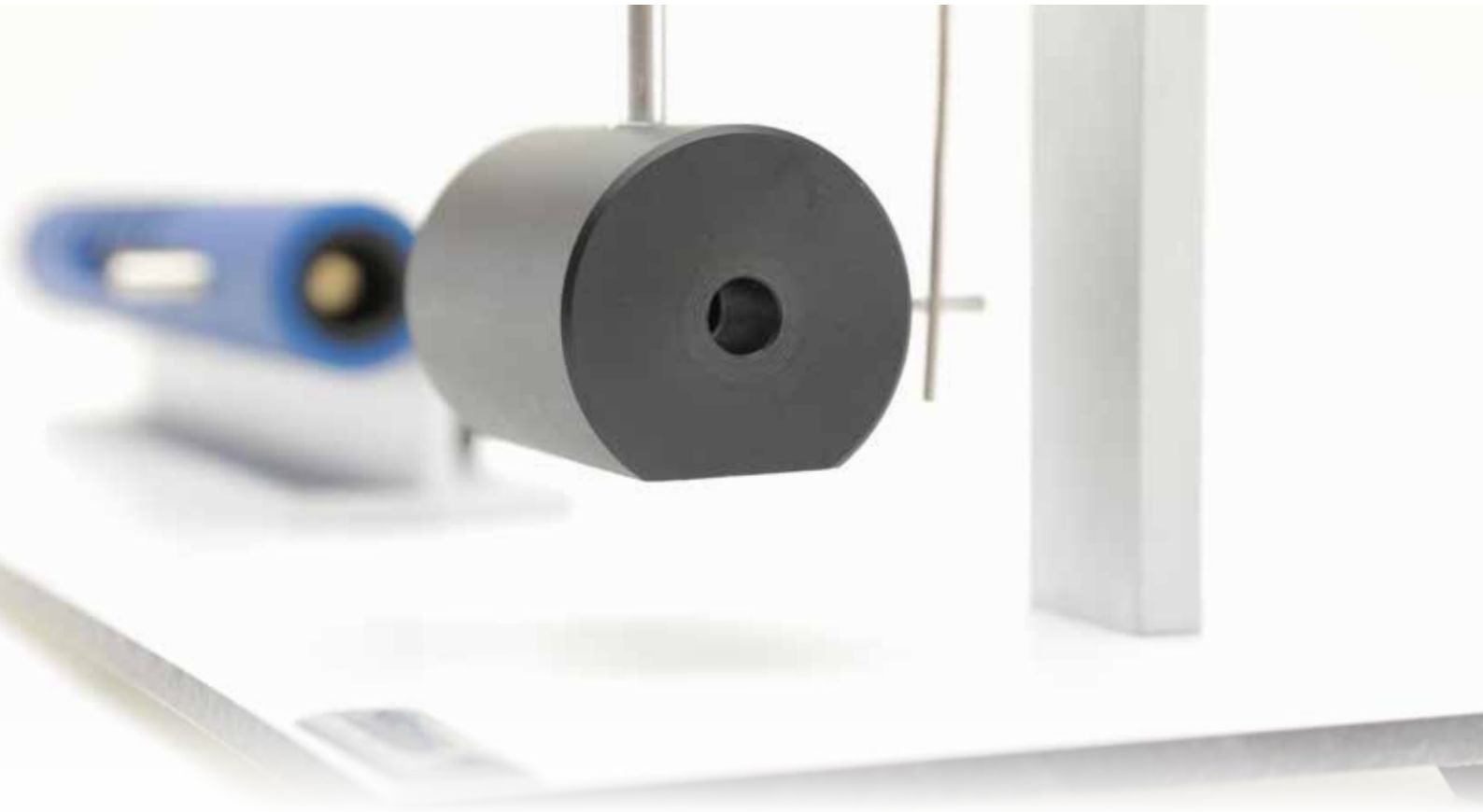
ON-LINE equipment required not supplied

- *1 interface*
- *1 distance sensor*

Otherwise

- *1 USB distance sensor*

BALLISTIC PENDULUM

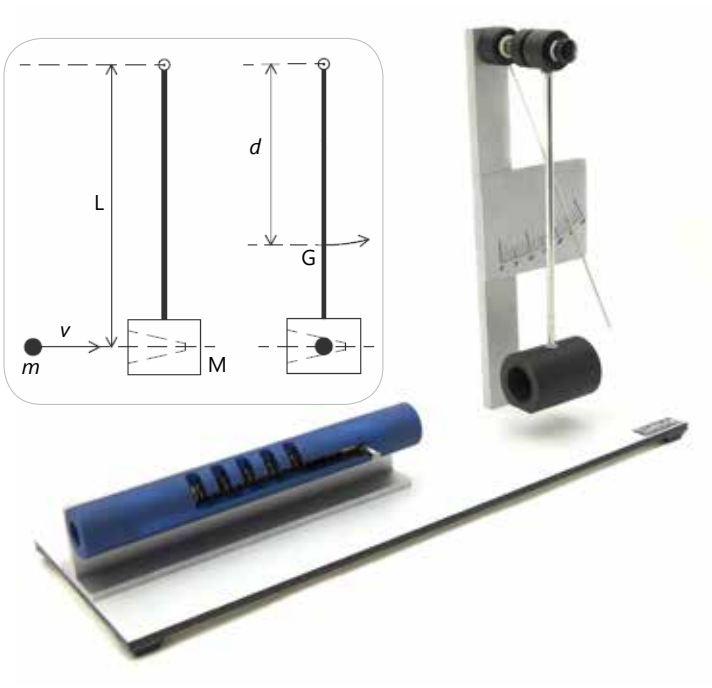


Ballistic pendulum

The ballistic pendulum allows to study the laws of conservation of energy and the conservation of momentum in a perfectly inelastic collision. This device is particularly sturdy, firmly fixed to its base and equipped by a state-of-the-art launcher made by using CNC technology.

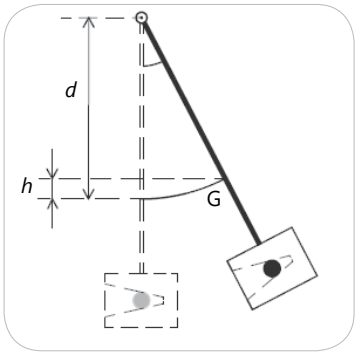
The launching system is removable and suitable to verify the initial speed of a projectile according to the laws of parabolic motion.

■ **1436**



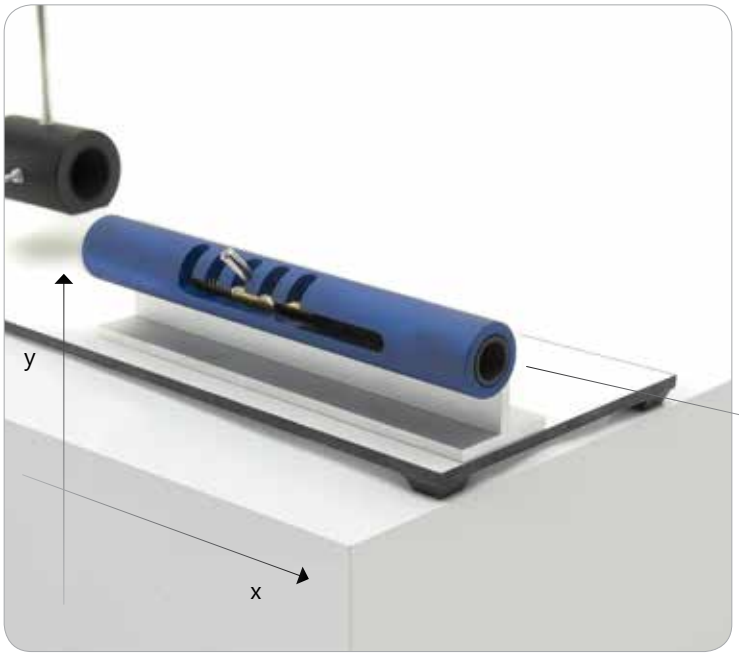
TOPICS

A steel projectile having mass m and speed v is fired horizontally into the PVC pendulum swinging block, which is initially stationary and whose mass M is far greater than the projectile's one.
The speed of the projectile can be calculated thanks to the law of conservation of angular momentum, neglecting the effect of any external or frictional forces.

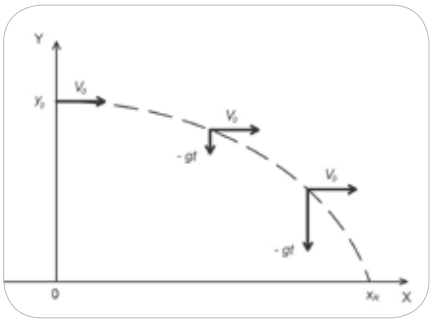


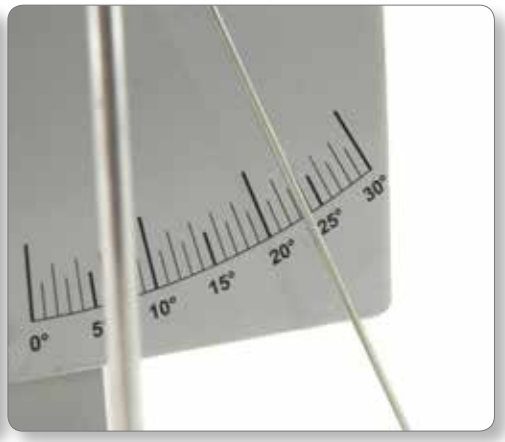
TOPICS

The launching system is removable and suitable to verify the initial speed of a projectile according to the laws of parabolic motion; this allows to compare the result with the one obtained performing the inelastic collision experience.



Parabolic motion experiment





Maxwell's pendulum

Maxwell'spendulum is composed of a wheel suspended by two strings. These strings will be rolled up on an axis passing through the wheel's centre of mass.
Releasing the wheel, the two strings are rolled up and down on the axis. If there was no friction, the wheel would reach the initial elevation.
This up&down motion will be done many times. Its period depends on: the initial height h, from which the wheel was released, the gravity acceleration g and the ratio between the wheel radius and the pivot radius.

Using the distance sensor (not supplied) students are allowed to evaluate the wheel velocity at the end of its stroke and to make accurate calculations.

■ **1375**

TOPICS

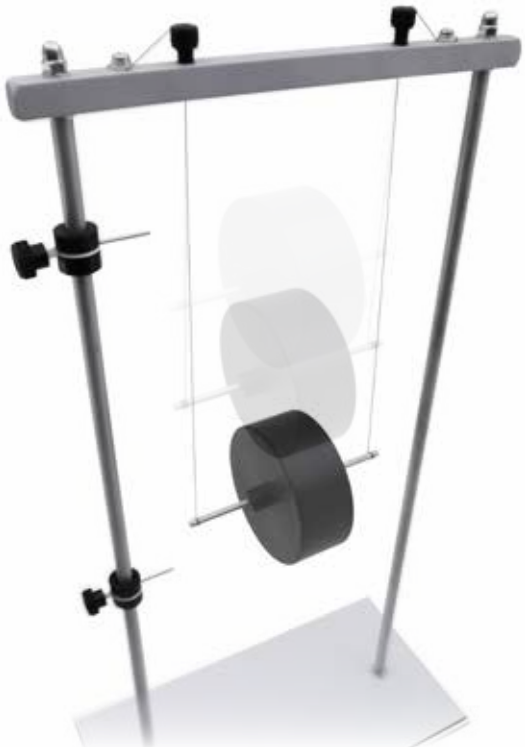
- *Energy conservation*
- *Angular momentum*

ON-LINE equipment required not supplied

- *1 interface*
- *1 distance sensor*

Otherwise

- *1 USB distance sensor*



Wilberforce's pendulum

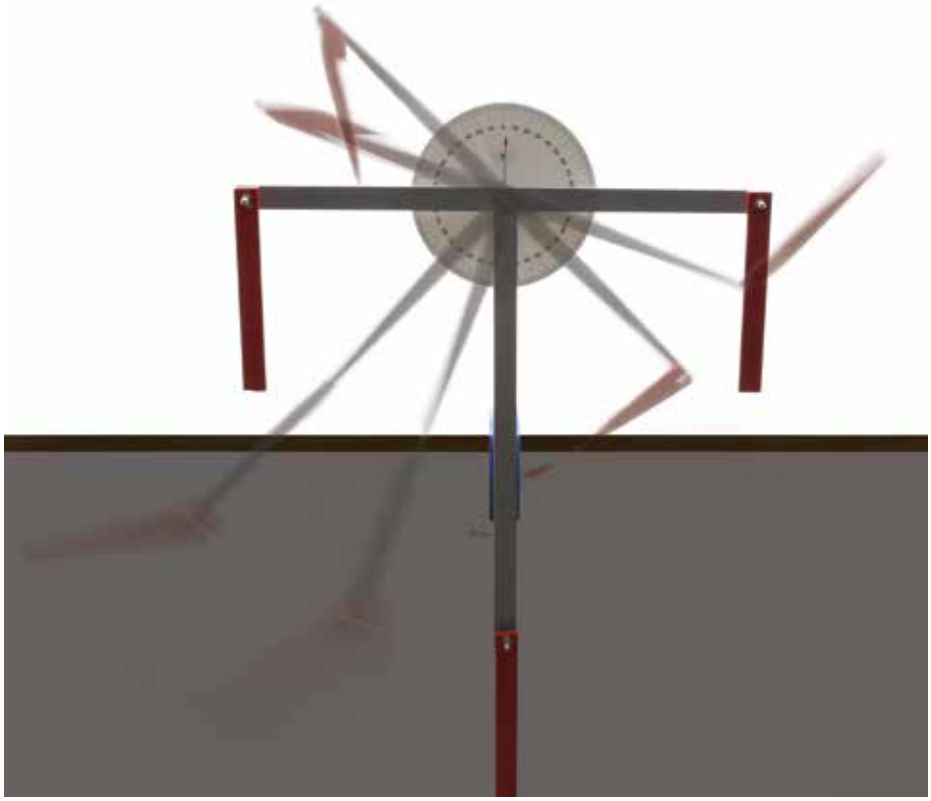
Lionel Robert Wilberforce was a British physicist.
He is best known for the invention of the Wilberforce pendulum, which exhibits a curious motion in which periods of purely rotational oscillation gradually alternate with periods of purely up and down oscillation.
The surprising effect is that, to a distant observer (who does not notice the torsional oscillation), it looks like the vertical oscillation first slows down and eventually stops; then, without external interference, it starts lifting up again as if it was under the influence of an invisible force.

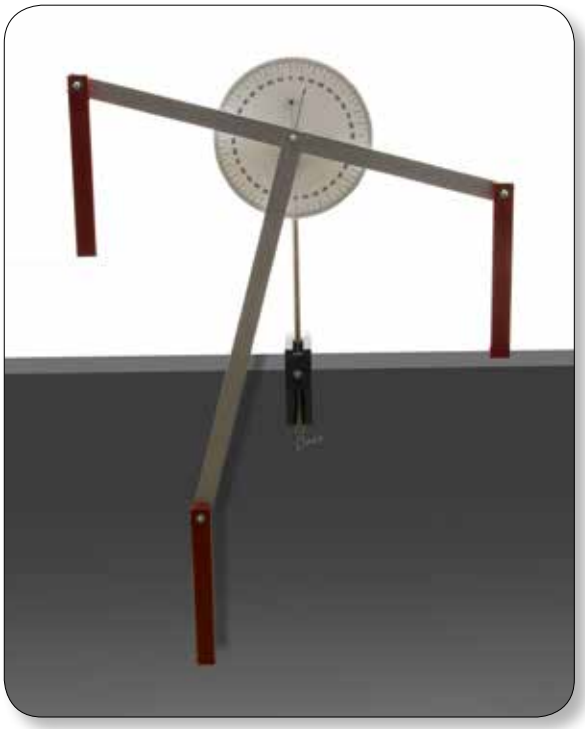
■ **1393**

Todd's pendulum

This pendulum undergoes a chaotic motion and shows a sensible dependence on initial conditions.
Todd's pendulum is composed of an aluminum T-shape frame which can rotate with minimal friction around a support.
At the center of the pendulum there is a protractor to measure the initial angle of rotation; at the three extremities of the frame are fixed three rods, able to rotate. It is easy to note that the evolution of the movement of the pendulum is very sensitive to the initial conditions. As a result, once moved from the equilibrium position, it begins to oscillate in a chaotic and unpredictable motion. It is useful to understand the importance of initial conditions in the so-called "deterministic chaos".

■ **1425**





Forced oscillation apparatus

This apparatus allows to study the phenomenon of a forced oscillations system and to observe what happens under resonance conditions.
If an oscillator is displaced from its rest position, and then released, it starts vibrating. If no more external forces are applied to the system, it is a free oscillator.
If a force is continually or repeatedly applied to keep the oscillation going, it is a forced oscillator.

This device has to be used with a function generator (not provided).

■ **1302**

Vibrator

To be used with a function generator, not to be connected directly to main voltage.

■ **3015**

Apparatus to study harmonic oscillations

In classical mechanics, an harmonic oscillator is a system that feels a restoring force *F* proportional to the displacement x when displaced from its rest position.
The study of the oscillatory motion of a mass hanging by a spring allows students to be introduced to the motion features of an harmonic oscillator and to get acquainted with one of the most powerful models for the physical interpretation of a wide range of phenomena.

Thanks to this kit, students are allowed to study not only harmonic oscillator but also three different kinds of pendulum such as the simple pendulum, the physical pendulum and the torsion pendulum.

■ **8111**

TOPICS

- *Hooke's law*
- *Armonic motion*
- *Mass-spring system*
- *Simple pendulum*
- *Physical pendulum*
- *Torsion pendulum*

ON-LINE equipment required not supplied

- *1 Interface*
- *1 Distance sensor*
- *1 Force sensor*

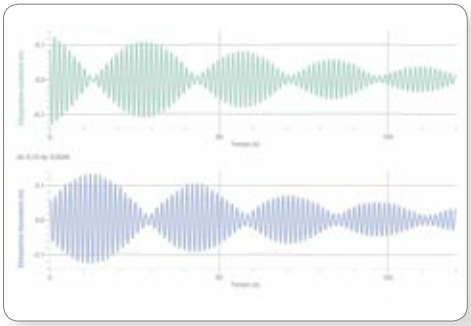
otherwise

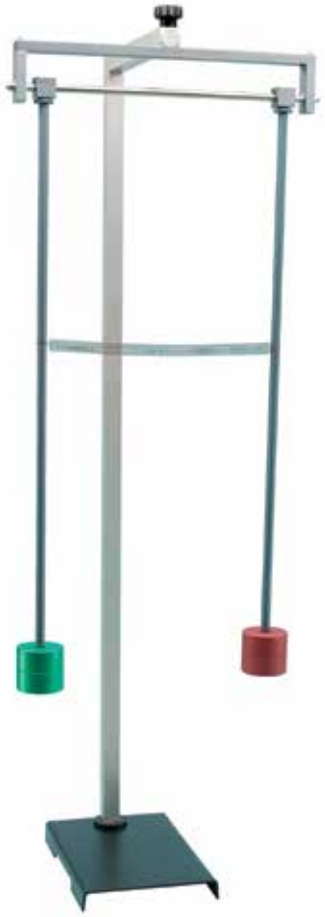
- *1 USB distance sensor*
- *1 USB force sensor*

Apparatus of coupled pendulum

The apparatus of coupled pendulums consists of two pendulums paired through a coil spring slightly stretched out. The spring allows the energy transfer between the two pendulums so it is possible to study the phenomena of resonance and beats.
The apparatus of coupled pendulum can be used as optional equipment of the apparatus for the study of harmonic oscillations (code 8111) or with the stand (code 0209), sold separately.

■ **8113**

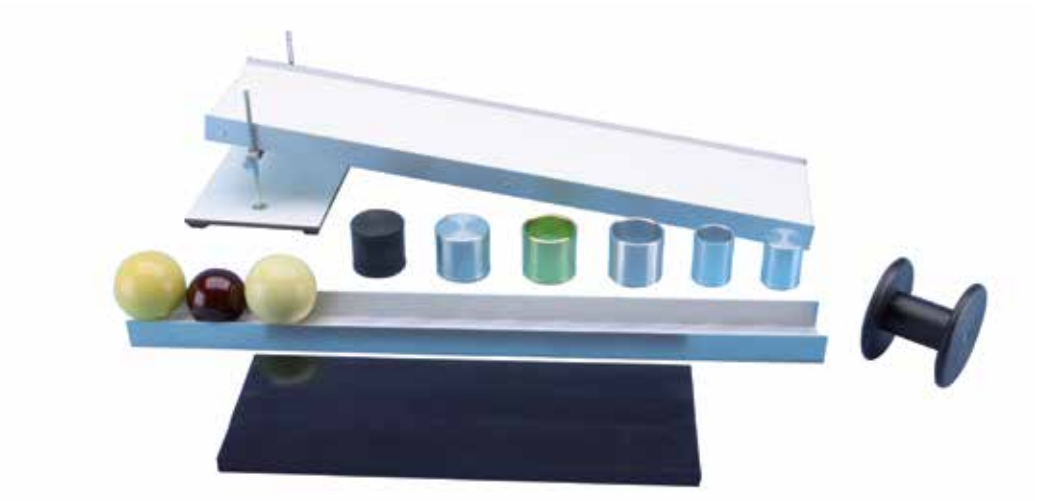




Rolling marbles and cylinders, strange acceleration

Rolling is a type of motion that combines rotation and translation of an object with respect to a surface; the body and the surface are in contact with each other without sliding. When an object experiences pure rotational motion about its center of mass, all of its points move at right angles to the radius in a plane perpendicular to the axis of rotation, with a speed proportional to the distance from the axis of rotation.
Thanks to this kit students are allowed to study the dynamics of rolling.

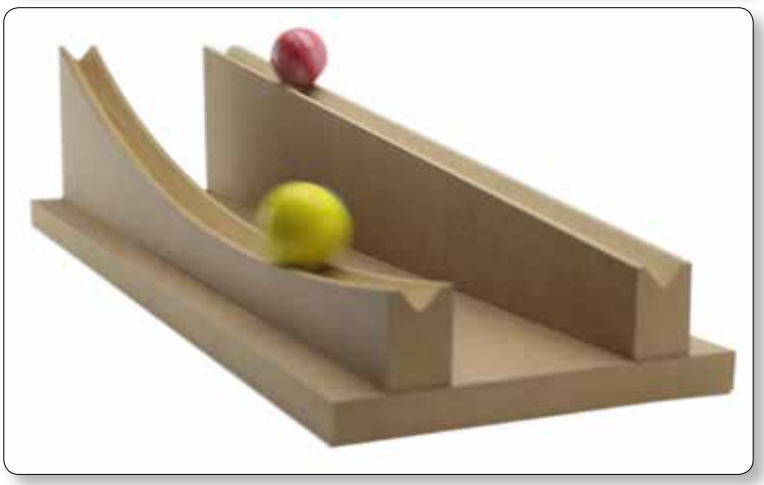
■ **1365**



Downward speed

Galileo demonstrated by geometrical methods that a body takes less time to descend along the arc of a circumference than along the corresponding chord.
Referring to the arc as equivalent to an infinite set of inclined planes, Galileo did not realize that the brachistochrone path of a body that leads downw between two points is the arc of the cycloid, and it is not the arc of a circumference.
The mathematical proof of the brachistochrone of a cycloid will be provided by Bernoulli in 1697.

■ **1364**



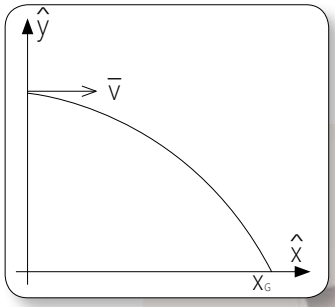
Parabolic motion apparatus

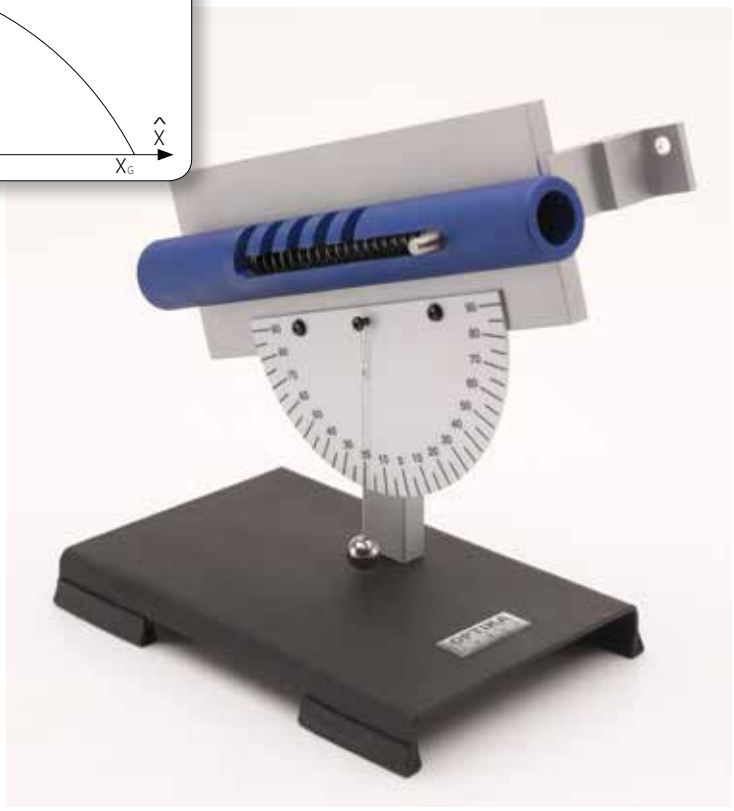
This simple apparatus allows students to study in a quantitative way the parabolic motion.
This launching system has 5 launch positions, and the projectile is a plastic sphere.
The regulation system allows to vary the inclination from 0° to 90°.
If the launching system is at a height of h metres from the ground and is horizontal, the rifle range depends on the launch velocity:

$$X_G = V\sqrt{\frac{2h}{g}}$$

If V is known, X_G can be determined and if X_G is known, V can be calculated.

■ 1431





Accessory for "Parabolic motion apparatus"

Apparatus to measure launch velocity

It is composed of a timer and one photogate (cable included)

■ 9095

The monkey and the hunter

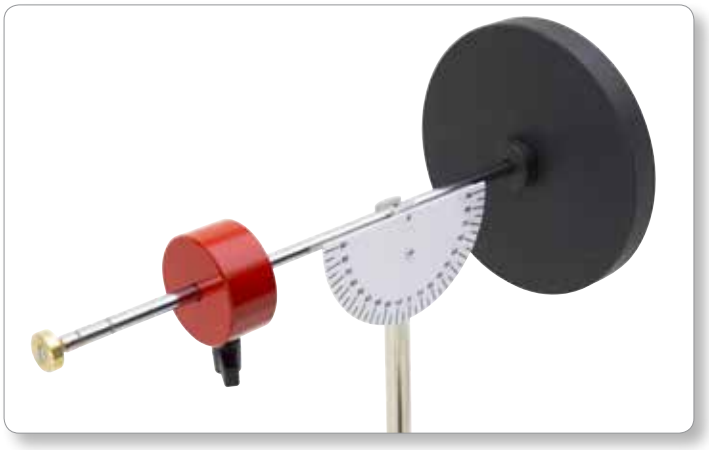
A hunter fires a dart with a harmless sedative to a monkey hanging on a tree at a vertical distance h from the dart and at a horizontal distance R from the dart. The hunter aims directly at the monkey and fires, but just as soon as he does it, the monkey realizes what is happening and drops from the tree. Could the monkey avoid the dart?
This kit allows students to study the effect of gravity on projectile motion.

■ **1422**

Precession motion

This equipment allows students to study the precession motion thanks to the laws of classical mechanics applied to rigid bodies using simple devices as the spinning top and the gyroscope.

■ **1432**



Apparatus to study viscosity

Viscosity is the quantity describing a fluid's resistance to flow.
In this specific experiment, we consider a metallic sphere falling down through a liquid: knowing liquid density, viscosity coefficient and sphere mass, using Stokes' formula, students are allowed to calculate the strength R with which the liquid opposes itself to the sphere motion.

■ **1001**

Pascal's apparatus, modular model

The pressure acting on a point of the surface of a liquid has the same intensity of the pressure acting on any other point of the surface of the liquid, and it is perpendicular to it.
This principle was stated in 1650 by the French physicist and philosopher B. Pascal and it is the base of the statics of liquids. Thanks to this apparatus, students are allowed to perform experiments about capillarity and pressure.

■ **1182**

Stevin's principle apparatus

The pressure within a liquid due to gravity was studied by S. Stevin, who discovered the law that allows us to evaluate it. A liquid can be compressed by the action of gravity or by a force acting on its surface.

■ **1042**

Hare's apparatus

Thanks to this apparatus students are allowed to compare the densities of liquids.
These liquids are poured in two separate vessels. The difference in density can be evaluated by means of the level they reach in the two graduated vertical tubes. This is possible connecting the tubes at the top with a third tube to which suction is applied.

■ **1219**

Torricelli's apparatus

Thanks to this experiment, Torricelli's law can be verified. It is consists of a tube with three separate holes and an open surface at the top. When the tube is full, the holes are blocked: from which hole, water getting out, reaches the maximum range?

■ **1426**

Apparatus to Measure Surface Tension

Thanks to this apparatus students are allowed to measure the surface tension of a liquid, using Lecomte du Noüy ring.
The surface tension value is obtained from the difference between the ring weight and the maximum tension read on the spring scale one second before the ring leaves the water surface.

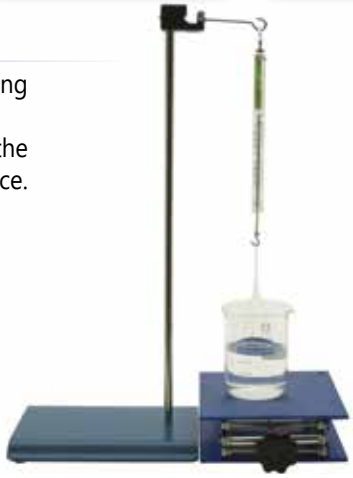
■ **1200**

ON-LINE equipment required not supplied

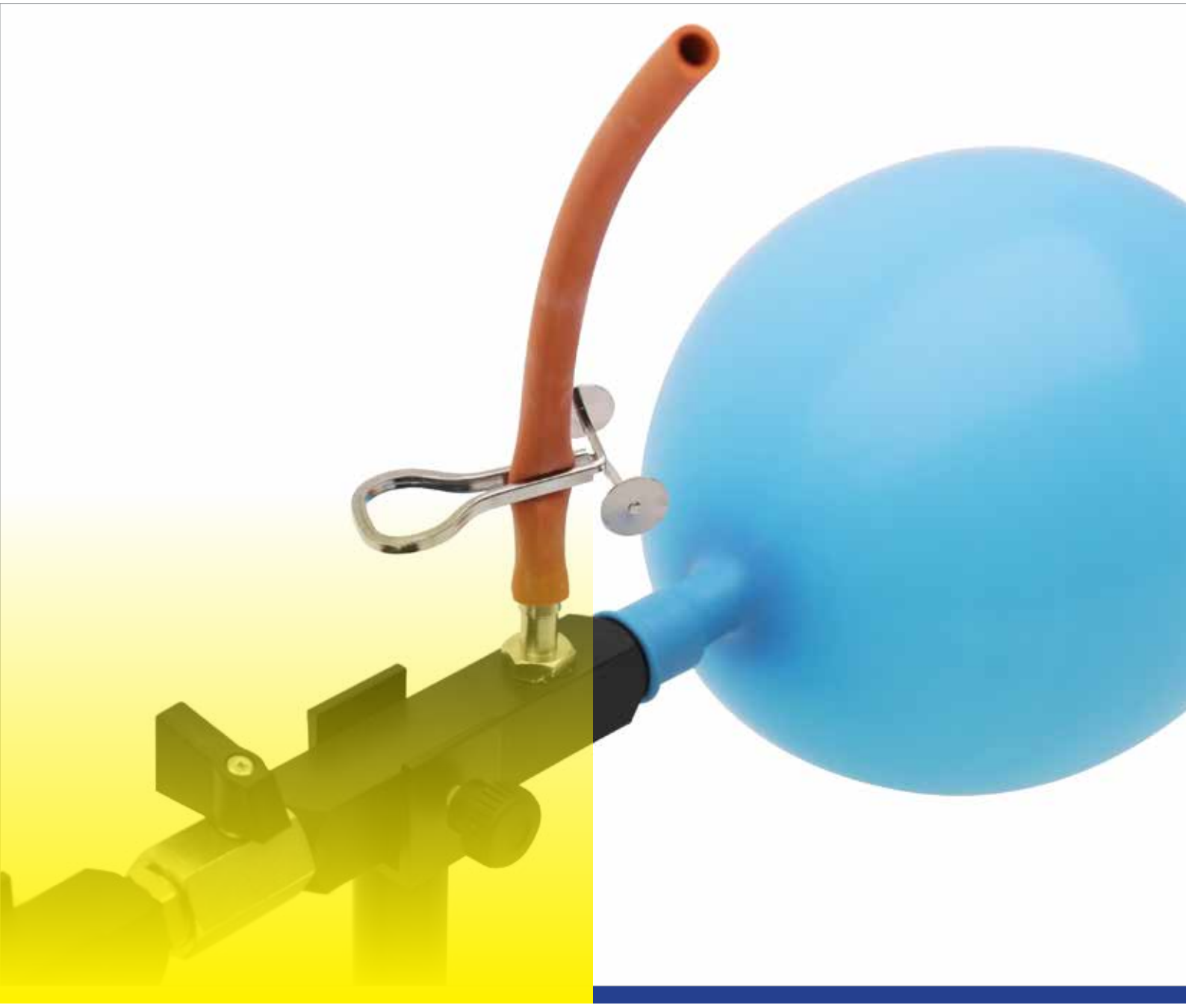
- *1 interface*
- *1 force sensor*

Otherwise

- *1 USB force sensor*



Vacuum And Gases



"And of universal nature, the notion I would offer should be something like this. Nature is the aggregate of the bodies that make up the world, framed as it is, considered as a principle by virtue whereof they act and suffer according to the laws of motion prescribed by the author of things."

Robert Boyle

Double stage rotary pump

- High double stage rotative vanes oil sealed vacuum pump
- Gas ballast valve to purge oil from condensable gasses (water vapor)
- Quiet operation and low vibration
- Compact dimensions, heavy duty construction and very low weight.
- Electric components high protection grade IP54, thermal protector for the motor
- Anti suck-back valve to avoid oil flow back at pump's stop.
- Pump complete of handle, base, light switch and power cord.
- High torque motor for easy start up also with low temperature and under vacuum

AV-12

Features	
Nominal displacement	3,6 m^3/h at 50 Hz
Pumping speed *	3,1 m^3/h at 50 Hz
Ultimate pressure *	0,01 hPa (mbar)
Motor power	0,12 Kw
Electric supply	1 ph ~ 220/240 V at 50/60 Hz
Noise	57 dB (A)
Weight	6,5 Kg
Inlet dimension	1/4" G
Oil filling	0,3 lt

* PNEUROP 6602

Plate for bell jar

This plate is made of metal with a perfect sealing and is provided with a rubber disk in order to increase its seal.
It is provided with two stopcocks: one of them is used to connect the vacuum pump, the other one is used to restore the atmospheric pressure.

■ **1068**

Bell Jar

Thick glass
ø outside 235 mm
ø inside 185 mm
h = 315mm

■ **1069**

Pressure tear device

In accordance with Pascal's principle, the atmospheric pressure act in all directions, and the forces that act on the surfaces of a body are in equilibrium.
With the pressure tear device it is possible to show the effect of the difference in pressure on the two faces of one membrane.
The pressure tear device is made of PVC, with perfect seal. It is supplied with its paper.

■ **1072**

Electric bell

Sound is a vibration that propagates as a mechanical wave of pressure through a medium such as air or water.
What happens if an electric bell is placed under a bell jar in which vacuum was created? Let us see...

■ **1074**

Baroscope

The baroscope, invented by Otto von Guericke (1602-1686), is used for demonstrating Archimedes' principle applied to gases.
It is a special kind of balance scale provided with a sphere that has a big volume on one arm and a solid counterweight with a small volume on the other. The system is in perfect equilibrium.
Placing the baroscope under the bell jar and creating vacuum, it is evident that the balance arm with the sphere moves downwards.
In vacuum, this sphere weighs more than the counterweight. In the air, the equilibrium is reached between the two weights since the sphere of larger volume moves a greater quantity of air and undergoes a greater upward thrust.

■ **1071**

Many techniques have been developed for pressure and vacuum. Instruments used to measure pressure are called pressure gauges or vacuum gauges.

The vacuum gauge must be placed between the bell jar, in which you create vacuum, and the pump. Opening the tap, you create a vacuum in the barometric tube: there will be a mercury displacement. The displacement indicates the depression of the environment. This measure is absolute and independent from atmospheric pressure. It is measured as a pressure force on the surface (of the mercury meniscus surface) and therefore has a direct reading.

Aneroid vacuum meter

Aneroid gauges are based on a metallic pressure-sensing element that flexes elastically under the effect of a pressure difference across the element. "Aneroid" means "without fluid": for this reason, they are often called mechanical gauges.
Double range: - 76 to 0 cm Hg, -1 to 0 mbar.

■ **1088**

Bennert's vacuum meter

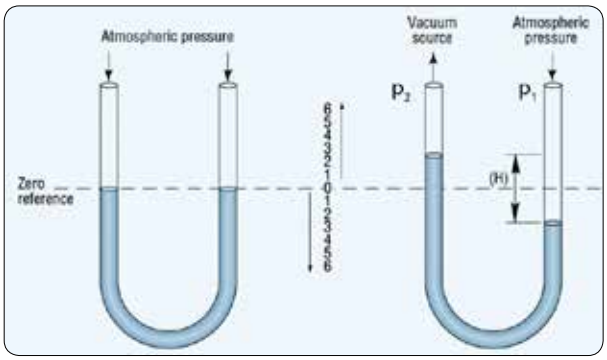
This vacuum gauge consists of a glass tube containing mercury and a T-shaped tube connection.
A glass tap is fixed on the first vertical branch of the tube. The other two branches are placed next to a graduated scale: the graduation goes from 0 up to 13 on both sides, each with 0.1 subdivisions.

■ **1089**

Manometer

Manometer is composed of a U-shaped tube (usually transparent) and filled with a liquid of known density. One end of the tube is open in contact with the atmosphere, while the other one is in direct connection with the environment to be measured.
The liquid contained in the tube will move in one of the two branches: this displacement will reach a value such that:

$\Delta p = p_1 - p_2 = \rho g \Delta h$.



Without stopcock

■ **1047** 20 cm height
■ **1048** 30 cm height
■ **1049** 40 cm height

With stopcock

■ **1050** 20 cm height
■ **1051** 30 cm height
■ **1052** 40 cm height

What are the Magdeburg hemisphers?
To make an example, 80 mm hemispheres will be considered.
One hemisphere is provided with a closure valve, which is connected to a pump. When the air is extracted and the valve is closed, the tube can be detached, while the hemispheres remain welded together due to the atmospheric pressure. The force holding them together is equal to the area described by their edge (0.02 m^2 ca.), multiplied by the difference in pressure between the inside and the outside. Known that 1 atm is equal to 101325 N/m^2, we can state that the value of the force acting on the instrument is equal to 2000N circa.

Magdeburg hemispheres

Diameter: 80 mm.

■ **1242**

Magdeburg hemispheres

Diameter: 100 mm.

■ **1075**

According to the legend, Galileo Galilei threw a cannonball and a bullet from the Pisa tower. Which body reached the floor first?

Empty newton's tube

This tube contains pieces of paper and a ball.
There is no air in the tube, only vacuum.
1 meter long, glass.

■ **1107**

Newton's tube (to be emptied)

This tube is provided with a stopper and a tap and has to be connected to a vacuum pump, after introducing some different small objects in it.
1 meter long, made of plastic.

■ **1070**

Pressure surprises

To demonstrate how air flows due to pressure, using two balloons containing different amounts of air.
Open the linking stopcock between the balloons: you would expect to see the air flowing from the most inflated balloon into the less inflated one. Let us see what happens instead...

■ 1374

Torricelli's experiment

Thanks to this kit, students are allowed to perform the ancient Torricelli's experiment.
In that experiment it was observed that the pressure was directly proportional to the height of a mercury column (Hg), so the millimetre of mercury was adopted to measure pressure.
Mercury not supplied.

1043

Gay-lussac's law apparatus

This kit allows students to perform an experiment to verify Gay-Lussac's law, which describes how gas pressure tends to increase when the gas is heated.
Mercury not supplied.

■ 1122

Charles' law apparatus

This kit allows students to perform an experiment to verify Charles' law, which describes how gases tend to expand when heated.

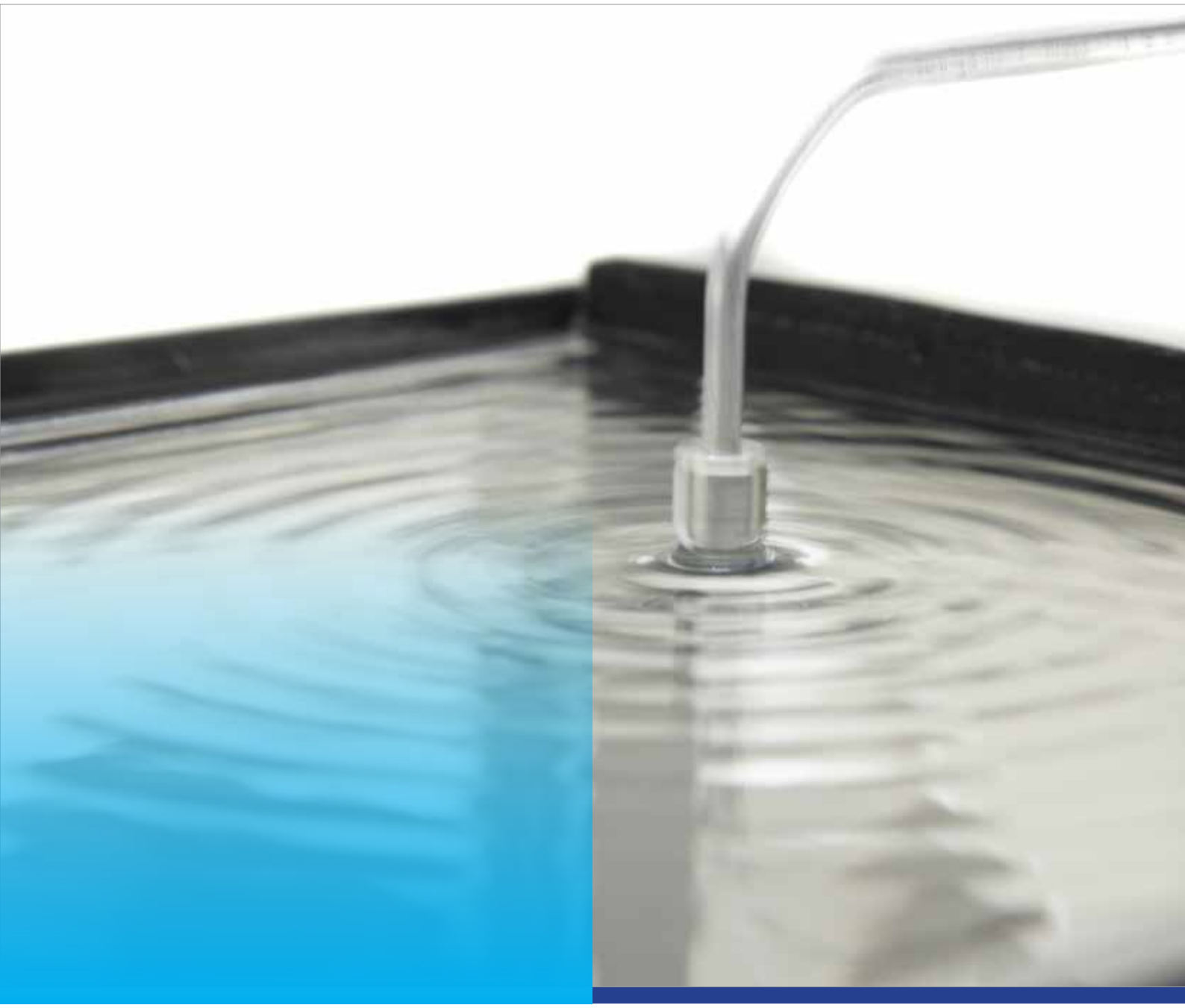
■ 1137

Kit to verify the laws of Charles and gay-lussac

This kit contains all the equipment necessary to perform experiments to verify Charles' law and Gay-Lussac's law.

■ 1217

Waves



"I believe that we do not know anything for certain, but everything probably."

Christiaan Huygens

OPTIKA®

RIPPLE TANK

OPTIKA Ripple Tank has the following advantages:
-Simple to assemble
-Easy to carry out experiments
-Reliable and repeatable results
-Excellent visual resolution of the wave front

The stroboscopic lamp is fitted with an extra-bright 3W LED, which is synchronised with the surface wave generator.
The control unit is equipped with a digital display and allows to set or to stop the synchronism of the vibrator with the lamp, the modulation of wave amplitude and its frequency.
The vibrator is of an electro-dynamic type.

The tank is provided with two adjustable feet and with an easy-to-use drain pipe ending with a tap.

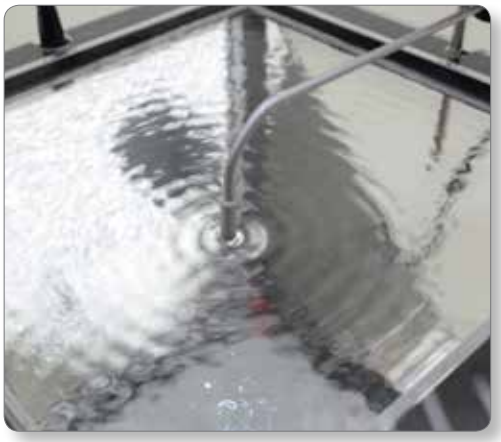
Dimensions:
Tank (overall): 30x30 cm
Projection Screen (overall): 30x30 cm

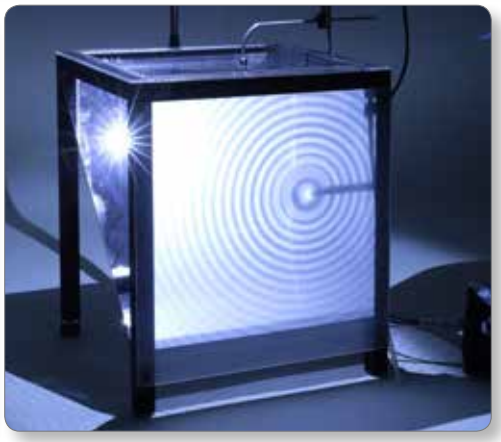
Packaging
OPTIKA Ripple tank is delivered in a preformed polystyrene packaging.

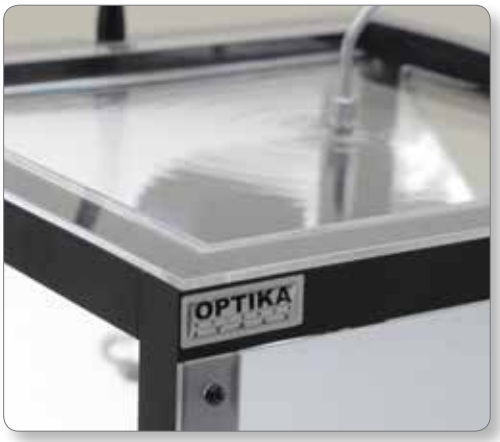
■ **3032**

TOPICS

- *Superficial waves on water*
- *Wavefront*
- *Wavelength*
- *Propagation speed*
- *Reflection*
- *Refraction*
- *Interference*
- *Stationary waves*
- *Diffraction*
- *Huygens' principle*







Ripple generator

Ripple generator with power adapter.
Frequency: 0-50 Hz.
Switch on/off synchro LED.
Digital display.

Vibrator

The vibrator is of an electro-dynamic type.

White LED

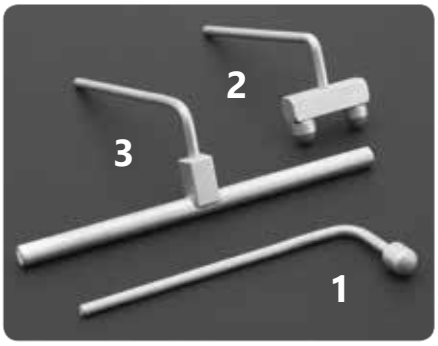
3W, white LED light source with both strobe and steady modes.

Acrylic lens

Acrylic lens, convex
Acrylic lens, concave
Acrylic trapezium
For experiments on refraction

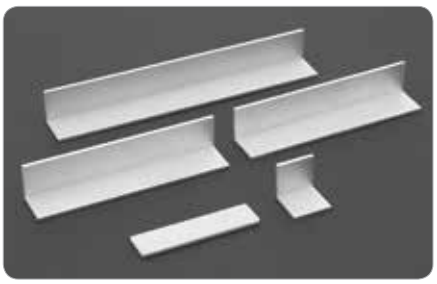
Dippers

1. Single Dipper
2. Double Dipper
3. Dipper for parallel waves



Barriers

For experiments on diffraction, reflection and for measuring wavelenght.



Convex reflector

For extra experiments on reflection.

Accessory for "Ripple Tank"

Trolley for Ripple Tank

Thanks to this trolley, teachers can easily move the ripple tank's equipment from a classroom to another.
It is very simple to assemble: the trolley is supplied with three trays to collect all the items you need to perform the experiments.

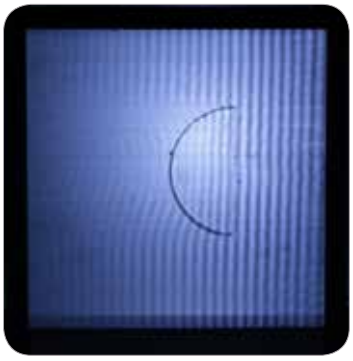
■ **3037 Trolley for ripple tank**

One point source dipper

Plane waves

Two points source dipper

Refraction using a convex acrylic lens



OPTIKA®

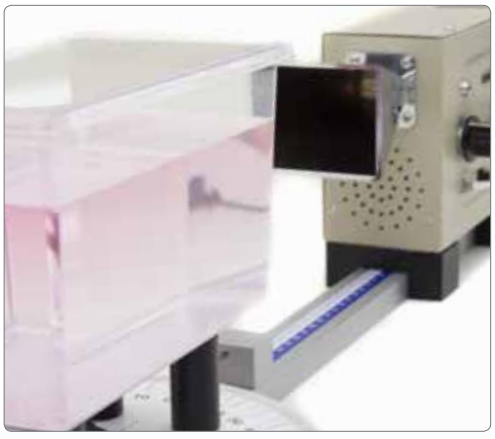
MICROWAVES OPTICS KIT

This microwaves set includes one transmitter, one receiver, one dipole probe and some accessories.
It is useful to study several experiments on microwaves.
I.e. it allows students to observe that microwaves have the same characteristics of light waves and that they result in the same phenomena as reflection, refraction and diffraction.

■ **5263**

TOPICS

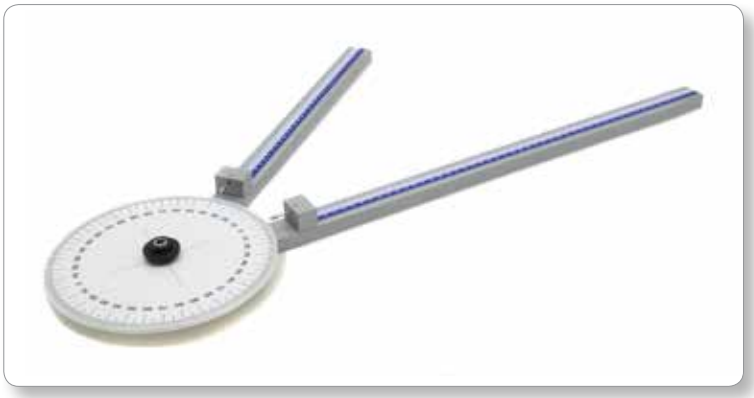
- *Polarization*
- *Diffraction*
- *Refraction*
- *Determining the wavelength of standing waves*
- *Reflection*
- *Absorption*
- *Straight-line propagation of microwaves*



Transmitter
Frequency of oscillator:
11±1GHz
Transmitted power: >10 mW
Acoustic signal:
-1 KHz
-on/off
-music
Dimensions: 270x100x150 mm
Mains voltage: 220V 50Hz

Receiver
Gain: ≥ 60 dB
Input for dipole probe
Voltage output: -1,11V
Dimensions: 270x100x150 mm
Mains voltage: 220V 50Hz
Sensitivity & gain control

Microwave probe
1 Dipole antenna with wire



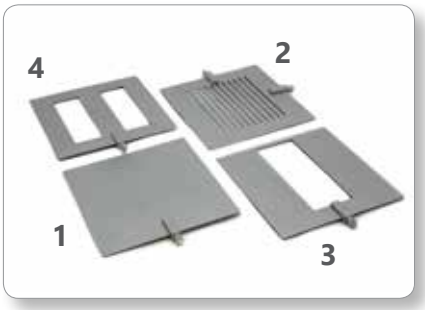
Jointed bench
Microwave aluminum bench, two arms: 500 mm and 650 mm long.
Provided with plate holder and protractor.

Paraffin prism
Useful to practice experiments on wave refraction.

Polystyrene body
Useful to practice experiments on wave absorption.

Protractor
With an accuracy of 1°, the graduated scale is screen-printed on a policarbonate plate for a simple and quick measurement reading.

Set of 4 plates
Dimension: 155x155 mm.
1. Reflection plate.
2. Polarization grating, 11 slits.
3. Slit plate, slit 50 mm.
4. Double slits plate, single slit 35 mm.



Water tank
Useful to practice experiments on wave absorption.

What is a standing wave? Let us take a practical example: the string of a guitar, a rope fixed at both ends, is vibrating.
After a transitional phase, in this vibrating string, point by point, two "movements" overlap. The first movement occurs by moving the string upward or downward along an axis perpendicular to it, for example by pinching it. Since the string elastically tends to return to its initial position, this perpendicular displacement is propagated along the length of the rope, until it reaches an extreme. The "second movement" occurs when it bounces back and forth. Meanwhile, however, the string maintains the first movement by inertia: the two movements overlap. The two equal waves propagate along the string in opposite directions. Overlapping, they can produce a destructive interference to reach an amplitude equal to zero, or a constructive one, reaching the amplitude of maximum oscillation.

Stationary wave apparatus

Thanks to this kit, students are allowed to perform experiments in an easy way to observe what a stationary wave is and its behavior. This vibrator has to be connected to a function generator (not supplied). It must not be connected to the main voltage.

■ **3014**

TOPICS

- *Standing waves: what they are and its physical meaning*
- *Propagation velocity and tension of a string*
- *Longitudinal waves in a spring*

Stationary wave apparatus (smaller kit)

This vibrator has to be connected to a function generator (not supplied). It must not be connected to the main voltage.

■ **3014.1**

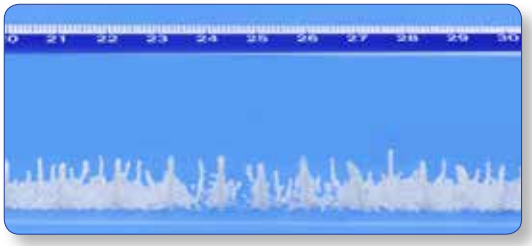
TOPICS

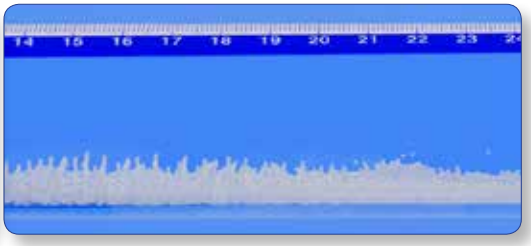
- *Standing waves: what they are and their physical meaning*
- *Propagation velocity and tension of a string*

Kundt's tube

The Kundt's tube is an apparatus invented in 1866 by the German physicist August Kundt.
This tube is transparent and horizontal, it contains an amount of a small styrofoam balls.
One end of the tube is free, the other one is blocked by a movable piston which can be used to adjust the length of the tube.
To perform the experiment a loudspeaker connected to a function generator producing a sine wave should be put near to the tube's free end.
When the function generator is switched on and the piston is adjusted until the sound from the tube gets suddenly much louder... what happens to the small balls inside?
Loudspeaker and function generator not supplied.

■ **3008**





As it is well known, the sound is in simple words a pressure wave. Because of the longitudinal motion of the air particles, there are regions where the air particles are compressed (compressions area) and other regions where the air particles are spread apart (depressions area). The compressions are regions of high air pressure while the depressions are regions of low air pressure.

Speed of sound in the air

An important gas property is the speed of sound in the air: thanks to this kit, students are able to measure the speed of sound in the air.
The speed of sound is the speed of transmission of a small pressure wave through a medium, in this case the air.
This kit should be used with an oscilloscope and an acustic wave generator (not supplied).

■ **3034**

Monochord

This instrument is composed of a single string, placed over a resonance box and fixed at both ends. The string is laid on an intermediate bridge which can be moved so that the sound reaches different frequencies.
The musical bow (bowstring or string bow) is a simple string musical instrument typical of many South African cultures, but also found in other places in the world.

■ **3004**

Vibrant bell

Everyday we hear many different sounds. Sometimes they are nice as for example music, sometimes they are annoying as the noise coming from the vehicle engines.
With this instrument, students will be able to verify that we hear a sound every time there is an elastic body that produce vibrations. Striking the bell with the little hammer, the little spheres bounce many times, demonstrating that the bell vibrates.

■ **3002**

Helmholtz resonance

Helmholtz resonance is the phenomenon of air resonance in a cavity. This is a widely-known phenomenon, though many ignore its name: blowing gently across the rim of an empty bottle, the sound produced is due to Helmholtz resonance.
When excess air is forced through a cavity, the pressure within it increases. Once the external force that caused the air pressure to increase stops, the air with the greatest pressure in the cavity will tend to exit from the same place it entered. This flow of air coming out overcompensates and the pressure level of the cavity will be slightly less than the external pressure, causing the air to be sucked. The resonant acoustic cavity has its own f0 frequency that depends on the geometry of the cavity.

■ **3010**

Current names of musical notes in use in Latin countries date back to the twelfth century. According to the legend, Guido d'Arezzo was in charge to decide the names of the notes following logical criteria: they corresponded to the first syllables of the first six verses of the hymn "Ut queant laxis":

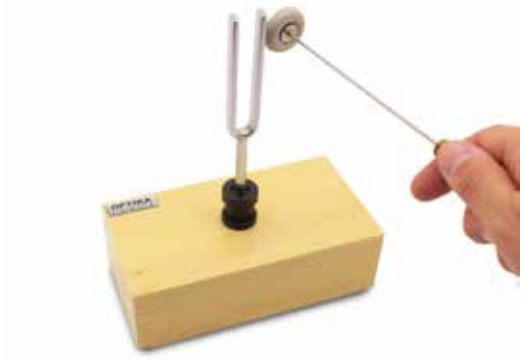
« Ut queant laxis
Resonare fibris
Mira gestorum
Famuli tuorum
Solve polluti
Labii reatum
Sancte Iohannes »

In the sixteenth century, the seventh note received its final name (SI, from the initials of Sancte Iohannes), while in the seventeenth century, in Italy, the musicologist Giovanni Battista Doni suggested to rename the UT, since it was formally considered difficult to pronounce, replacing it with the initial of Dominus, the Lord.

Tuning fork

Oscillation frequency: 440 Hz.
It is supplied with resonance box and hammer.

■ **3003**



Couple of tuning forks

Oscillation frequency: 440 Hz.
With resonance box, hammer and adjustable masses for beats.

■ **3029**

Set of 8 tuning forks

Frequencies : 261.6 Hz - 293.6 Hz - 329.6 Hz - 349.6 Hz - 392 Hz - 440 Hz - 493.9 Hz - 523.2 Hz
With case and hammer.

■ **3020**

5W amplifier

Power: 5W

■ **3114**

A loudspeaker is an electro-acoustic transducer which converts an electrical audio signal into a corresponding sound.

2.5 W loudspeaker

Power: 2.5W
Impedance: 8 Ohm

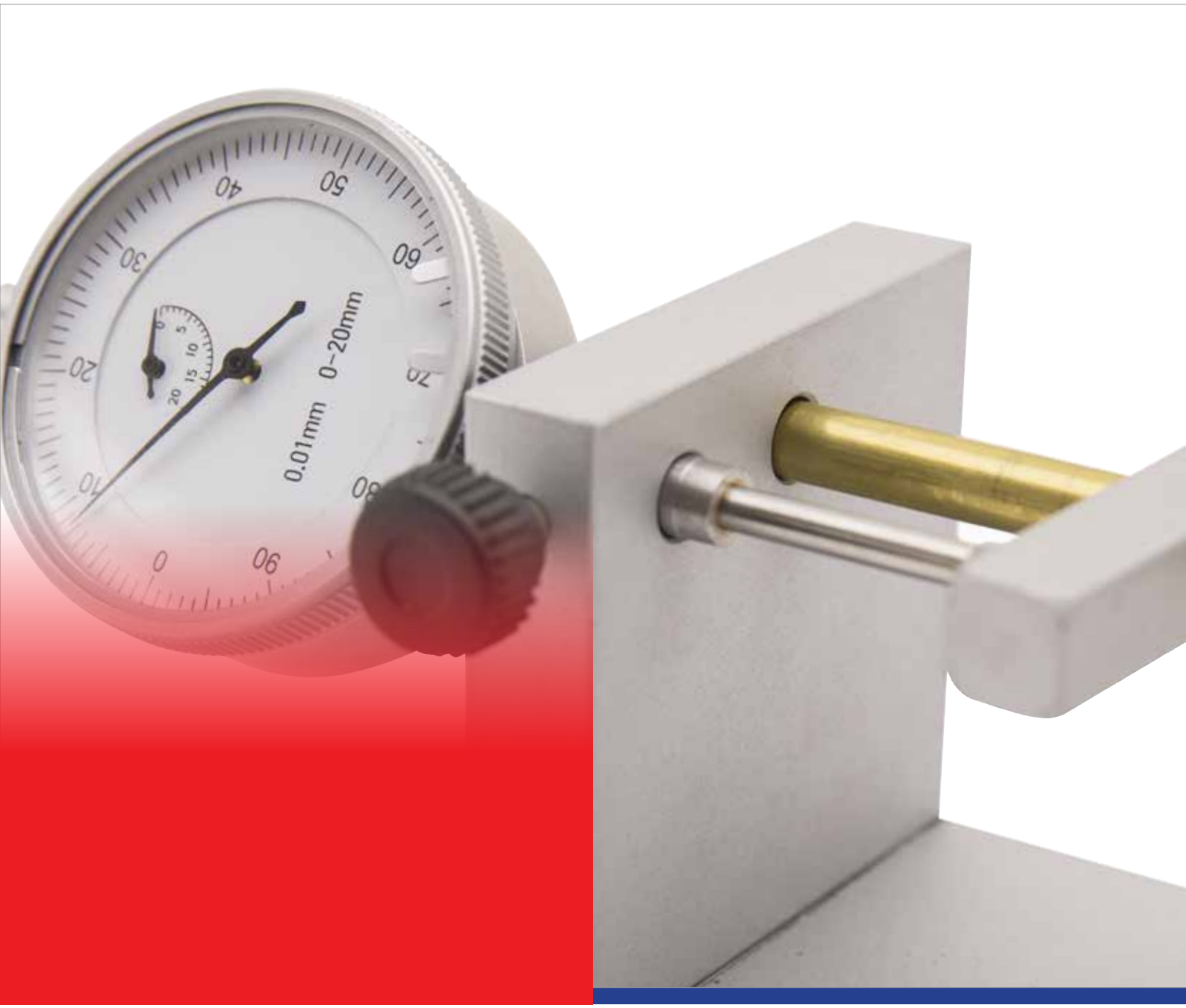
■ **3017**

0.5 W loudspeaker

Power: 0.5W
Impedance: 8 Ohm

■ **3021**

Heat



"The more thoroughly I conduct scientific research, the more I believe that science excludes atheism."

Lord Kelvin

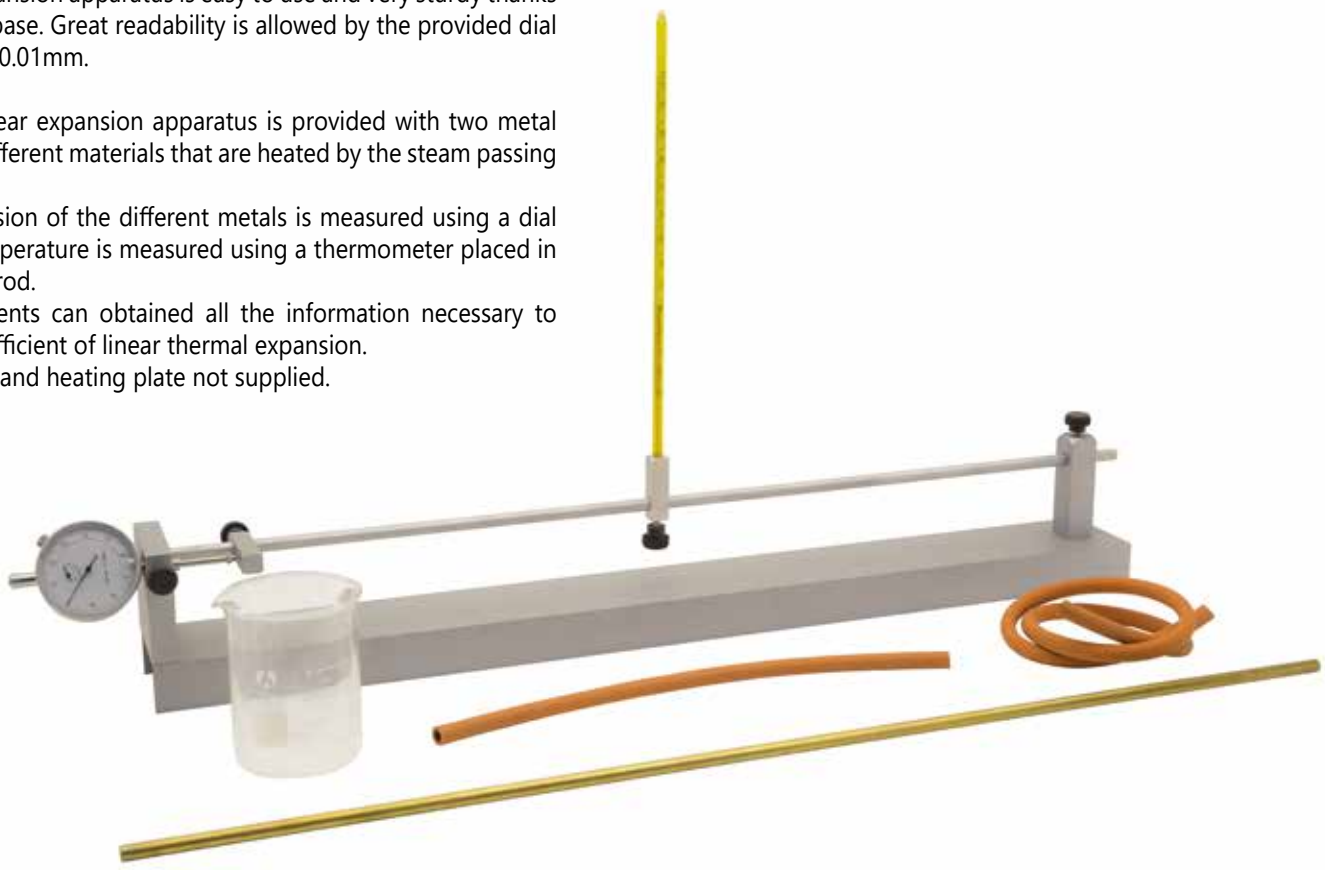
Thermal variations of bodies are always accompanied by other phenomena.
Among them, one particular phenomenon concerns solid, liquid and gases as well, that is, thermal expansion. This expression defines the fact that, except for very few substances, an increase in temperature produces an expansion, that is, an increase in the dimensions of the body.
When metallic rods expand, this phenomenon is called linear thermal expansion, since the expansion noticeably concerns their prevailing dimension, which is length.
A useful practical application of thermal expansion is the railway line.
The rails are placed at a distance of one or two centimeters from one another, because if they do not find space enough for their expansion with temperature increase in the summer season, they buckle as a consequence.

PRECISION LINEAR EXPANSION APPARATUS

Optika linear expansion apparatus is easy to use and very sturdy thanks to its aluminum base. Great readability is allowed by the provided dial gauge 0-10 mm, 0.01mm.

The precision linear expansion apparatus is provided with two metal hollow rods of different materials that are heated by the steam passing through them.
The linear expansion of the different metals is measured using a dial gauge, while temperature is measured using a thermometer placed in contact with the rod.
In this way students can obtained all the information necessary to calculate the coefficient of linear thermal expansion.
Steam generator and heating plate not supplied.

■ **2095**



Linear expansion apparatus

The thermal expansion is a characteristic physical phenomenon of solid bodies, liquids and gases. The physical property of a body that describes its expansion is called coefficient of thermal expansion. Thanks to this apparatus, students are able to observe the different expansions due to different coefficients.
The apparatus should be used with cotton wool soaked in alcool; it is supplied with three different rods made of iron, brass and aluminum.

■ **2046**

Expansion apparatus for liquids and gases

We cannot speak of an actual thermal expansion for gases, because they tend to occupy all the volume of their containers.
If a gas is heated in a closed container that has a movable wall, it can be noticed that the wall moves up to a certain point, increasing the volume of the gas container; there is therefore a close relation between the gas volume and pressure.

■ **2137**

Ball and rings apparatus

Holding the stem of the ring it can be verified that, at ambient temperature, the metallic ball passes effortlessly through it.
If the ball is heated for a few minutes, it is evident that the ball no longer fits the ring, because its volume increased in proportion to its own temperature increase. When the temperature returns to its initial value, the ball resumes its primitive dimensions and passes again through the ring.

■ **2076**

Ingenhousz case

Ingenhousz case is an easy-to-use instrument to observe what a different thermal conductivity between different materials entails.
This small case is filled with hot water in order to create a temperature difference between one end of the bar and the other one. So heat is transmitted to every bar in the same experimental conditions (same length and section) but, as the materials they consist of have different natures, the piece of wax covering them melts in a different moment. To be more precise, it melts faster on materials that have a greater thermal conductivity (good thermal conductors).

■ **2059**

The calorimeter concept is based on the exchange of heat energy between two or more bodies placed in contact with one another. From a thermal point of view, the thermodynamic system composed of the calorimeter and the body placed in it should not interact with the surrounding environment. Any heat exchanges with the outside are usually minimized thanks to some expedients, as the use of hollow spaces filled with air or water or walls of low emissive power.

Water calorimeter

Provided with thermometer and stirrer.
Capacity: 1000 ml

■ **2056**

Electric calorimeter

Provided with thermometer and stirrer.
It is supplied with two resistors, which can be used alone or in series.
Maximum working voltage: 6V.
Capacity: 350 ml

■ **8201**

Set of 4 samples with equal volume

For the measurement of specific heat using a water calorimeter up to 350 ml.
They are made of iron, brass, aluminum and PVC.

■ **2036**

Set of 4 samples with equal mass

For the measurement of specific heat using a water calorimeter up to 1000 ml.
They are made of iron, brass, aluminium and PVC.

■ **2087**

Joule determined the mechanical equivalent of heat thanks to his most famous experiment: the paddle wheel driven by weights rotates in a water calorimeter.

Apparatus for the measurement of the mechanical equivalent of heat

This apparatus is composed of a brass calorimetric cylinder supported by ball bearings. A copper ribbon is rolled around the cylinder and retained by a spring; a 5 kg weight hangs from it.
Because of the friction between the ribbon and the cylinder during the rotation, the water in the cylinder warms up.
Measuring the work done and the heat produced, it is possible to determine the mechanical equivalent of heat.
The apparatus is supplied with boss heads and a 1/10 degree digital thermometer.

■ **2055**

Rüchardt apparatus

Thanks to Rüchardt experiment it was possible to study the quasi-static adiabatic processes of a gas. Eduard Rüchardt performed it in 1929 to measure the relationship between C_p and C_v, indicated with $\gamma = C_p/C_v$, respectively, the ratio between the specific heat at constant pressure and that at constant volume.
Thanks to this apparatus, it is possible to study an adiabatic gas process. This experimental apparatus is a modified version of the classical Rüchardt experiment.

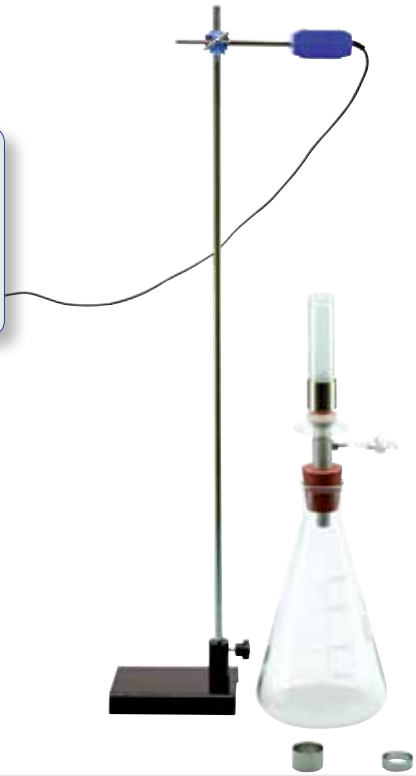
■ **2136**

ON-LINE Equipment required not supplied

- *1 Sensor support*
- *1 Distance sensor*
- *1 Interface*

otherwise

- *1 USB distance sensor*
- *1 Sensor support*

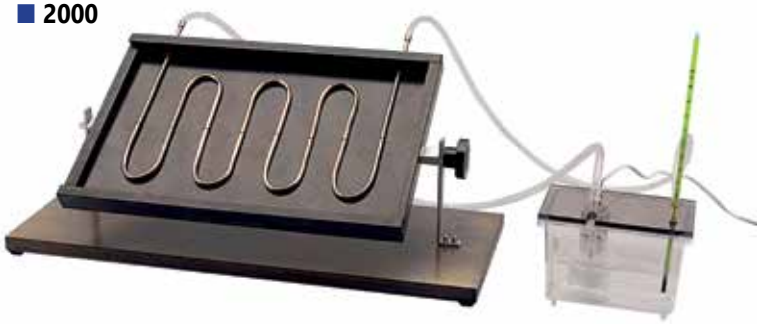


In solar thermal systems with forced circulation, the tank is mounted separately from the primary circuit and the liquid is pushed by a pump. The pump is started by an electronic control unit which compares the temperatures of the manifolds and of water in the storage tank detected by the probes.
The main components of a solar thermal system are:
- a solar panel;
- a hot water storage tank;
- a pump for water circulation;
- an electronic control unit.

Solar water heater

Thanks to this device students can heat water by means of sun radiant power. An immersion pump, working at 12 V dc, makes the water circulate in the heating coil of the solar panel.
After a few minutes it is possible to observe an increase in temperature.
It is supplied with a transformer.

■ **2000**



Radiation is one of the three ways in which the propagation of heat occurs: it does not require a direct contact between the exchangers or a medium to propagate.
It is a phenomenon that affects every aggregate material, whether solid, liquid or gas, and also takes place in vacuum. This is justified by the fact that the heat transfer by radiation occurs in the form of electromagnetic waves.

Radiation apparatus

Thanks to this apparatus students are allowed to perform some simple but effective experiments to observe and measure the propagation, reflection and absoption of thermal radiation.

■ **2052**

TOPICS

- *Rectilinear propagation of thermal radiation*
- *Reflection of thermal radiation*
- *Absorption of thermal radiation*

Convection tube

An heat exchange, always observed when there is a change in temperature, can occur in different ways: conduction, convection and radiation.
The heat convection takes place when there is an exchange of energy together with a real movement of matter. We talk about convective motions: they take place in liquid or gaseous substances, since the particles of a solid are not free to move.

■ **2058**

Absorbent and emitting powers apparatus

The incident radiation on a surface is partly reflected, partly absorbed and partly transmitted. Calculating the percentage of radiant power transmitted, reflected and absorbed with respect to the incident radiant power, the following coefficients can be defined:
1) the absorption coefficient
2) the reflection coefficient
3) the transmission coefficient
Thanks to this instrument, students are able to evaluate the radiant power absorbed and transmitted by two different bodies.

■ **2031**

TOPICS

- *Radiation emission*
- *Coefficient of absorption*
- *Emission power*

Optics

"Truth is ever to be found in simplicity, and not in the multiplicity and confusion of things."

Isaac Newton

Either photography or television use the mixing of colours to work. Applying a process known as additive colour synthesis, three primary colours are added, red, green and blue, to obtain all the other colours. In order to project a beam of red light, a beam of green light and a beam of blue light on a white surface in a completely dark room, in such a way that they partially overlap, the areas where two primary colours overlap will show other three colours, known as secondary colours and precisely yellow, magenta and cyan.

The additive colour synthesis is based on a feature of our eyes, known as the persistence of vision on the retina.
When the retina is excited by light, it sends impulses to the brain. The cells in the retina continue to send impulses for a few fractions of a second even after the incident light is removed: that is why it is not possible to distinguish two consecutive light events following one another at time intervals shorter than one tenth of a second.

Electric Newton's disk

Provided with 5 disks
Power supply: 3V dc

■ **4200**

Benham's disk

A Benham's disk has only two colours: black and white.
By making the disk rotate around its axis, different coloured arches appear, which vary depending on the drawing, the rotation speed, the direction and the person who observes the disk.
Such phenomenon has not been fully explained, however it relates to the human visual field and particularly to its colour perception.

■ **4510**

Subtractive colour synthesis apparatus

This kit enables students to perform experiments demonstrating that subtracting different chromatic components from white light, you can obtain primary colours or their additive synthesis on a white screen. In the printing method: paint and ink play the role of the filters.

■ **4353**

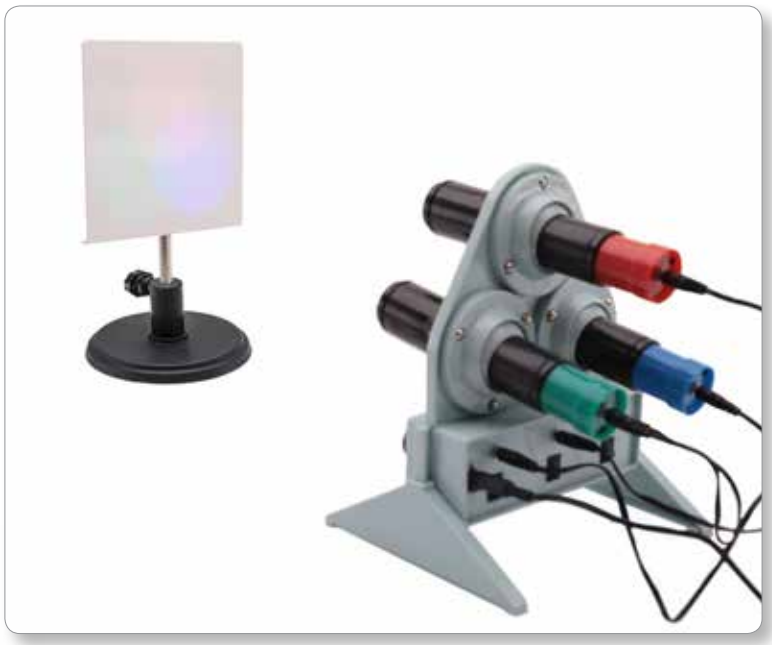
Additive colour synthesis apparatus

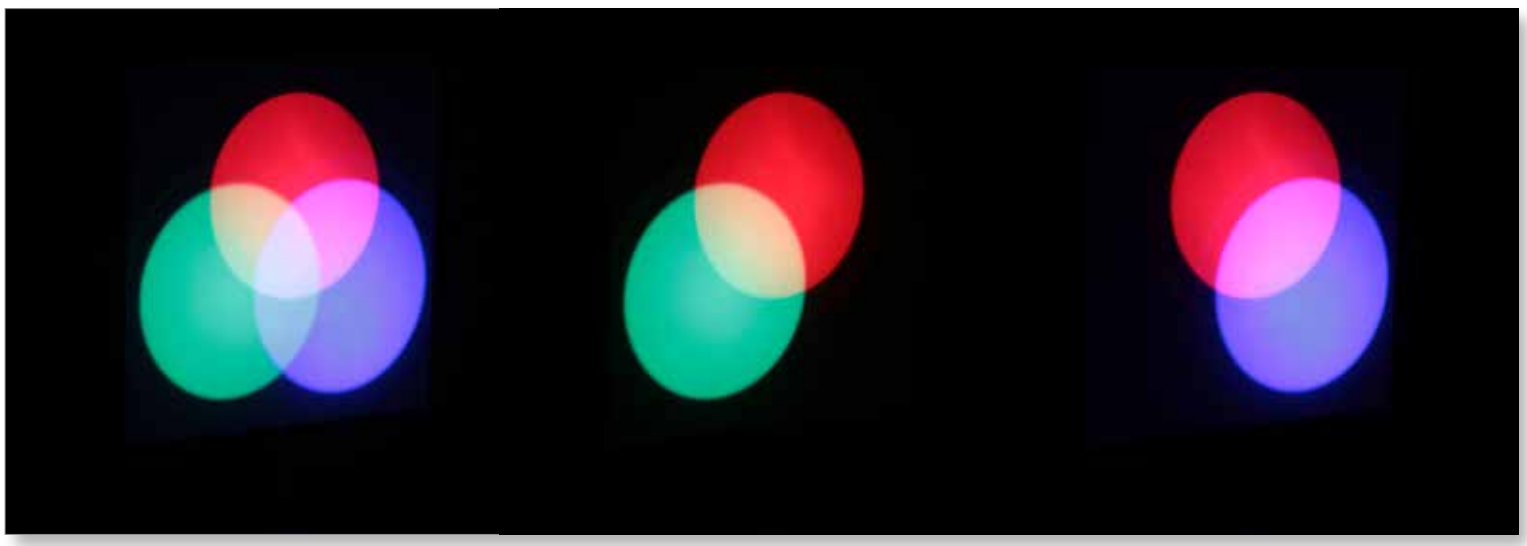
Thanks to this apparatus students are allowed to perform the additive colour synthesis using the primary colours: red, green and blue.
The apparatus is supplied with 3 LEDs, whose intensity can be adjusted. In this way it is possible to obtain the white colour and all the other colours of the colour triangle.

■ 4352

TOPICS

- *Binary colour synthesis*
- *Complementary colours*
- *The trichromatic coordinates*
- *Colour triangle*
- *Colour reproduction*





Optical benches, modular system

In this modular system it is possible to choose between benches of different lengths. It is also possible to connect a joint extension of 50cm to each of them: this is very useful to perform optical experiments where the optical beam, due to the effect of reflection or refraction, comes out from the main axis of the bench.
Thanks to these optical benches, the teacher can perform a large number of experiments on optics core topics.
To satisfy teaching needs, we offer various accessories to complete your own optical bench.

- **4401** 100cm, Optical bench
- **4402** 150cm, Optical bench
- **4404** 200cm, Optical bench

Accessories for "Optical benches, modular system"

- **4361** LED Light Source
- **4362** Optical Bench Extension 50cm
- **4363** Lens Holder with Rod
- **4365** Plexiglas White Screen 250x190x4mm
- **4366** White Screen With Scale
- **4367** Screen Support
- **4368** Optical Bench Laser
- **4370** Couple of Polarizing Filters
- **4372** Set of Optically Active Substances
- **4373** Prism Support
- **4374** Optical Bench Lux Meter
- **4375** Iris Diaphragm
- **4376** Punctiform Lamp
- **4377** Earth-Moon System
- **4380** Adjustable Slit
- **4060A** Converging Lens, +6
- **4060B** Converging Lens, +10
- **4060C** Diverging Lens, -10
- **4060D** Converging Lens, +20
- **4381** Set of 4 Plexiglas Lenses and Two Mirrors
- **4382** Set of 4 Glass lenses + 2 Mirrors and Container
- **4383** Horizontal Goniometer
- **4371** Polarimetric Tube
- **4212** Diffraction Grating 500 lines/mm
- **4106** Diffraction Grating 80 lines/mm
- **4213** Diffraction Grating 1000 lines/mm
- **4104** 1 Slit Slide
- **4105** 2 Slits Slide
- **4143** 3 Diffraction Gratings (100-300-600 lines/mm)
- **4301** Support Straddle
- **4151** Green Diode Laser
- **4207** Red Diode Laser
- **4144** Hollow Equilateral Prism
- **4112** Flint Glass Prism
- **4111** Crown Glass Prism
- **4016** Plexiglass Equilateral Prims
- **4072** Rectangular Isosceles Prism
- **4025** Semicylindrical Plexiglass Body
- **4158** Set of 7 Optical Bodies (glass)
- **4363** Lens Holder
- **4390** Filter Holder
- **4020** Blue Filter
- **4019** Green Filter
- **4018** Red Filter

Accessories for "Optical benches, modular system"

4361


4362


4363


4365


4366


4367


4368


4370


4372


4373


4374


4375


4376


4377


4380


4060A


4060B


4060C


4060D


4381


4382


4383


4371


4212


4106


4213


4104


4105


4143


4301


4151


4207


4144


4012


4111


4016


4072


4025


4158


4363


4390

4019 - 4019 - 4020

Thanks to the optical benches we propose below, teachers will be able to perform a great number of quantitative and qualitative experiments on both geometric and ondulatory aspects of optical waves.
These benches are a fundamental educational instrument to transform a lesson into a moment of real union between theory and experimental reality, thanks to the quick assembly and the ease in performing the experiments.

90 cm small optical bench

■ **4202**

TOPICS

- *Rectilinear propagation of light*
- *Eclipses and moon phases*
- *The laws of lighting*
- *Diffusion, Reflection and refraction of light*
- *Total reflection*
- *Reflection of light into spherical mirrors*
- *Refractive index and the colours of light*
- *Refraction of light through a prism*
- *Dispersion of the white light*
- *Lenses and mirrors*
- *Conjugate points of spherical mirrors*
- *Images in converging lenses*
- *Conjugate points of converging lenses*
- *The eye and its defects*

120 cm wave and geometrical optics bench

■ **4080**

TOPICS

- *Rectilinear propagation of optical waves*
- *Lunar and solar eclipse*
- *Light scattering*
- *The laws of radiation*
- *Refraction and reflection laws*
- *Reflection in spherical mirrors*
- *Images in spherical mirrors*
- *Total reflection*
- *Refraction through a prism and lenses*
- *Images in lenses*
- *The eye and its imperfections*
- *Optical instruments*
- *The diode laser*
- *Diffraction through a hole and a slit*
- *How to measure the wavelength of a laser*
- *Interference of light*
- *Interference according to Young*
- *Measurement of a wavelength with Young's method*
- *Measurement of a wavelength with a grating*
- *Measuring the wavelength of white light*
- *Linear polarization*
- *Polarized light*
- *Natural rotational power*

90 cm waves optics bench

■ **5680**

TOPICS

- *Optic waves*
- *Dioptric projector*
- *Diode laser*
- *Optics waves speed*
- *Polychromatic and monochromatic sources*
- *Emission spectrum*
- *Diffraction through a hole*
- *Diffraction through a slit*
- *Measurement of λ*
- *Interference of light*
- *Interference according to Young*
- *Diffraction grating*
- *Linear polarization*
- *Polarized light*
- *Polarization by reflection*
- *Brewster's angle*

How to measure the wavelength of light

■ **4322**

TOPICS

- *Undulatory nature of light*
- *How to measure the wavelength of a monochromatic source*
- *How to analyze the spectrum emitted from a polychromatic source*
- *How to measure spectral width*
- *Characteristics of filters*

Geometrical optics kit

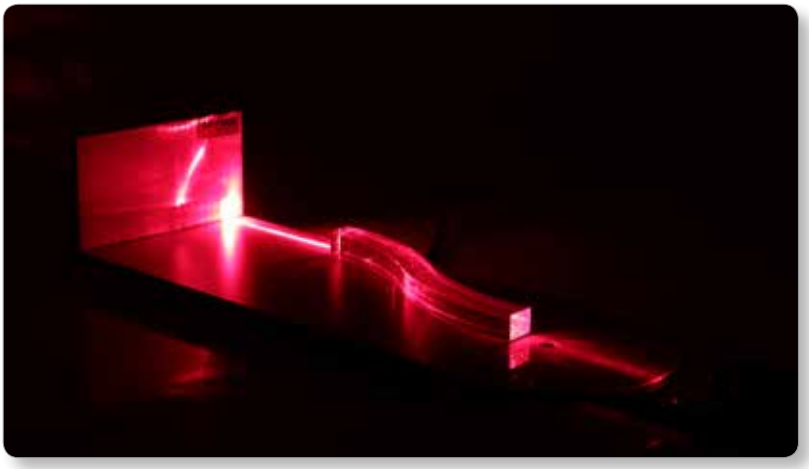
■ **4321**

TOPICS

- *Light reflection on a plane mirror*
- *Reflection on a concave spherical mirror*
- *The properties of the focus and of the centre of a mirror*
- *Convex spherical mirror*
- *Refraction on a plane surface*
- *Refraction through prisms: how to measure total deflection angles*
- *How to measure the index of refraction by means of the minimum deflection angle*
- *The index of refraction of liquids*
- *Total reflection and critical angle*
- *Focal distance of converging and diverging lenses*
- *Galileian telescope systems*
- *Spherical aberration*

Optical fibre kit

■ **4329**



TOPICS

- *The optical fibre as light waveguide*
- *"Air mantle" optical fibre*
- *"Water mantle" optical fibre*

Mirror-like dihedral

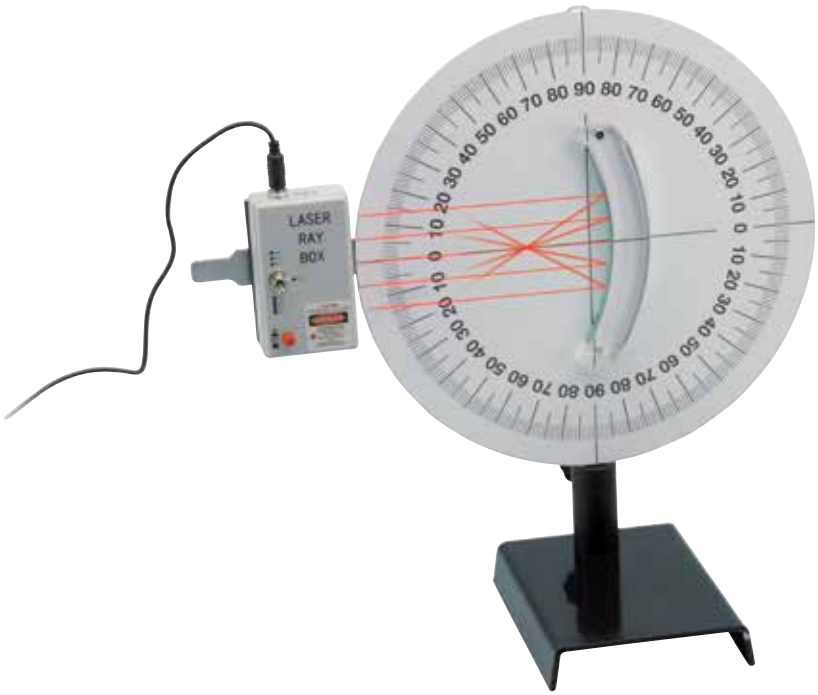
This device is composed of a couple of plane mirrors forming a dihedral angle with a variable amplitude.
The amplitude of the dihedral angle can be measured using the protractor placed on the base.
When an object is placed in front of the mirror along the bisector of the angle, students are able to verify that the number of images, created by the system, depends on the amplitude of the angle.

■ **4030**

Hartl's disk with laser

An easy and simple instrument to perform experiments on geometrical optics.
The laser ray box is supplied with a switch which allows three different beam configurations (1-3-5 rays).

■ **4214**



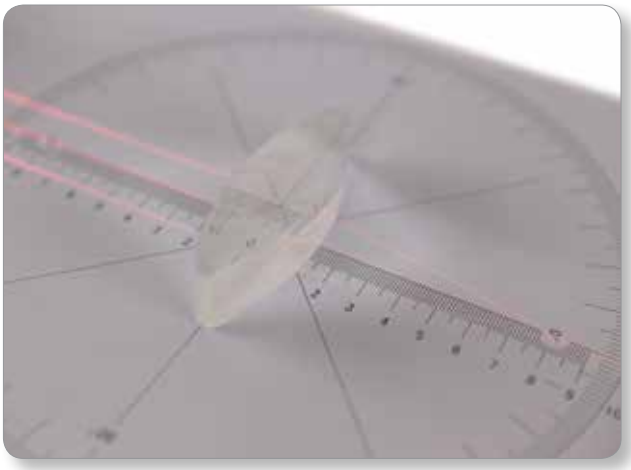
TOPICS

- *Reflection and refraction law*
- *Reflection in spherical prism*
- *Converging and diverging lenses*
- *Total reflection and refractive index*

Geometrical optics kit with laser ray box

Thanks to this kit, students can easily and quickly perform all basic geometrical optics experiments.
The laser ray box is supplied with a switch that allows three different beam configurations (1-3-5 rays).
The high-quality optic bodies allow to observe the trajectory of reflected and refracted beams.
Thanks to its good quality/price ratio and to number and quality of the feasible experiments, this kit represents the best solution for geometrical optics experimentation for primary and secondary school.

■ **5607**

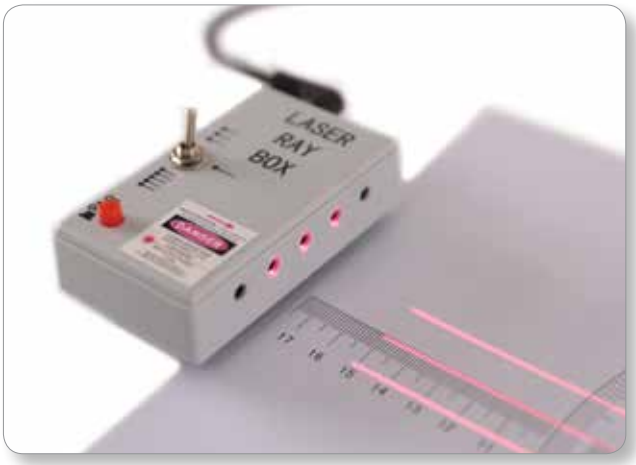


TOPICS

- *Reflection and refraction laws*
- *Reflection in concave and convex mirrors*
- *Refraction across a plate with plane and parallel faces*
- *Refraction through converging and diverging lenses*
- *How to measure refraction index of a liquid*
- *Total reflection*

Geometrical optics kit, magnetic version

■ **5609**



TOPICS

- *Reflection and refraction laws*
- *Reflection in concave and convex mirrors*
- *Refraction across a plate with plane and parallel faces*
- *Refraction through converging and diverging lenses*
- *How to measure refraction index of a liquid*
- *Total reflection*

Electricity And Magnetism

"It is paradoxical, yet true, to say, that the more we know, the more ignorant we become in the absolute sense, for it is only through enlightenment that we become conscious of our limitations. Precisely one of the most gratifying results of intellectual evolution is the continuous opening up of new and greater prospects."

Nikola Tesla

Rubbing certain bodies with a cloth, they become able to attract light objects, such as pieces of paper, feathers or hair.
This characteristic was known since the ancient times and was called electricity, from the Greek word elèctron, that means amber.
The first experiments regarding electricity were performed rubbing some amber rods with animal skins.
These experiments has then shown that the electricity isn't an exclusive characteristic of the amber, but we can find it in many bodies.

Rods

- **5139** Hard rubber - Ø 12 mm; l 25 mm
- **5002** Plexiglass - Ø 12 mm; l 25 mm
- **5003** PVC - Ø 12 mm; l 25 mm
- **5058** Glass - Ø 12 mm; l 25 mm

A body can be charged even by electrostatic induction.
Placing a neutral body near to another one which is charged, charges are induced on the neutral body, the similar ones on the opposite side with respect to those of the charged body, the opposite charges on the surface of contact between the two bodies.

Set of 5 friction rods

- **5348**

Electrostatic cell

- **5714**

Double electrostatic pendulum

- **5090**

Volta's electrophorus

The electrophorus, also called Volta's electrophorus, is an electrostatic generator able to accumulate a certain amount of electric charges. Designed by Alessandro Volta around 1775 during his studies on electricity and quoted in his "Letter to Joseph Priestley," it currently has an educational value.

- **5431**

WIMSHURST MACHINE

It has two special disks which do not deform over the course of time.
Two Leyda decomposable bottles.
Spark: 50-60 mm.
Disk diameter: 400 mm.

THE BIGGEST ON THE MARKET

■ **5085**

100% Plexiglas

VAN DE GRAAFF GENERATOR

The Van de Graaff generator is an electrostatic machine which uses a moving belt to accumulate electrostatic charge on a hollow metal globe on the top of a transparent and insulated column, that allows students to see how the system operates.
It is provided with a 225 mm sphere which can generate approximately 150 ÷ 200 KV.

It is provided with an electric variable speed motor or hand driving.
Discharge sphere, electrostatic plume and electrostatic whirl are included.
It is possible to adjust the distance between the globe and the discharge sphere thanks to an articulated joint placed on the base.

Dimensions:
Spheres' diameter: 225 mm and 70 mm
Height: circa 650 mm
Base: 250 x 350 mm

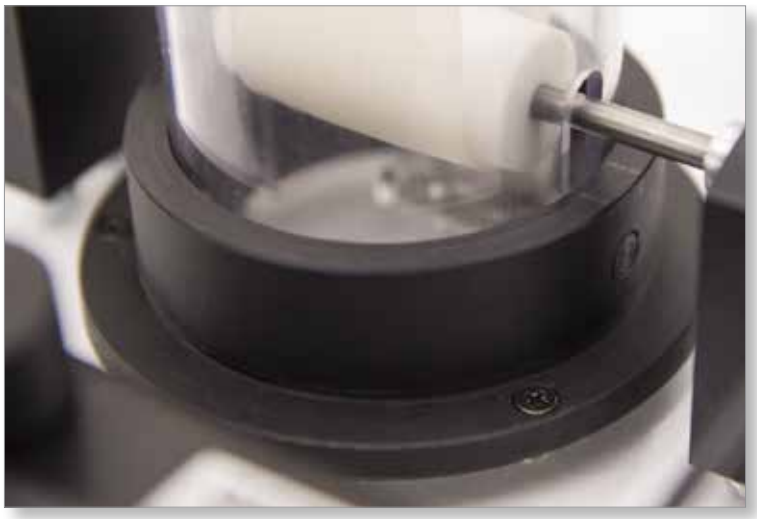
■ **5549**

Electrostatic plume

Plumes stand on due to the repulsive force between same charges.

Electrostatic whirl

When placed on the globe of the Van de Graaff Generator, the spokes are propelled by the charges leaving the points.



Accessories for "Van De Graaff generator"

Accessories for the Wimshurst machine

All-in one kit: it contains all what you need to perform experiments using your Wimshurst machine.
Equipment supplied:
- dancing balls
- double electrostatic pendulum
- electrostatic plume
- electrostatic blower
- electrostatic whirl

■ **5051**

Accessories for "Wimshurst machine"

Accessories for Van De Graaff generator

All-in one kit: it contains all what you need to perform experiments with your Van de Graaff generator.
Equipment supplied:
- dancing balls
- electrostatic whirl
- Faraday's cage
- double electrostatic pendulum
- electrostatic plume
- electrostatic blower
- articulated discharger
- spark panel
- electrostatic engine

■ **5404**

Plate capacitor

This capacitor is composed of two plates, supported by insulating supports that can slide on a guide to vary, at your leisure, the distance between the two plates.
This instrument allows students to analyze how capacitor capacity depends on, the distance between the plates and on the dielectric material that is used.

■ **5093**

Electric field lines

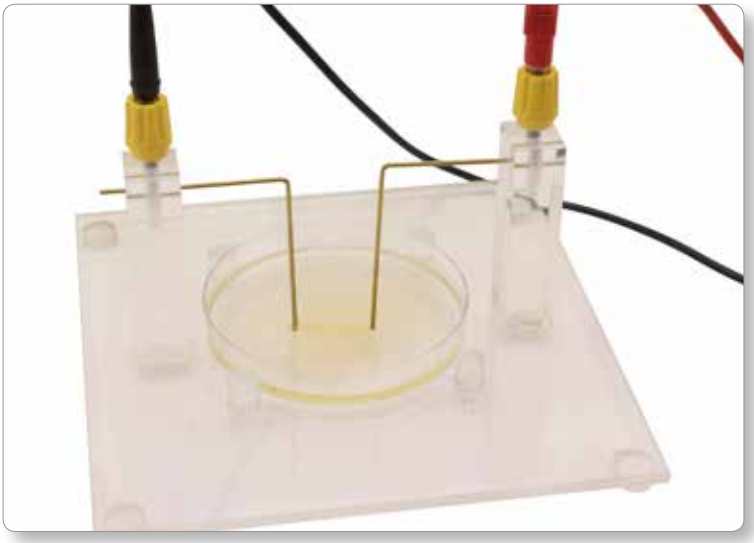
The theory of the field lines came from Michael Faraday (1791 - 1867), who used them to represent the magnetic field, that is, the deformation of the physical space around a magnet; today his idea is used to represent any vector field size.
The electric field is an area of space modified by the presence of electric charges, but the deformation is not visible to the naked eye. We may represent the field by drawing the electric field vectors at several points of space, but it would be a fairly confusing sketch.

■ **5351**

Electrostatic smoke precipitator

The smokes and powders coming out of the chimneys of factories using toxic substances heavily contribute to air pollution. With this apparatus, teachers can show how to eliminate these smokes. A lit cigarette is connected to flask, thanks to a rubber tube. If you suck the air out using the pump, the flask fills up with smoke.
The internal electrode and the external plate must be connected to an electrostatic machine. Switching on the machine, at first the smoke spins around, then it disappears. Repeating this operation several times, the walls become black. Cleaning the flask with a bit of alcohol, the tar contained in the cigarette smoke melts down, allowing the teacher to show the damage caused to the airways.

■ **5703**



Electrostatic whirl

This instrument is an electrostatic conductor equipped with three metallic rays, all bent in the same direction and pivoting on a vertical axis. By connecting it to a Wimshurst machine or to a Van de Graaff generator, the whirl starts to rotate, since the tips high potential partially ionizes the air.

■ **5099**

Point-shaped conductor

■ **5204**

Electrostatic bell ring

This instrument is composed of a metal pendulum placed between two bells. One of them is electrically insulated while the other one must be connected to an electrostatic machine. In this way, charges with opposite sign are generated on bells and the pendulum strikes the two bells alternately.

■ **5073**

Electrostatic blower

■ **5046**

Cylindrical conductor

■ **5070**

Faraday's cage

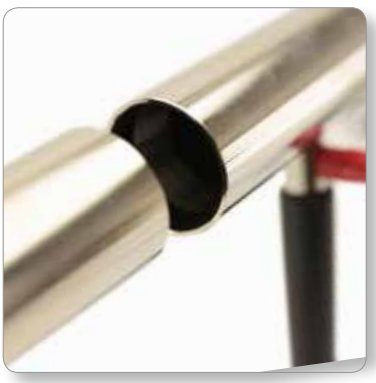
■ **5140**

Conductors – electroscopes

■ **5089**

Cylindrical conductors, couple

■ **5071**



Articulated discharger

■ **5092**

Spherical conductor

■ **5091**

Coulomb sphere

■ **5087**

Cavendish hemispheres

The Cavendish hemispheres are used to demonstrate that in an isolated conductor the electric charges move to the outer surface of the conductor.

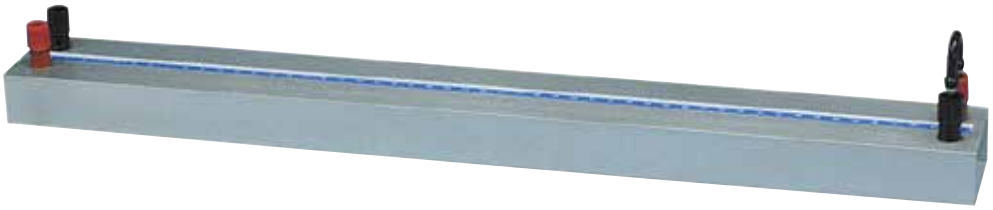
■ **5072**

Thanks to the German physicist Georg Simon Ohm, we are able to state that the difference of electric potential applied to the ends of a conductor and the intensity of the electric current that passes through it are directly proportional.
The constant of proportionality is called the electrical resistance.

Ohm's law table

This instrument is supplied with a short-circuit bridge. No wires are supplied.

■ **8504**



Series of conductors

This device is supplied with kanthal, nichel-chromium and constantan wires – 1 m long.

■ **5098**

Optika's electrical accessories are made of sturdy blue plastic material 100x55x30 mm circa. They allow students to study in an easy and direct way the most widely used electrical components.

Silicon diode

It can straighten up a half-wave.

■ **5146**

Thermistor NTC

Its resistance decreases as temperature increases.

■ **5144**

Thermistor PTC

It's resistance increases as temperature increases.

■ **5389**

Photoresistor

It varies its resistance as a function of the light received.

■ **5133**

Lamp holder e12

■ **5009**

Switch

■ **5008**

Deflector

■ **5136**

Shunting switch

■ **5132**

Inverter

■ **5137**

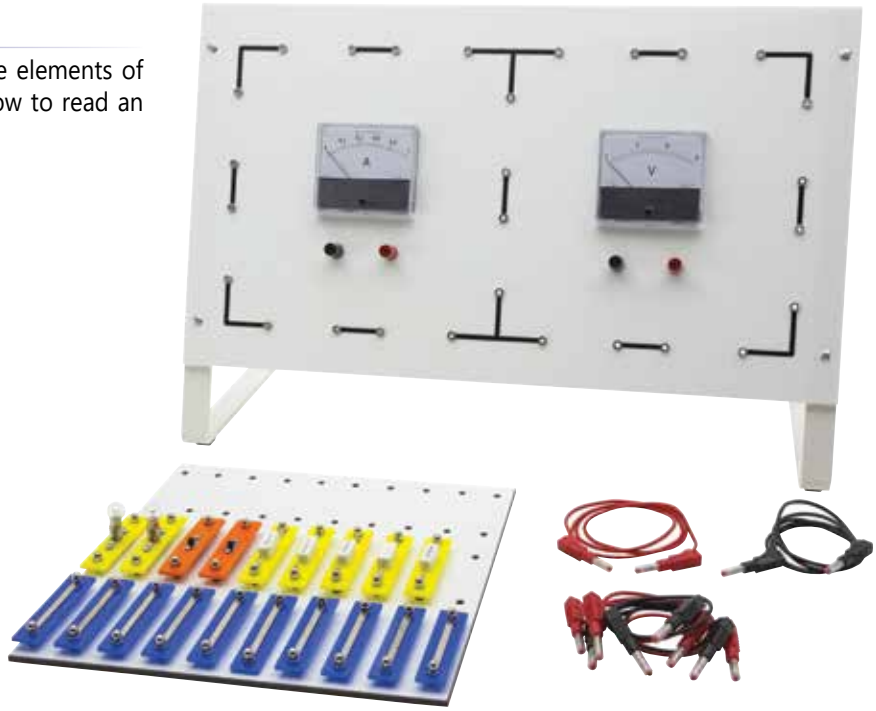
Resistor and capacitor holder

■ **5056**

Set for experiments on electric circuits

This kit provides all the items needed to study the core elements of electric circuits such as series and parallel resistance, how to read an ammeter and a voltmeter and so on.

■ **5130**



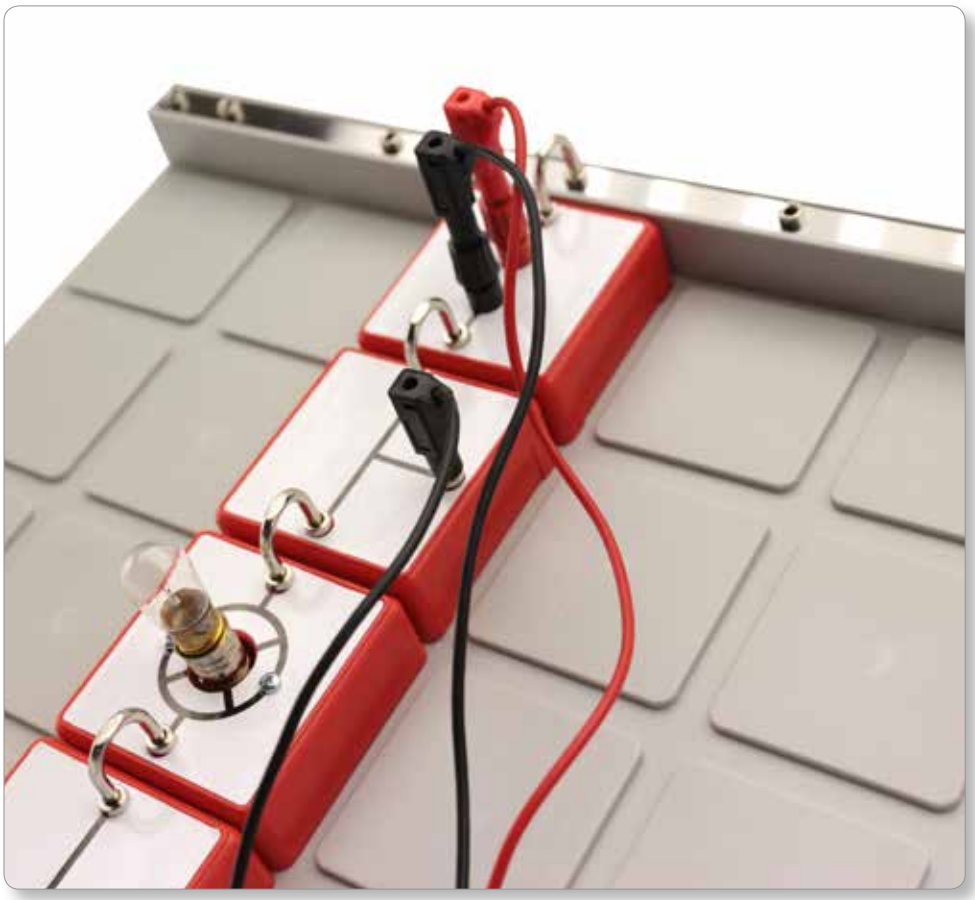
TOPICS

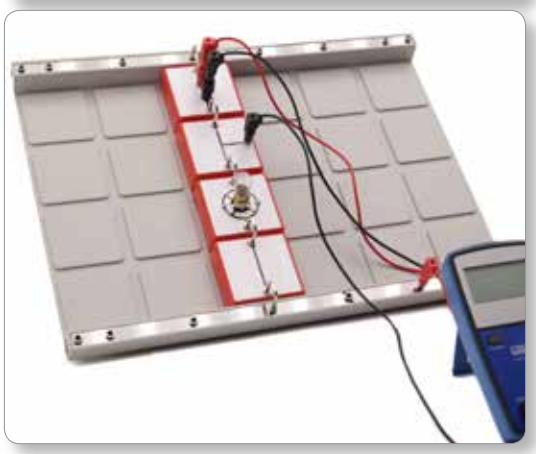
- *Electric circuit*
- *Ohm law*
- *Series resistance*
- *Parallel resistance*
- *Resistor and temperature*

Modular system to study electric circuits

Power supply not included.

■ **5332**





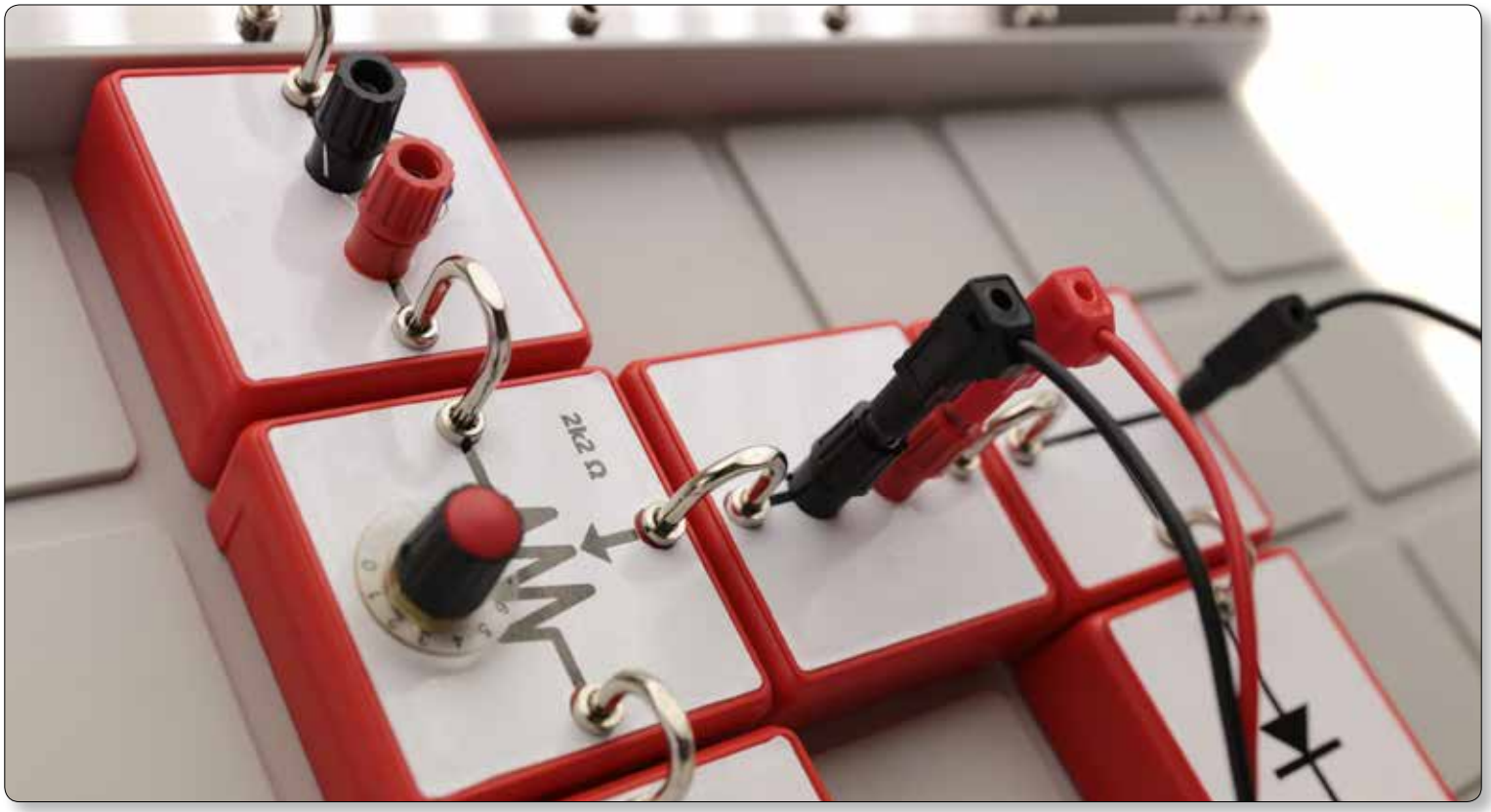
TOPICS

- *Series resistance*
- *Parallel resistance*
- *Ohm laws*
- *Lamps*
- *How to use a voltmeter and ammeter*
- *Potentiometer*
- *Rheostat*

Modular system to study electronics

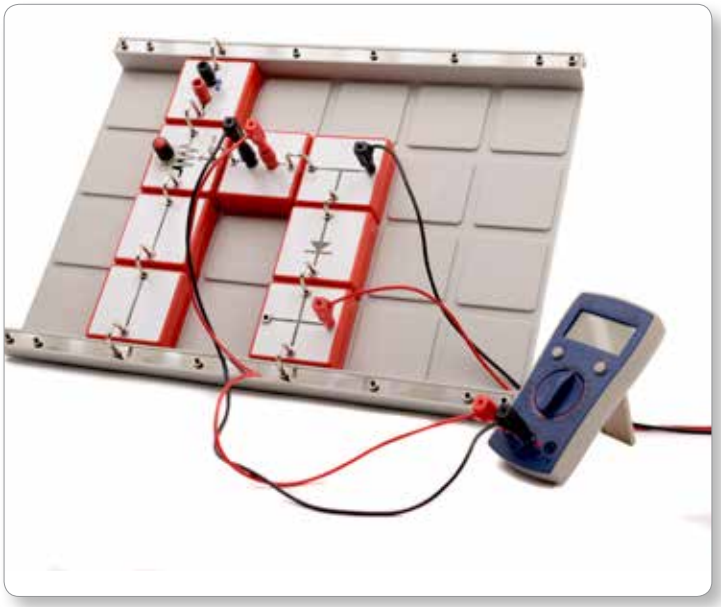
Function generator not included.

■ **5433**



TOPICS

- *Capacitor using direct current*
- *Voltage and current*
- *Capacitor using alternating current*
- *Inductive reactance*
- *Capacitve reactance*
- *RCL circuit*
- *P-n junctions*
- *Wave rectifiers*
- *Transistor*
- *Thermistor*



Board support

For a better view of the circuits assembled on the table.
A good accessory for kits code 5332 and 5433.

■ **5333**

Alessandro Giuseppe Antonio Anastasio Volta (1745-1827) was an Italian engineer. He teached at the University of Pisa and he is known for the invention of the first electric generator, the battery, and the discovery of methane.
A battery is a device that turns the chemical energy into electric energy through reduction–oxidation reaction.

Volta's battery – column type

The Volta column battery is composed of an alternated succession of metal disks. Every disk is separated from the following one by a cloth dampened with a solution of sulphuric acid (not supplied).
The disks are put on a central rod and they are kept in contact on the other thanks to the pressure exerted between the base and the cover, made of insulating material.

■ **5124**

Volta's battery – cups type

This is another kind of Volta's battery, composed of four beakers to be filled up with a solution of sulphuric acid (not supplied). Placing the zinc-copper electrodes in the solution, students are able to arrange a voltameter system. Thanks to this system, a potential difference will be generated enough to switch on a LED.

■ **5167**

The electrical conductors can be divided into three categories:
1. metal conductors, in which there are free electrons that, under the action of an electric field, are directed in a flow;
2. liquid conductors, in which the passage of electricity is allowed by a double flow of positive and negative ions with opposite directions and accompanied by the transportation of matter;
3. gas conductors, in which the flow of electricity is caused by the motion of gaseous ions or even free electrons.

Human battery

When a solid body is in contact with an aqueous solution, some molecules tend to migrate from the body and dissolve in the liquid. This phenomenon is called pressure solution. Once the molecules of the immersed body have been dissolved, they exert a pressure (called osmotic pressure) that opposes to the dissolution of new molecules so that the greater the number of molecules that have migrated in the liquid, the stronger the osmotic pressure. When the pressure solution and the osmotic pressure are balanced, the dynamic equilibrium is reached.
If the solid is a metal, the molecules in the solution are ions, i.e. they have a positive or negative charge.
The system composed by an ionic solution and a metal is called half-cell and, from an electric point of view, it can be compared to a capacitor. The electric potential due to the division of the charges we have previously described, is called absolute electrode potential. If we put together two half-cells made of two different metals, because the absolute potentials are generally different, the electric current will be generated because of the electron flux from a cell to the other one.

■ **5287**

Liquids electrical conductivity

The electric conductivity of an electrolytic solution, that, in a general meaning, is known as its capacity to conduct the current of ions contained in it, depends on different factors:
1 - the chemical nature of the solution
2 - the ions concentration
3 - the temperature
4 - the ions charge

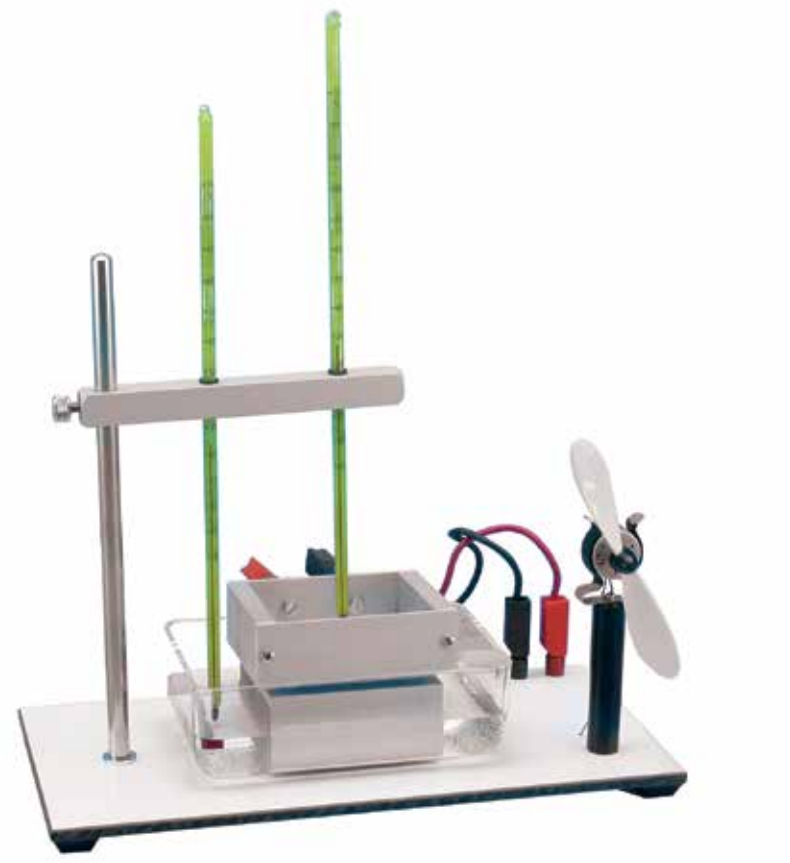
The apparatus shown in the picture allows to perform experiments on several solutions at the same time, showing their electric conductivity through the luminosity of the relative lamp.
The circuit must be supplied with an alternating current, voltage from 4 up to 12 V.
Chemicals are not included.

■ **5113**

Thermoelectric generator

The device exploits the physical properties of Peltier cell.
When there is a temperature difference between the sides of the cell, a voltage is created because of the Seebeck effect; this voltage can be measured from the terminals of the cell.
In the device, a side of the cell is in contact with an aluminium fin that must be immersed in hot water, while the other one must be immersed in a small basin that contains ice or cold water. Thanks to the small voltage produced, an electric engine can work and make a fan rotate.
On the contrary, if we have a voltage on the terminals (max 12V) there is a temperature difference between the two sides of the cell, because of the Peltier effect.

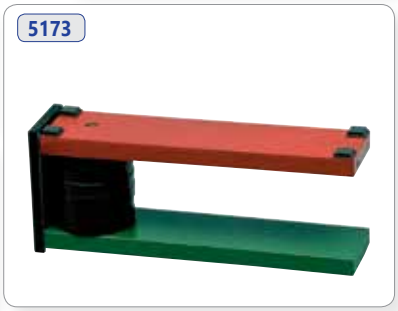
■ **5350**



The phenomenon called magnetism was well known to ancient Greeks already in 800 a.C. They discovered that in a coastal region of Turkey, called Magnesia, there was a mineral called magnetite (Fe3O4) which under certain conditions was able to attract ferrous bodies. According to the legend, a shepard named Magnes (hence the name of the mineral, "magnetite"), who used to wear iron-ridged shoes and to use an iron-tipped pole, discovered this property while grazing his flock.
The property of magnetite can be acquired by a steel bar when rubbed with it, allowing us to create magnets. Indeed, you can easily find bar, horseshoe or ring magnets

Steel magnets

- **5279** Rectangular 170x20x10 mm
- **5281** U-shaped 55x10x14 mm
- **5286** U-shaped 75x16x40 mm
- **5173** U-shaped 200x75x45 mm



Sinterox/f alloy

- **5182** disk magnet
Ø 18 mm
h: 5 mm

Sinterox/d alloy

- **5183** ring magnet
Ø external: 51 mm
Ø internal: 24 mm
h: 9 mm

Neodymium – Iron – Boron magnets

- **8517** Ring magnet
Ø external: 25 mm
Ø internal: 10 mm
h: 10 mm
- **8516** Disk magnet
Ø 25 mm
h: 10 mm

Al-Ni-Co magnets

- **5238** circular section 60x6 mm
- **5024** circular section 100x10 mm
- **5169** circular section 150x12 mm
- **5170** circular section, couple 150x12 mm
- **5077** U-shaped with stem 30x20x21 mm Stem: Ø 6x135 mm
- **5141** U-shaped with stem 45x29x30 mm Stem: Ø 6x135 mm
- **5382** U-shaped 80x53x21 mm
- **5383** U-shaped 130x81x30 mm

A magnetic needle is a slender magnetized rod used in a lot of instruments, such as the magnetic compass, to indicate the direction of a magnetic field.

Magnetic needle

- **5105** h 120 mm length 75 mm

Magnetic needle with protractor

- **5174** h 100 mm length 60 mm

The invention of the compass is attributed to Chinese people: it seems they used this discovery to arrange a show. Some magnetized cans were thrown as if they were dices and, to the amazement of the spectators, they were always pointing at the North.
Much time passed before this "circus" attraction was applied to navigation: once the North position was known, it was possible to identify the South as in the opposite direction, while East and West were respectively on the right and on the left of the observer facing the North.

Big didactic compass

■ **5135**

Set of 12 compasses

■ **5359**

Magnetic levitation

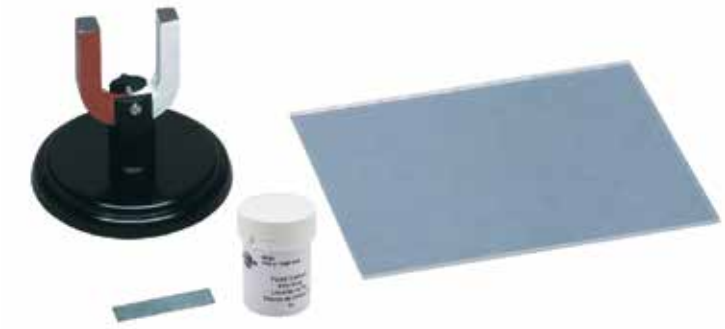
When the magnetic force applied to an object is strong enough to balance its weight, magnetic levitation is achieved, i.e. the object is suspended in the air.

■ **5125**

Magnetic field lines

When iron filing is spread on the plexiglass plate, lying on a magnet, it orientates towards a precise direction: it is possible to observe a system of lines. Those lines are defined as the flux lines of the magnetic field generated by the magnet.

■ **5027**



Set of magnets

■ **5322**

TOPICS

- *What a magnet is*
- *Magnetic poles*
- *What a compass is and how it works*
- *Magnetic forces and induction*
- *Magnetic spectrum*

The magnetic gun is a mechanical model that allows students to explore in a simple and intuitive way, without any calculation, concepts such as energy configuration, exothermic systems and reversible reactions. It is also a very useful exercise to understand mechanical systems using energy balances and symmetries rather than analytical or mathematical details.

One-stage gauss gun

Two "one stage guns" may be connected in series to create a 2 stage gun.
Length: 40 cm

■ **5369**

Three-stage gauss gun

Length: 100 cm

■ **5370**

In physics and electrical engineering, a coil is a set of windings, the number of which can vary from a fraction of windings to many thousands, realized with conductive material.
The application fields are extremely varied, from electronics to mechanical and electrical engineering, and also in medicine.

Induction coils

■ **5026** 400 windings, 1A

■ **5078** 1600 windings, 1A

Electromagnet field lines

When Iron filing is spread on the plexiglass plate, lying on an electromagnet, it orientates towards a precise direction: it is possible to observe a system of lines. Those lines are defined as the flux lines of the magnetic field generated by the electromagnet.
It should be used with a power supply, not supplied.

■ **5356**

Horseshoe electromagnet

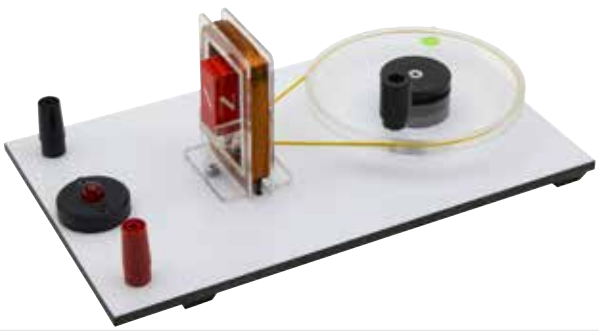
6-12V dc
h: 30 cm

■ **5274**

Alternator model

If the magnet is rotated with a constant angular speed, the magnetic flux linked with the coil varies according to the sinusoidal law, so that alternating voltage can be collected at the output terminal.
Rotating the magnet, a light bulb lights up.
Why does the bulb brightness increase if we raise the rotating speed of the magnet?

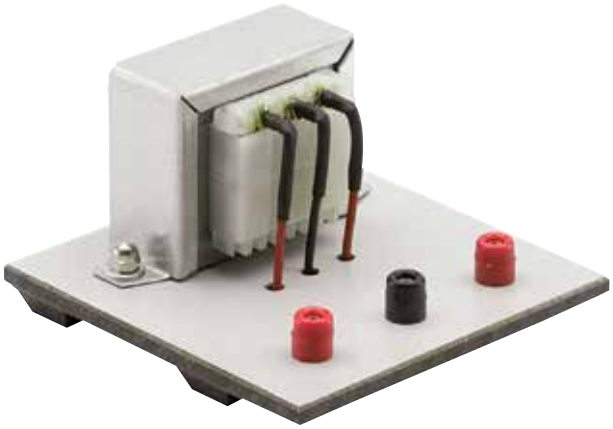
■ **5434**



Inductor

Alternating current, 1 kHz:
L=0.22 H, R= 56 Ohm between two extreme poles
L= 58 mH, R= 24 Ohm between an extremity and the intermediate pole
Direct current:
R= 0.6 Ohm between two extreme poles
R= 0.3 Ohm between an extremity and the intermediate pole

■ **8510**



The Ørsted experiment, named after the physicist who performed it in 1820, Hans Christian Ørsted, was chronologically the first experiment to demonstrate a correlation between the electric current and the magnetic field.
A similar experience had already been performed in 1802 by Gian Domenico Romagnosi, but had been ignored by the international scientific community. Ørsted himself wrote in a publication in the "Encyclopedia of Edinburgh" (1830), that "... the knowledge of Romagnosi's work would have anticipated the discovery of electromagnetism of eighteen years ..."

Linear Ørsted apparatus

■ **5110**

Circular Ørsted apparatus

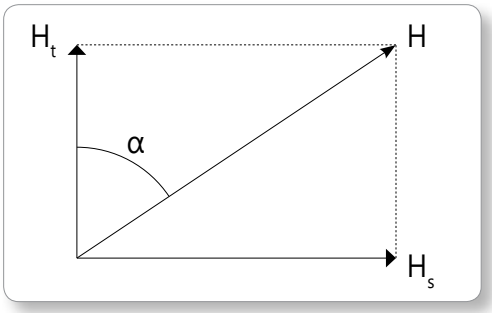
■ **5109**

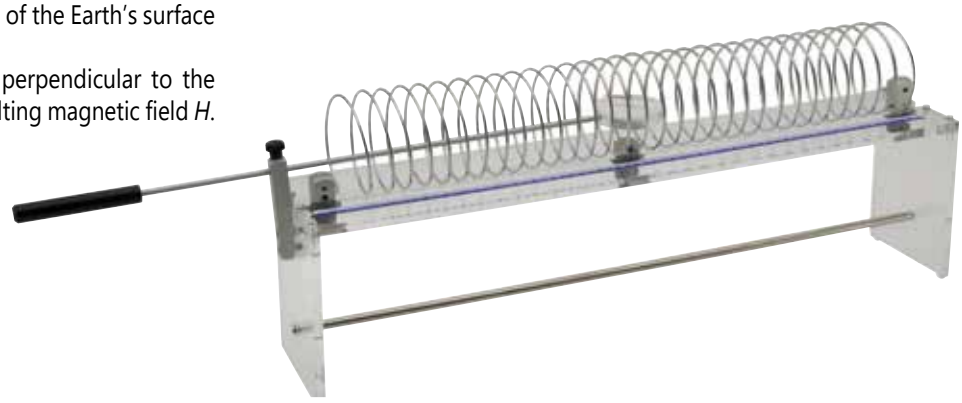
Ørsted apparatus with two needles

■ **5122**

Extensible solenoid

A magnetic needle, free to rotate about a vertical axis, if no other magnetic forces are acting, places itself along the direction of the Earth magnetic field, i.e. along the tangent to the magnetic meridian of the Earth's surface in the point in which it operates.
If another magnetic field is acting on the needle, perpendicular to the Earth's one, the needle moves in the direction of resulting magnetic field *H*.





Max current 5A

■ **5178**

ON-LINE Equipment required not supplied

- *Sensors support and cables*
- *Magnetic field sensor*
- *Current sensor*
- *Interface*

Otherwise

- *Sensors support and cables*
- *USB Magnetic field sensor*
- *USB Current sensor*

Electromagnetic actions kit

Thanks to this kit, students are allowed to study the characteristics of the magnetic field generated by a coil.
A coil that carries electric current acts like a magnetic bar whose polarities depend on the circulating sense of the current.

■ **5184**

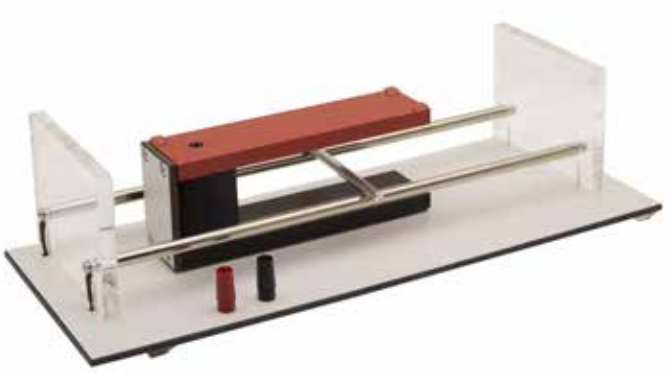
TOPICS

- *Magnetic field created by a linear conductor*
- *Interaction between a coil and a linear magnet*
- *Interaction between a linear conductor and a magnet*

Lorentz law apparatus

The electric current consists of an ordered motion of electric charges, and if a conductor, carrying an electric current, is immersed in a magnetic field, then the Lorentz force acts on the conductor itself.
Thanks to this kit, students are allowed to perform Lorentz experiment in an easy and efficient way.
5A, from 2 up to 5 V.

■ **5177**



Modular tranformer

The transformer is a four-terminal (quadripolar) device which increases or decreases the alternating voltage by electromagnetic induction.
Every transformer consists of two coils (primary and secondary) wound on the same laminated iron core to maximise the linkage of the magnetic flux of the primary coil to that of the secondary one.

■ **5114**

Electromagnetic scale

A useful instrument to understand the practical importance of the application of discoveries concerning the interaction between currents and magnets. Taking advantage of Lorentz law is possible to build a real scale.
This instrument is provided with weights. Power supply not supplied.

■ **5179**

Electromagnetic induction law

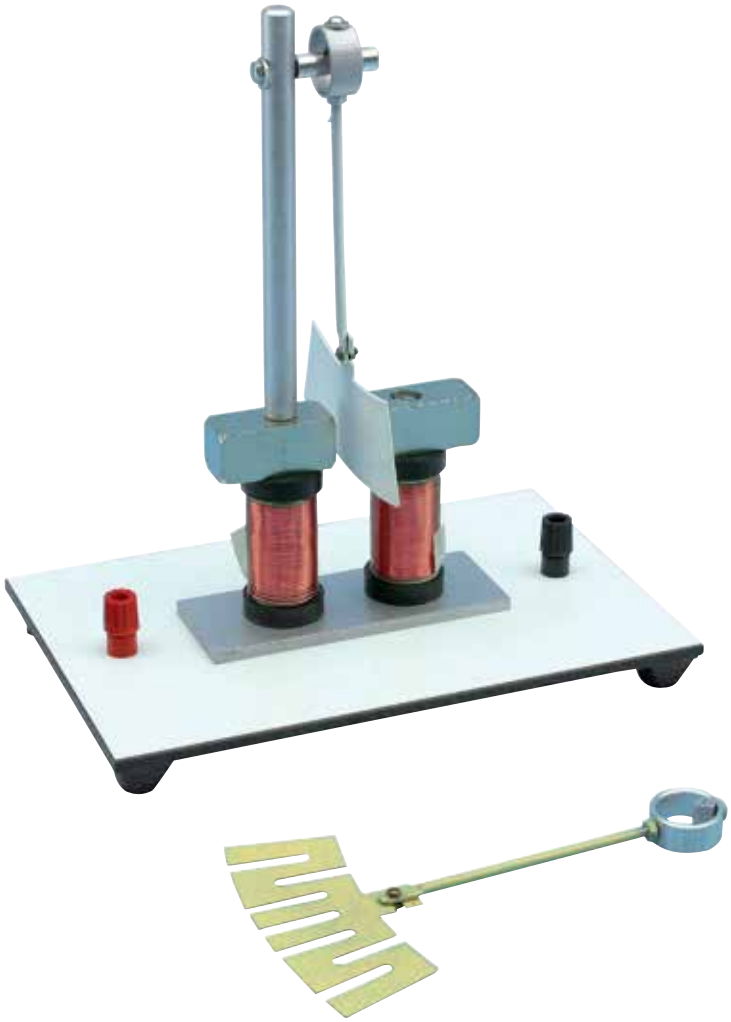
This apparatus is composed of an aluminum tube and a couple of different magnets. Once the magnet is put into the tube, it takes several seconds to reach the ground: this is due to electromagnetic induction. During the magnet fall, the aluminum tube is concatenated with a variable magnetic flux, i.e. it is the seat of eddy currents, which, according to Lenz's law, oppose themselves to the motion that generated them: the magnet motion. After a transitional phase, very short, the falling motion of the magnet becomes uniform.

■ **1342**

Waltenhofen's pendulum

The Waltenhofen's pendulum is a simple instrument to show the effect of eddy currents induced in a condu ctor moving in a magnetic field. This apparatus consists of a pendulum having a curved strip of copper on its lower part. It hangs between the poles of an electromagnet. If no magnetic flux is acting on the conductor, the pendulum swings freely, but as soon as the electromagnet is switched on, the oscillations of the pendulum are heavily damped and die away rapidly.
5A DC, from 6 up to 12V.

■ **5120**



Atomic Physics

"Science cannot solve the ultimate mystery of nature.
And that is because, in the last analysis, we ourselves are a part of the mystery that we are trying to solve."

Max Planck

PHOTOELECTRIC EFFECT - PLANCK'S CONSTANT

Thanks to this apparatus you are allowed to study the photoelectric effect, retracing the fundamental steps that have underlined the unsuitableness of the classic mechanics and have introduced all these new concepts thanks to which the quantum mechanics was born.
The photoelectric effect or photoemission is the production of electrons or other free carriers when light is shone onto a material.
Varying the voltage across the phototube, you will be able to check the relation between the energy of the emitted electrons and the wavelength of the incident radiation. Thanks to Einstein notion regarding photoelectric effect, you will also be able to estimate the value of the Planck constant.
This instrument is a good starting point to study quantum mechanics.
It is basically composed of two parts: a phototube and a control unit (in which is built-in a voltmeter and a nanoammeter).
Three LEDs, with average wavelength known, are supplied.
The light intensity could be varied from 0 to 100%.

Technical data
Power supply: 24V DC
Voltmeter 4 digits, sensibility < 2mV
Ammeter 4 digits, sensibility < 5nA
Button to cut off current
LED light adjustment 0-100%
Anodic tension adjustment
Three LEDs (red, green, blu)

■ **5435**

TOPICS

- *Historical notes on the nature of light*
- *Electromagnetic waves*
- *Intensity of electromagnetic waves*
- *Photoelectric effect*
- *Photoelectric cell*
- *Work function*
- *Threshold frequency*
- *Characteristic graphic of a photocell*
- *Stopping potential*
- *Kinetic energy of electrons does not depend on radiation intensity*
- *The number of emitted electrons depends on radiation intensity*
- *Summary*
- *Einstein's quantum theory*
- *How Einstein's quantum theory explains events*
- *How to value threshold frequency*
- *How to measure Planck's constant*

Led light wavelength measurement kit

The light emitted by a LED is not monochromatic; it covers a small frequency band. In order to measure Planck's constant with a LED, it is necessary to know its band medium frequency, which is easy to measure thanks to this kit able to exploit the diffraction grating.

■ 5392

Planck's constant (leds method)

Taking advantage of the quantum properties of a LED, students are allowed to determine Planck's constant. A LED, begins to emit light, as soon as the potential energy supplied to the electrons is enough to make them pass from the conduction band to the valence band (energy gap).
Because of this energy gap, each electron emits a photon of energy: knowing the potential at which the LED starts emitting a weak light, it is possible to determine the value of Planck's constant.

■ 5410

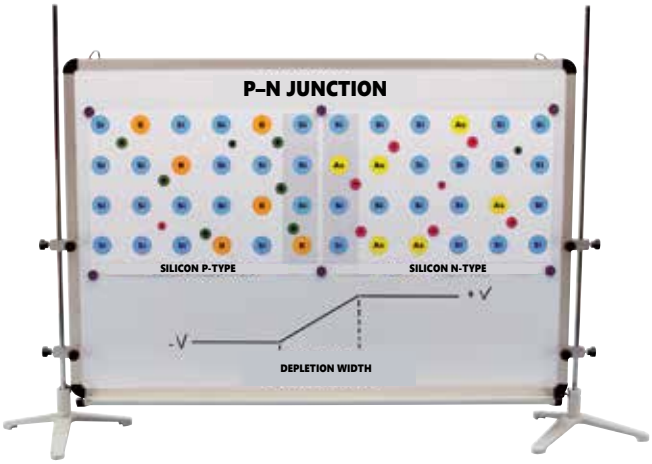
Set to study the solid state

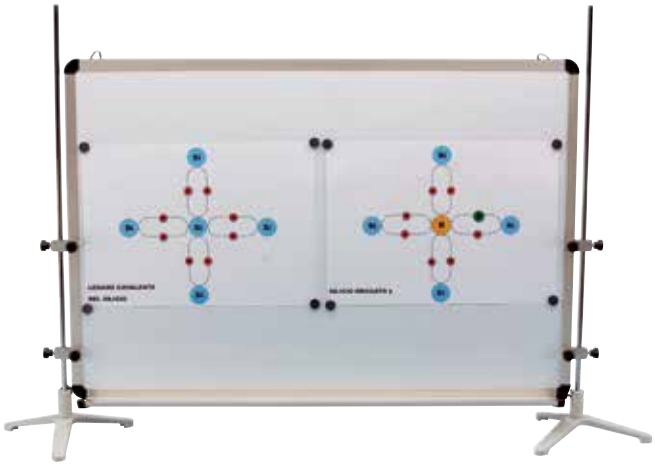
In 1948 when the American physicists H. Brattain, W. and J.Bardeen Shockley discovered the transistor effect, the electronic technique has implemented an extraordinary evolution.
Since when, in 1948, the American physicists H. Brattain, J.Bardeen and W. Shockley discovered the transistor effect, the electronic technology has seen an amazing development.
The technology world is more and more dominated by semiconductors and the energetic future of mankind is tightly linked to them. But the functioning of the devices which employ the semiconductors is based on the principles of quantum physics, whose fundamental notions are normally included in the educational curriculum of high schools.
This set has been designed to make it easier for students to grasp concepts which are not very intuitive. It consists of a series of explanation charts to be applied on a magnetic board. The interactive feature of the set allows the teacher to simulate some processes of interaction between photons and matter, showing the passages from a situation to the following one.
Magnet board and power supply not furnished.

■ **5413**

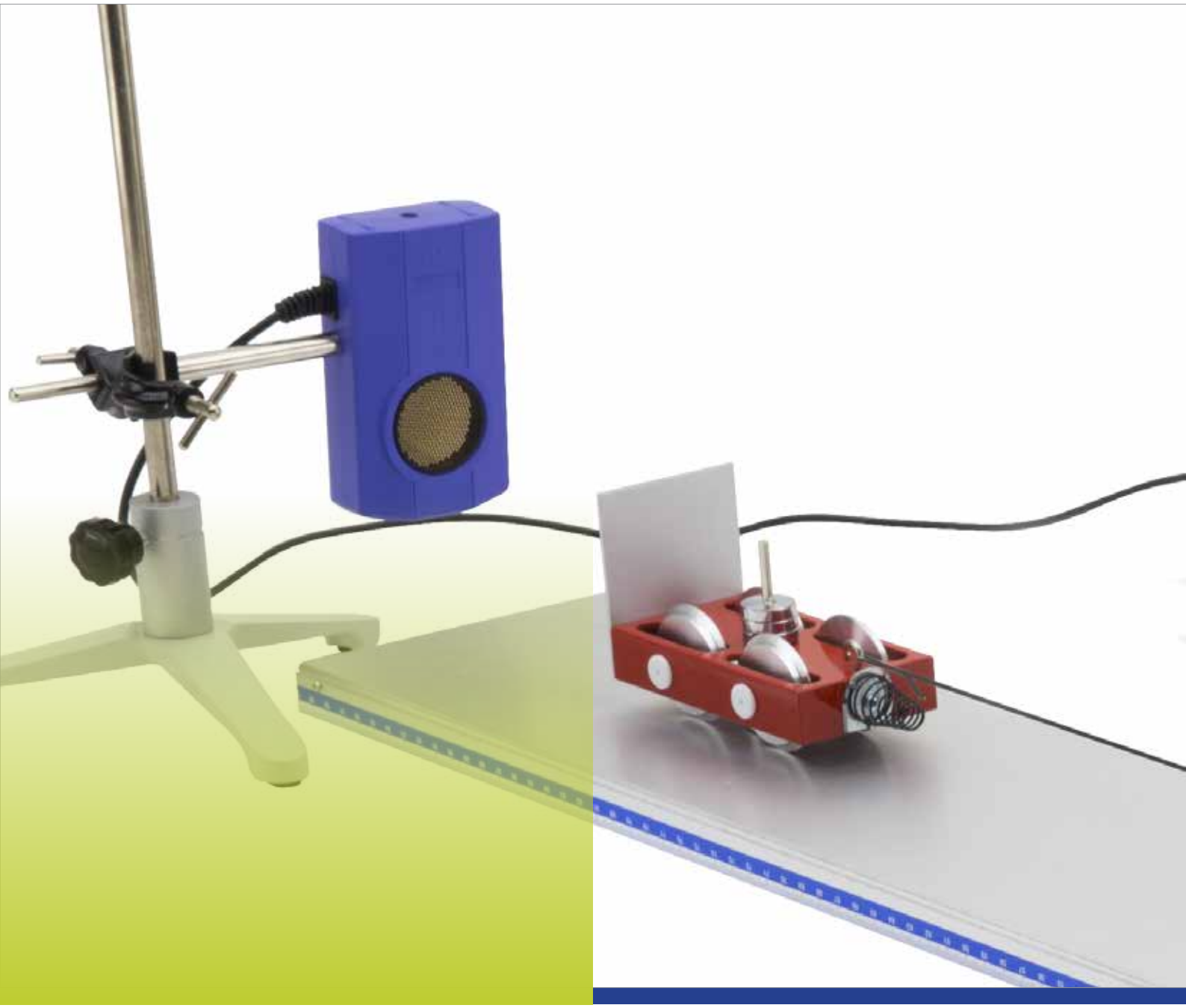
TOPICS

- *Atomic energy levels*
- *The metals crystal lattice*
- *Energy bands*
- *Allowed bands and forbidden bands*
- *Insulators, conductors and semiconductors*
- *The PTC thermistor*
- *The NTC thermistor*
- *The photoresistor*
- *Semiconductors doping*
- *The junction diode*
- *Leds*
- *How to measure Planck's constant*
- *The reversibility of the Led*
- *The photovoltaic cell*
- *The solar panels*





Online Physics



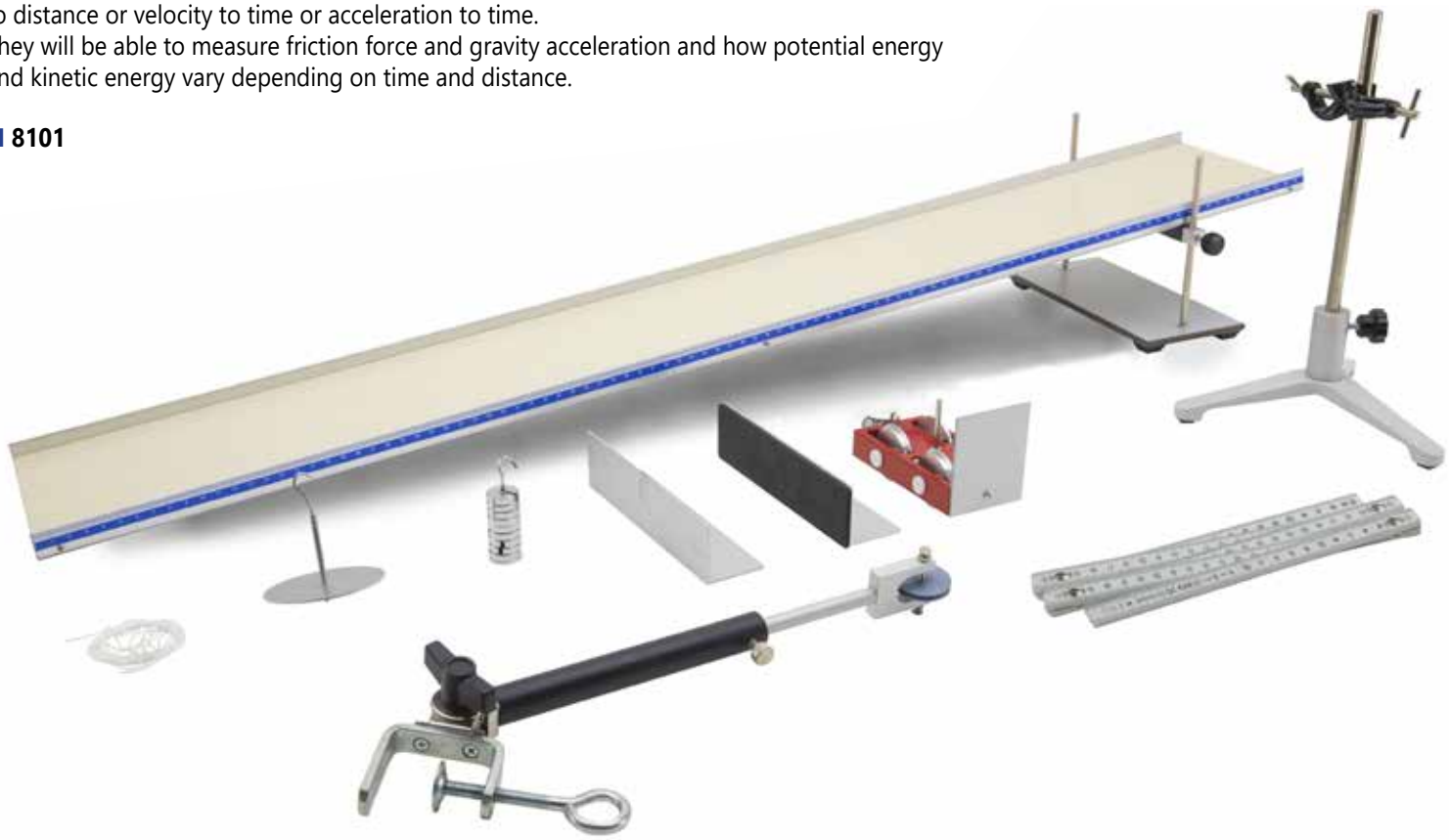
"We can only see a short distance ahead, but we can see plenty there that needs to be done"

Alan Turing

Plane to study the motion

Thanks to this kit, students are allowed to perform experiments regarding motion using RTL method.
Students will be able to study the magnitudes of motion, to draw graphics, connecting time to distance or velocity to time or acceleration to time.
They will be able to measure friction force and gravity acceleration and how potential energy and kinetic energy vary depending on time and distance.

■ **8101**



TOPICS

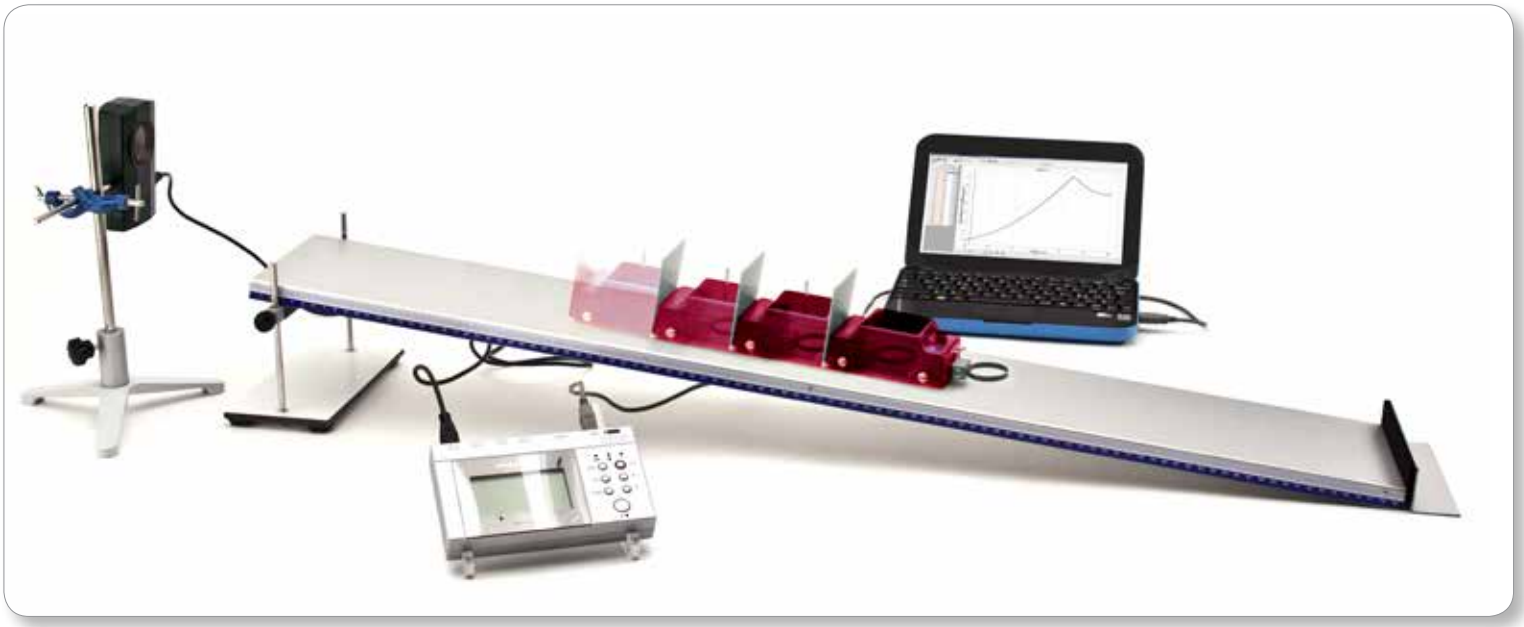
- *Uniformly rectilinear motion*
- *Uniformly accelerated rectilinear motion*
- *Dynamics fundamental law*
- *Glider's motion along an inclined plane*

ON-LINE equipment required not supplied

- *1 distance sensor*
- *1 interface*

otherwise

- *1 USB distance sensor*



Additional kit for "Plane for studying motion"

Kit to study rolling motion

The motion of bodies which roll on a plane is a combined motion because they translate while they are rolling. Their rolling motion does not occur around the axis which passes through the centre of gravity but around the axis passing through the point of contact with the rolling plane.
A rolling body has two types of energy: translational kinetic energy E_t and rotational kinetic energy E_r.
I_0 is the moment of inertia with respect to the axis of the centre of gravity, which has a great importance in the energy balance because the way the total kinetic energy distributes into the two forms depends on its value.
It is an easy and instructive kit to perform experiments on rolling body dynamics.

■ **8105**

Galileo's cart

Thanks to this cart it is possible to perform experiments on reference systems in translational motion. It is provided with an electromagnet which holds a steel sphere at a height of 25 cm from the cart's plane. The release of the sphere is controlled by a photocell which can be activated through a simple torch.
The falling point of the sphere is imprinted on a strip of carbon paper, letting students check Galileo's relativity principle for the systems in uniform and accelerated motion both on an horizontal and on an inclined plane.

■ **8123**

Translational, rotational and oscillatory motion

Thanks to this kit students are allowed to study in depth concepts as translation, rotation and oscillatory motion.
Translational motion is the motion by which a body shifts from one point in space to another.
Rotation is described in terms of angular displacement, time, angular velocity, and angular acceleration. Angular velocity is the rate of change of angular displacement and angular acceleration is the rate of change of angular velocity.
Oscillation is the repetitive variation, typically in time, of some measure about a central value (often a point of equilibrium) or between two or more different states. The term vibration is precisely used to describe mechanical oscillation. Familiar examples of oscillation include a swinging pendulum and alternating current power.

■ **8120**

TOPICS

- *Rotational motion*
- *Uniformly rectilinear motion*
- *Uniformly accelerated motion*
- *How to measure gravity acceleration*
- *Simple pendulum*
- *Compound pendulum*

ON-LINE equipment required not supplied

- *1 interface*
- *1 distance sensor*

Otherwise

- *1 USB distance sensor*

Atwood's machine

Atwood's machine is a common classroom demonstration used to illustrate principles of classical mechanics.
The Atwood's machine was invented in 1784 by the English mathematician George Atwood as a laboratory experiment to verify the mechanical laws of motion with constant acceleration.
The ideal Atwood's machine consists of two objects of mass m1 and m2, connected by an inextensible massless string over an ideal massless pulley.

■ **1437**

ON-LINE equipment required not supplied

- *1 stopwatch*
- *1 distance sensor*
- *1 interface*

Otherwise

- *1 USB distance sensor*

Accessory for "Atwood machine"

Kit to study uniformly motion

This kit is provided with a couple of magnets that, falling down through the tube, are slowed down due to eddy currents.
On these magnets is acting a force F=-kv, that is proportional to and opposed to the velocity: thanks to this force the motion of the two magnets will be uniform.
To perform the experiment concerning the uniform motion using Atwood's machine, we suggest to use our Atwood's machine code 1437.

■ **8107**

Cylinder for hydrostatics and hydrodynamics experiments

Thanks to this cylinder, using a pressure sensor, students are able to verify that the pressure on each "surface element" immersed in a liquid does not depend on the surface orientation and has a value equal to the weight of a liquid column whose base is the "surface element" considered and its height is the distance between the center of this surface and the free surface of the liquid.

Students can also perform experiments regarding the outflow speed of a liquid under the action of gravity and the thrust that a solid body receives when it is immersed in a liquid (Archimedes' principle).

■ **8121**

TOPICS

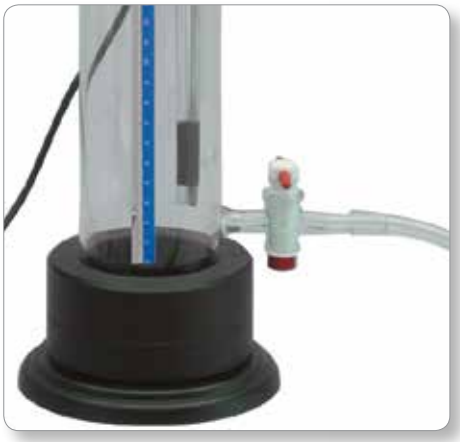
- *Stevin law*
- *Torricelli law*
- *Archimede law*

ON-LINE equipment required not supplied

- *1 accessories kit*
- *1 interface*
- *1 pressure sensor*
- *1 force sensor*

Otherwise

- *1 USB pressure sensor*
- *1 USB force sensor*



Accessory for "Cylinder for hydrostatics and hydrodynamics experiments"

Cylinder to study water equilibrium

Thanks to this additional kit, students are allowed to perform experiences also regarding communicating vessels:
- Water equilibrium - cylinders of equal capacity;
- Water balance - cylinders of different capacity.

Connecting the two cylinders containing the same liquid at different levels, the liquid flows from the cylinder with the higher level to the cylinder with the lower level.
The flow lasts until the water reaches the same level in the two cylinders.
During the transition phase, the higher level decreases exponentially over time.

■ **8122**

Thermal equilibrium

Thanks to this kit, using two temperature sensors, students are allowed to study how the transfer of heat between two bodies works; they can be solid or liquid, at a different initial temperature. As it is well known, the hotter body transfers heat to the colder one until thermal difference is equal to zero.
This kit should be used with a heating plate (not included).

■ **8202**

ON-LINE equipment required not supplied

- *1 interface*
- *2 temperature sensor*
- *Otherwise*
- *2 USB temperature sensor*

Thermal conductivity in solid bodies

Heat propagation in solids occurs by conduction.
The velocity of this phenomenon varies from substance to substance.
In metals it is high, while in other substances such as glass or plastic, is very low.
For this reason metals are known as good heat conductors.
The thermal conductivity can be studied using this kit and three temperature sensors (not supplied). This kit is provided with three different rods made of aluminum, brass and PVC. Each rod is connected to a temperature sensor and simultaneously immersed in a beaker containing hot water. In this way, it is possible to see, in real time, how the velocity of heat propagation varies.

■ **8203**

ON-LINE equipment required not supplied

- *1 interface*
- *3 temperature sensor*

Otherwise

- *3 USB temperature sensor*

Kit to study radiation

The heating of a body occurs when it is exposed to electromagnetic radiation, and it depends on its surface, on its mass and its absorption power. Exposing two disks, with different characteristics, at a radiation flow emitted by the same source (the sun, or simply a lamp – not supplied), it is possible to observe in real time the different temperature trend.

■ 8205

ON-LINE equipment required not supplied

- *1 interface*
- *3 temperature sensor*

Otherwise

- *3 USB temperature sensor*

Heat dissipation kit

Thanks to this kit, using two temperature sensors, students are allowed to compare the different heat dissipation velocity of two bodies having equal mass and equal initial temperature. Students are able to observe that the greater the surface area of exposure, the faster the dissipation, which is considerably slower if the body is protected with a thermally insulating material.

■ 8206

ON-LINE equipment required not supplied

- *1 interface*
- *2 temperature sensor*

Otherwise

- *2 USB temperature sensor*

Thermology kit

Thanks to this set, it is possible to perform a lot of core experiments on thermal phenomena.
For the purpose of collecting and plotting data, students should use three temperature sensors.
The acquisition data system in real time allows to obtain the plot of temperature versus time in many thermal phenomena such as the heat equilibrium, the propagation of heat, the changing in status, etc.

■ **8212**

TOPICS

- *Heat and temperature*
- *Thermal effect due to current*
- *Thermal equilibrium*
- *Specific heat of solids*
- *Cooling*
- *Greenhouse effect*
- *Evaporation and boiling*
- *Solidification and melting*

ON-LINE equipment required not supplied

- *1 interface*
- *3 temperature sensor*

Otherwise

- *3 USB temperature sensor*

Gas thermometer

To complement this kit, students need a pressure sensor and one temperature sensor in order to characterize the system evolution when it is heated or cooled.
Heating plate is not included.

■ **8209**

TOPICS

- *Gay-Lussac law*
- *Gas thermometer*
- *Absolute zero*

ON-LINE equipment required not supplied

- *1 interface*
- *1 temperature sensor*
- *1 pressure sensor*

Otherwise

- *1 USB temperature sensor*
- *1 USB pressure sensor*

Boyle's apparatus

Thanks to this equipment it is possible to study in quantitative terms the isothermal process of a gas.
A graduated cylinder, made of transparent plastic, is connected to a pressure sensor using a two-way stopcock.
By acting on the control handle, students are able to move the piston changing the volume of air contained in the cylinder.
By connecting the sensor to a data acquisition system in real time, students get the pressure versus volume plotting at a constant temperature.

■ **8216**

ON-LINE equipment required not supplied

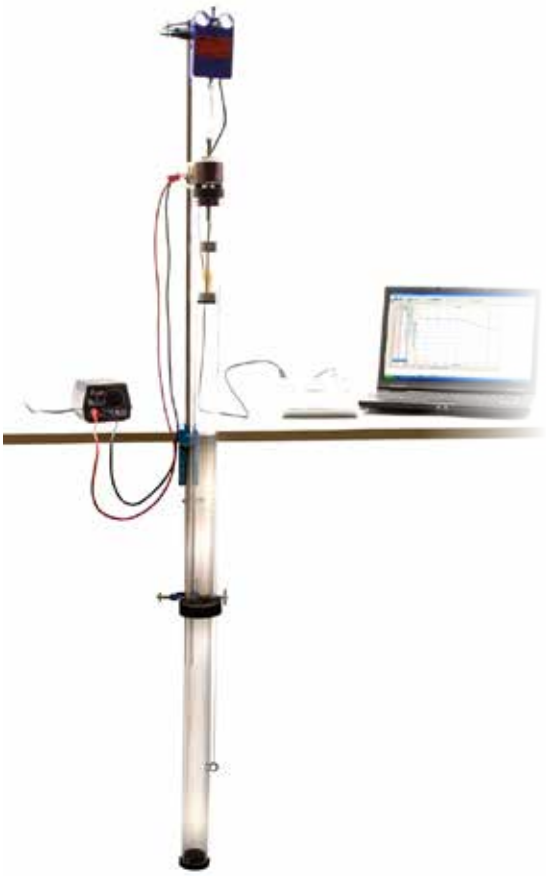
- *1 interface*
- *1 pressure sensor*

Otherwise

- *1 USB pressure sensor*

Einstein lift

At the beginning of the XX century, Einstein's General Theory of Relativity developed and overcame Newton's Gravity theory. Without going into details of a such a complex mathematics-physics theory, we indicate the main points it is based on. Gravity is known as a geometric effect, as the matter present in the Universe determines the space-time curvature. Einstein's equations simply expresses the relation between the curvature on one side and matter and energy on the other.
The reasons that led Einstein to develop the General Relativity Theory can be basically explained using ideal experiments. The most important one is known as Einstein's elevator.
This lift is composed of a pair of aluminum disks fixed to a common pivot, free to slide inside a plexiglass tube. The elevator may be initially anchored to the upper end of the tube by means of an electromagnet. Releasing the electromagnet, the elevator falls in free fall along the tube down to the lower end.
A system of holes, drilled on the caps, prevents the indoor air compression from slowing down in the elevator during the falling.



■ **1428**

ON-LINE equipment required not supplied

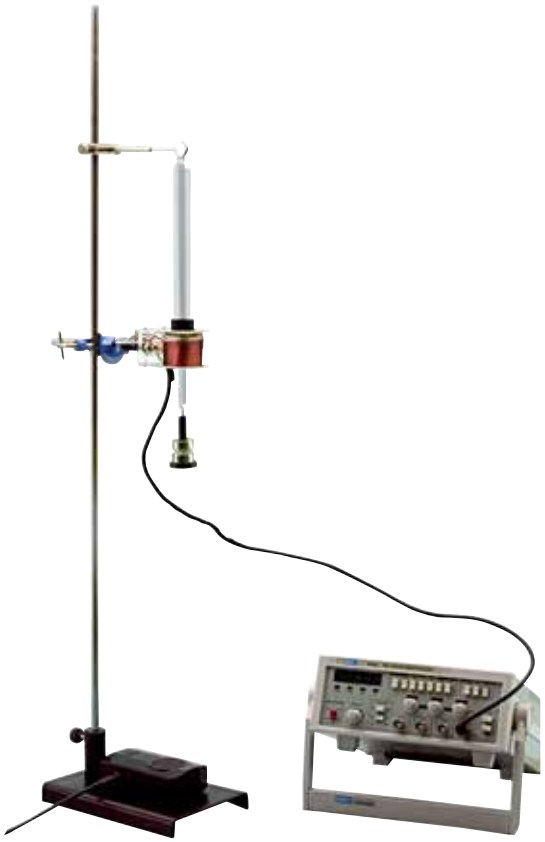
- *1 interface*
- *1 force sensor*

Otherwise

- *1 USB force sensor*

Electromagnetic pendulum

This is a fundamental apparatus to study the electromagnetic interactions.
It is composed of a magnet, hanging from a spring, placed inside a coil. When the magnet is put in motion, it induces an electromotive force in the coil, measured thanks to a resistor. Similarly, making circulate an alternating current in the coil, the magnet is set in motion.
This kit should be used with a function generator and power supply, not supplied.



■ **8515**

TOPICS

- *Electromagnetic induction*
- *Alternating current*
- *Electromagnetic resonance*

ON-LINE equipment required not supplied

- *1 interface*
- *1 voltage sensor*
- *1 current sensor*

Otherwise

- *1 USB voltage sensor*
- *1 USB current sensor*

Electromagnetism kit

Laboratory experiments on electrical circuits are difficult due to the use of cables to connect the different parts. It becomes difficult to vary the typology of a circuit without risking incorrect or damaging connections.
This kit is based on modules which can be quickly assembled on a table. In this way, the type of circuit is immediately recognizable and replacing a part or changing the circuit become simple and quick.
This kit should be used with a function generator and power supply not supplied.
We suggest to buy also the "extensible solenoid" code 5178.

■ **8514**

TOPICS

- *Ohm's Laws*
- *Adjustment in series/parallel*
- *Charging and discharging the capacitor*
- *Auto induction*
- *Components in alternating current*
- *Magnetic field in a solenoid*
- *Electromagnetic induction*
- *Transformer*
- *Resonance*
- *Rectifier circuit*

ON-LINE equipment required not supplied

- *1 interface*
- *1 magnetic field sensor*
- *2 current sensor*
- *2 voltage sensor*

Otherwise

- *1 USB magnetic field sensor*
- *2 USB voltage sensor*
- *2 USB current sensor*

OPTIKA Srl

Via Rigla, 30 - 24010 Ponteranica (BG) Tel. +39 035.571.392 - Fax: + 39 035.571.435

www.optikascience.com - www.optikamicroscopes.com

info@optikascience.com