Dear teachers,

Didalab has been a higher education's key player for many years, thanks to you. Our only wish is, and has always been, to provide the best facilities for the best value. You've always manage to show us the right direction through our partnership.

Didalab is taking the path of modernization and has been renovating its range for 4 years. The results are convincing, but we have to go further to suggest new products, more functional, more pedagogical, at the best price. Going further, to provide a better service, a support always more precise. We understand your requests, to go forward together.

Together, let's take a stand for evolution and let's build together tomorrow education.

Jean SANCERRE
President

>> *To read the catalogue...*

DIDAFIRST

Product, especially designed to answer to your technical needs and give you the best value for money.

SELECTION DIDALAB

When the produtc is not manufactured by DIDALAB, but picked, approved and tested by us.

The other products («not marked») are high quality and designed to offer the best ratio Quality/Multifunctions.

didalab
WWW.DIDALAB.FR

SOMMAIRE

Méchanics

Optics

Thermodynamics

Electricity

Matter Physics

Measuring instruments

Sélection Secondaire

Mechanics

Experiments

Free fall and inclined plane

This multi-function bench allows you to create a mechanics standard. You can create 2 set-ups: free fall and inclined plane. The main components of this device are a V-shaped 1.50 m aluminium bench mounted on a stable base, and a release device (ball) with electromagnet.

Both operations can be computerised thanks to an optical fork sensor system/chronometer for didactic processing of your experiments. These optical sensors can be positioned all along the bench. The device is equipped with a system that can tilt the rail to the inclined position. A recipient is provided to dampen the fall and collect the ball.

Necessary equipment

Reference	Designation	Quantity	Page
PHM 022 405	Free fall and inclined plane set	1	26
PMM 013 961	Timing system	1	25

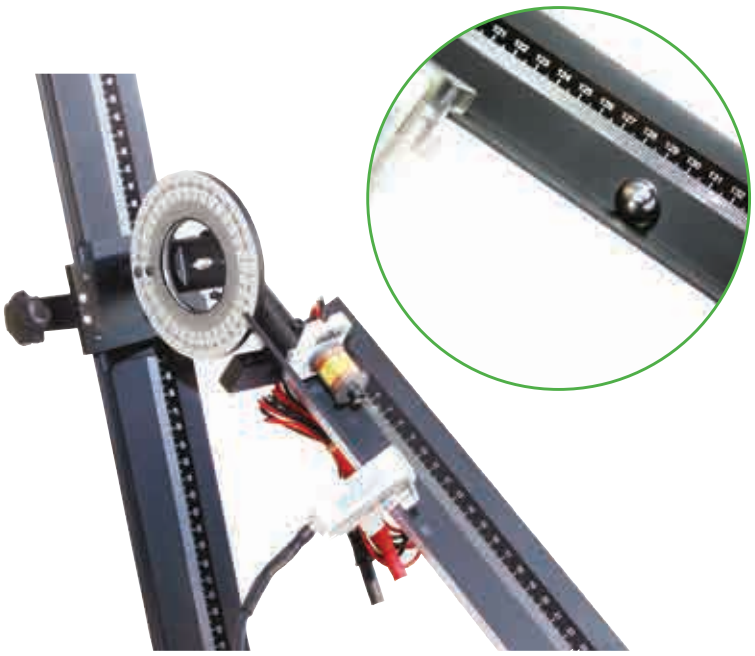
Subjects approached

» Gravity potential energy
» Kinetic energy
» Relationship between drop height and fall time
» Acceleration due to gravity
» Static friction study
» Determining the gravitational constant

→ Determining the gravitational constant

To determine the gravitational constant, the bench is used in free fall configuration. The first sensor is placed at the required height on the graduated rail. It will be placed preferably on a graduation multiple of 10 to facilitate measurement reading. The sensors are connected to the chronometer. The electromagnet holder is placed on the graduated rail above the first sensor, so that ball initial speed is zero. The chronometer software is started, thus allowing activating or deactivating the electromagnet. Switch off the power to release the ball. The software displays ball speed on the first sensor, ball speed on the second sensor, and the time elapsing between the two measurements, thus giving ball acceleration. If both sensors are placed at a distance of 1 m, the gravitational constant can be calculated and compared to the theoretical value. The acceleration value will be equal to the gravitational constant in free fall.

→ Studying the inclined plane fall



It is very easy to convert the free fall bench to the inclined plane bench by adding to it the second bench and the coupling system. An angle measurement system is used to identify the angle by which the rail is inclined : in analog version on the graduated disk or in digital version by connection to the acquisition box. Activate the electromagnet via the software to allow the ball to remain at the top of the bench, and deactivate it to make the ball fall onto the bench : the software will display the ball acceleration value.

EXP 100 010 **Acceleration and friction**

Uniform motion and collisions

The air cushion bench is a scientific device used to study motion in a low friction environment. Its name is derived from its structure : air is blown into a bench equipped with small holes throughout its surface, allowing mobiles to slide in, thus minimising friction. The triangular-base mobiles adapt perfectly to the bench shape and are used to study motion in low friction conditions.

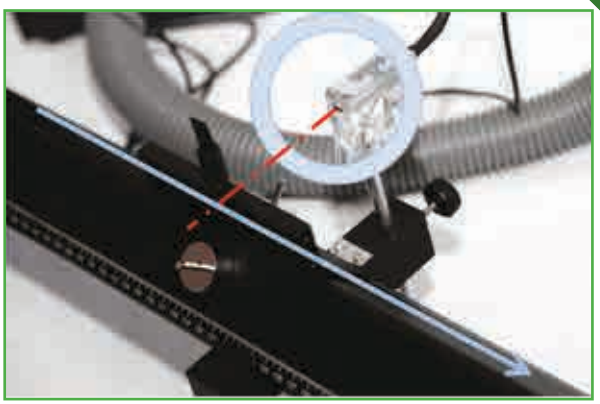
The air cushion bench is also used to study elastic and inelastic collisions. As very little energy is lost in friction, it is easy to prove the quantity of motion preserved before and after the collision. The bench can be used to calculate the gravitational force when it is inclined with respect to the horizontal plane or also act as a free fall system when vertical. An optical fork sensor system completes the bench to acquire measurements on the computer.

Necessary equipment

Reference	Designation	Quantity	Page
PHM 022 565	Air cushion bench only	1	24
PMM 013 961	Timing system	1	25

Subjects approached

» Uniform motions
» Accelerated motions
» The second Newton's law
» Accelerometry
» The collision law
» Free fall



→ Uniform motions

An animated object of a uniformly variable rectilinear motion is observed. The instantaneous speed and the mean speed of the object are determined in its uniformly variable rectilinear motion.

When an object is animated by a rectilinear motion over a lapse of time Δt and covers the distance ΔX, its mean speed over a lapse of time Δt is :

$$v = \frac{\Delta X}{\Delta t}$$

To express real speed of an object at a given point, Δt must be as small as possible. The smaller Δt, the closer mean speed will be to real speed. When Δt is close to 0, mean speed is close to the critical value, so that object mean speed is considered as equal to instantaneous speed at the point in question.

$$v = \lim_{\Delta t \to 0} \frac{\Delta X}{\Delta t} = \lim_{\Delta t \to 0} v$$

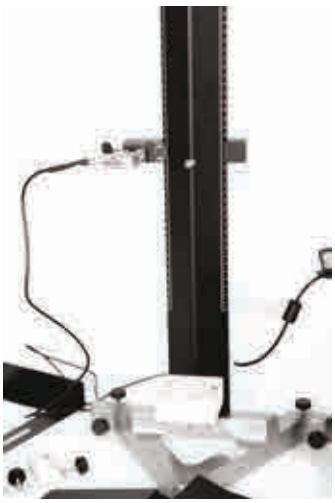
→ The collision law

A shock absorber is fastened to each end of the air cushion bench. Two mobiles are placed, at 30 cm and at 80 cm. We check that the air cushion bench is horizontal.

Take the two mobiles with an overload disk and a flexible metal stopper. Use a scale to determine the weight of each mobile. Instil an initial low speed on one of the mobiles, while the other is at rest, and record the trajectory. Check that total momentum and mechanical energy are preserved. Place a second overload on one of the mobiles. Instil an initial low speed on one of the mobiles, while the other is at rest, and record the trajectory. Use the conservation of momentum principle to determine overload weight, and check the result by weighing the overload.

→ Free fall

To determine the gravitational constant, the bench is used in vertical position. The electromagnet holder is placed on the graduated rail above the first sensor so that ball initial speed is zero (the electromagnet is energised or de-energised via the software). The software displays ball speed on the first sensor, ball speed on the second sensor, and the time elapsing between the two measurements, thus giving the ball acceleration value. Acceleration value will be equal to the gravitational constant in free fall.



EXP 100 020 Uniform motion and collisions

Forced oscillations and resonance

This complete forced oscillations and resonance pack is designed to study, statically and dynamically, the simple spring pendulum. A weight-holder platform is connected by a rod, and four weights are delivered with the device. A graduated rule, which can be moved to be placed in front of the mobile index linked to the spring, is used to read the elongations. A test tube filled with water or oil is used to study fluid damping.

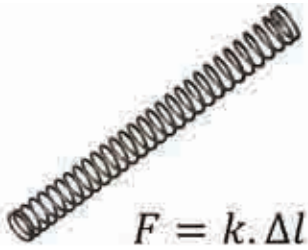
Moreover, the weight-holder platform plunging into this test tube is interchangeable in the form of disks of various diameters, thus allowing variation of the friction coefficient. The spring is coupled to a motor by a disk, thus ensuring sinusoidal excitation of the system. Excitation frequency is variable, while the static study is conducted simply with the motor shut down. Excitation frequency (adjustable from 0.1Hz to 3Hz) is displayed in digital figures on the motor box.

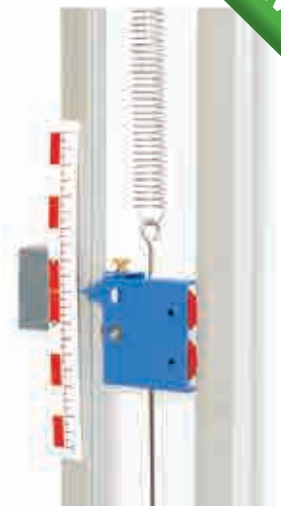
Necessary equipment

Reference	Designation	Quantity	Page
PHD 015 130	Oscillations study pack	1	25

Subjects approached

- Static and Hooke's law
- Free and forced oscillation dynamics
- Fluid friction
- System differential equation
- System natural frequency
- Damping rate
- Resonance study





→ Static study : determining spring constant of stiffness

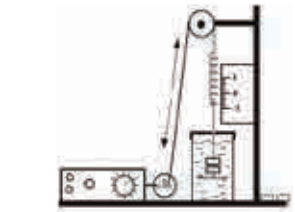
The aim is to determine the spring constant k of the available springs by measuring their elongation when balanced and loaded with masses of known weight : a spring is chosen and its unloaded length is measured. A mass is then placed at the end of this spring, and its new loaded length is measured. Repeat the operation with a number of masses to obtain the spring constant.

→ Damping study

Fill the water cruet and, if necessary, adjust system height so that the mass remains in the water throughout the motion. Secure the mass with smallest diameter to the spring, and separate the mass vertically from its balanced position by 2 or 3 cm. Release the system and measure the system oscillation period. You can repeat the experiment with another mass or fluid.

→ Resonance study

The oscillating system consists of the spring of least stiffness and of a small diameter cylindrical mass. Forced oscillations will be generated by motor rotation. Motor rotation speed and thus system oscillation frequency will be varied. Fill the graduated cruet with water and plunge the mass into it. Gradually adjust motor frequency to start system motion. Motor rotation frequency and spring oscillation frequency can thus be compared, and the resonance curve plotted.



EXP 100 030 Forced oscillations and resonance

Pendulum study

This comprehensive mechanical pack is designed to study a pendulum weight, a spring pendulum or pendulum pairs. It consists of two pendulum weights (that can be tilted to 90° to become a spring pendulum), a set of weights, twisted wires, and solids at different moments of inertia. Each pendulum is equipped with a contactless sensor for fluid and friction-free motion. This is accompanied by an acquisition system and a dedicated software allowing operation of data such as the pendulum period or its oscillation amplitude.

Necessary equipment

Reference	Designation	Quantity	Page
PHD 006 580	Pendulum	2	22
PHD 006 851	Coupling parts	1	23
PHD 006 582	Set of solids	1	23

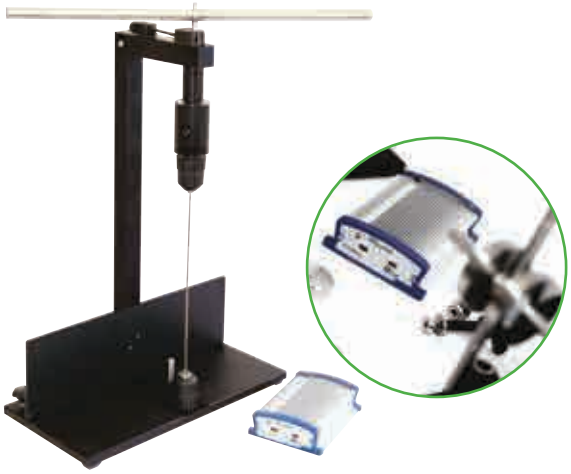
Subjects approached

» Pendulum study
» Fluid and solid damping study
» Verification of Huygens theorem
» Measuring metal rod torsion constant
» Measuring body moment of inertia
» Sympathetic pendulum study
» Resonance stud

→ Damping by fluid friction study

When a magnet is inserted at the end of the pendulum, the eddy currents generated by displacement of the magnet in front of the aluminium plate result in damping by viscous friction. The magnet may be placed at varying distances from the plate to simulate a varying degree of damping. The software is used to measure the period T (cursors on the x-axis) and the successive amplitudes (cursors on the y-axis) of the pendulum. It can be seen that amplitudes decrease according to a geometric progression and that fluid braking does not markedly affect the pendulum period.

→ Determining metal rod torsion constant



A solid of a simple geometric shape (disk, bar), whose moment of inertia is easy to calculate compared to an axis, is fixed to the end of the vertical torsion wire. The solid is oscillated, and its period T read via the software provided.

Using this period and the moment of inertia of the solid, the torsion constant of the metal rod can be calculated. You will be provided with several rods (different diameters).

→ Checking beating periods

The two pendulums are connected by a torsion rod, and the same mass m is applied on them. While one pendulum is released in its balance position, the second is separated from its balance position and released. The software retrieves the time elapsing between two successive stops of this second pendulum.

It represents the beating period that can be compared to the theoretical value.

EXP 100 040 Pendulum study

Standing sound waves

A standing wave is the phenomenon resulting from the addition of at least two waves, of identical frequency, propagated in the same medium in different directions.

This wave is characterised by time invariant elements (wavelength, antinode, node, speed).

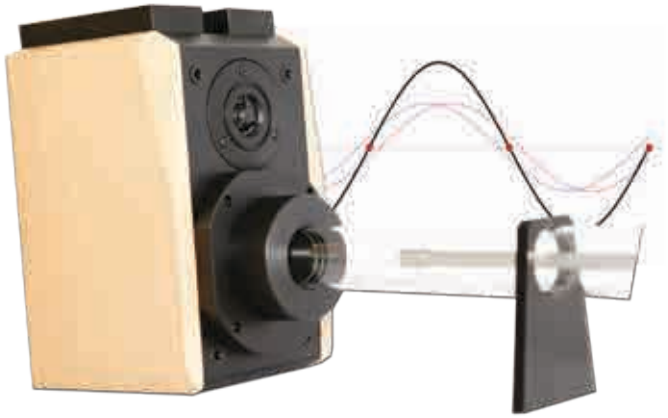
The Kundt tube is used to observe a standing wave. A loudspeaker coupled to a function generator generates waves of varying frequencies. A micro equipped with an amplifier observes waveform at various points of the tube, thus identifying by measurement the maximum (probe on an antinode) and minimum (probe on a node) pressure values of the standing wave. The observed signal is visible on the oscilloscope.

Necessary equipment

Reference	Designation	Quantity	Page
PHD 015 602	Kundt tube	1	28
PHD 015 613	Amplifier	1	28
PMM 063 805	2 x 70 MHz digital oscilloscope	1	152
PMM 062 685	5 MHz function generator	1	156
PEM 010 180	Black BNC/2x Ø 4 mm lead	2	139

Subjects approached

» Material absorption
» Standing sound waves



→ Standing sound waves

The Kundt tube principle is as follows : a tube is closed at one end by a "micro-holder", made up of an absorbing material (homogeneous, isotropic). It is also cylindrical and of finished thickness e. At the other end, a loudspeaker supplied by a LF generator emits a pure frequency sound wave (incident wave) that is reflected by the micro-holder. As it crosses the tube, the wave loses amplitude (energy transformation by absorption). Moreover, the reflected wave is phase-shifted (due to lag) with the incident wave. The reflected and incident waves meet to form a standing wave. The micro and its amplifier then allow us to observe easily the complete waveform.

→ Material absorption

Using a Kundt tube, you can measure the absorption coefficient of various materials. To do this, just place in front of the "micro holder" a ring, made of the material that you wish to study, with the tube's internal size. Below are a few examples of the absorption coefficients of various materials :

Matériaux	Coefficient d'absorption		
	125 Hz	1 kHz	4 kHz
Painted wood	0,05	0,03	0,029
Plastered wall	0,01	0,04	0,018
Carpet	0,15	0,46	0,36
Felt	0,18	0,58	0,61
Wooden parquet	0,03	0,11	0,18
Glasses, Windows	0,03	0,03	0,019
Bricks	0,015	0,028	0,05
Velvet curtain	0,1	0,51	0,45
Light curtain	0,05	0,17	0,43
Glass wool	0,5	0,89	0,71
Plaster ceiling	0,04	0,039	0,079
Marber floor	0,01	0,01	0,01
Tiles floor	0,01	0,012	0,012

EXP 100 090 Standing sound waves

Ultrasonic wave study

An ultrasonic wave is a mechanical vibration propagated in an elastic medium. Its frequency range is between 20 kHz and 1 GHz. It is defined by its wavelength, frequency and propagation speed, which depends on medium density and elasticity.

Their small wavelength confers on them a propagation similar to that of optical waves, thus allowing application of physical optics laws to them.

We shall generate ultrasonic waves using an LF function generator and a speaker. Suitable microphones will be used to receive and analyse these waves. A set of accessories will be available to study the laws of optics (transmission, reflection, diffraction, etc.).

Necessary equipment

Reference	Designation	Quantity	Page
PHD 015 615	Speaker	1	28
PHD 015 614	Dual transmitter	1	29
PHD 015 612	Microphone	1	29
PHD 015 616	Ultrasonic receiver	1	29
PED 022 163	Slits and multi-slits	1	127
PED 022 164	Metal screen	1	127
PBU 070 300	Bench with coupling and 2 riders	1	27
PMM 063 805	2 x 70 MHz digital Oscilloscope	1	152
PMM 062 685	5 MHz function generator	1	156
PEM 010 180	Black BNC/2x Ø 4 mm lead	2	138
PEM 010 021	Black BNC lead, male/male	2	138

Subjects approached

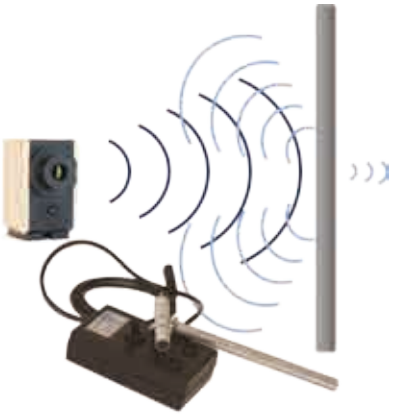
» Standing ultrasonic waves
» Air ultrasonic absorption
» Diffraction via a single slit or an edge
» Interferences via a dual slit
» Determining wavelength
» Interferences with two coherent sources
» Reflection

→ Diffraction via a slit or an edge

Diffraction is the behaviour of waves when they encounter an obstacle or an opening. The phenomenon can be interpreted by diffusion of a wave by the object points. Diffraction occurs when, after an encounter with an object, wave density is not preserved. Diffraction is the result of interference of the waves diffused by each point.

When studying wave propagation phenomena, diffraction occurs systematically when the wave encounters an object that obstructs part of its propagation (typically the edge of a wall or a lens). It is then diffracted : diffraction intensity increases progressively as the size of the opening it crosses approaches its wavelength : for example, a radio type wave will be difficult to diffract by buildings in a town. In this case, we shall highlight this phenomenon by means of the variable width slit or just at one of its edges.

→ Reflection



When a sound wave reflects on a surface, part of the wave is absorbed and transmitted in the material, while the rest of the wave is reflected as an optical specular reflection.

For solid materials such as wood and metal placed in air, most of the wave is reflected, roughly 99%, while the tiny remaining percentage is absorbed and transmitted in the material. For porous materials such as foams and sponges, we observe a greater absorption and thus, indirectly, a smaller reflection, as the sound wave loses energy due to the friction force promoted by the porous surface. As a rule, the denser the material, even if it is porous, the more it contributes to increasing reflection of the sound wave.

→ Interferences with two coherent sources

For this experiment, we shall use two LF generators, those of the dual transmitter with a frequency approaching 40 kHz. We can then, by placing the transmitter on the goniometric platform and the receiver at the end of the 50 cm bench, implement and observe a number of situations :

- *In phase.*
- *Varying phase-shift.*
- *In opposition of phase.*
- *Different amplitudes.*
- *Variation in distance between the two sources*

EXP 100 100 Ultrasonic wave study

Flat waves and diffractional principle

The ripple tank is an ideal demonstration tool. Using this new system digitised by Webcam, the ripple tank can now be used with interactive charts and video projectors. This simple, intuitive software allows rapid implementation of measurements via cursors, and can thus be used for hands-on exercises to take accurate measurements.

The ripple tank makes all wave phenomena accessible and understandable to students : flat waves, diffraction, interferences. Everything can be proved.

Necessary equipment

Reference	Designation	Quantity	Page
PHM 022 690	Ripple tank	1	33
POD 010 030	Didactic Webcam	1	69
POD 002 193	120 mm high half-moon stand	2	36

Subjects approached

» Huygens principle
» Flat waves
» Diffraction
» Interferences

→ Reflection

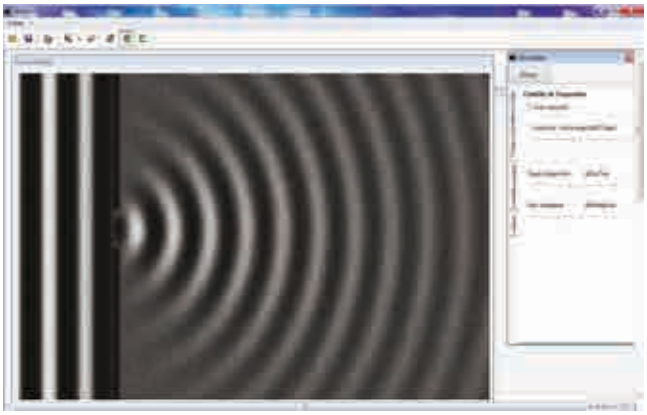
The aim of this activity is to study reflection of a flat wave on various obstacles : a straight barrier and a curved barrier.

A ray is a straight line indicating the direction of a flat wave. Wave fronts are perpendicular to the ray. When a wave is reflected on a surface, the angle of incidence (angle between the incident ray and the surface normal) is equal to the angle of reflection (angle between the reflected ray and the surface normal).

For this experiment, we shall use two of the ripple tank accessories and the plane exciter.

The reflections will be viewed on the software.

→ Diffraction



Still using the plane exciter, this activity aims at determining how the diffraction phenomenon develops when slit width (space between barriers) is adjusted or when wavelength changes.

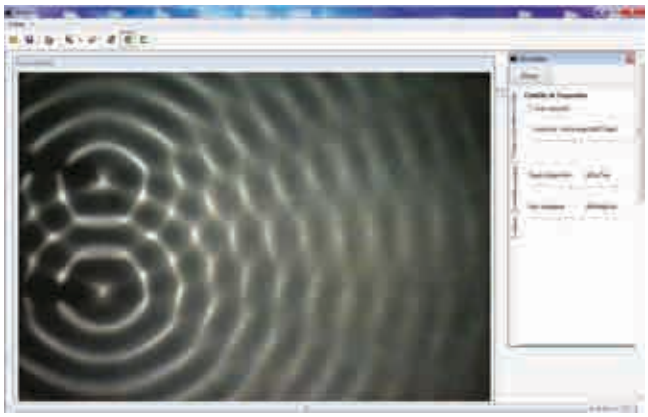
When a flat wave front passes through a slit, a new circular wave front is created. If the slit is wide compared with the wavelength, the new circular wave front will tend to become a flat wave front. If, however, the slit is small compared with the wavelength, the part of the flat wave front passing through the slit will form a circular wave front. This phenomenon is called diffraction.

→ Interferences

The aim of this activity is to determine how the «wave interference» formed by 2 slits or by 2 sources of excitation changes when slit width or wavelength changes. When a flat wave front crosses 2 slits, the new wave front generated behaves as though there were 2 punctual excitation sources. The circular waveforms leaving the 2 slits interfere with each other, constructively or destructively. The maximum intensity positions (constructive interference) are defined by the following formula :

$$d.\sin\theta = n.\lambda$$

Where d is the space between the 2 slits, θ the angle between the 2 maximum intensity positions, and λ the wavelength.



EXP 100 110 Flat waves

Liquid surface tension

This device is used to measure the surface tension coefficient using the ring method (also known as the du Nouÿ ring method) for fluids with small and average surfactant concentrations (water, hot water, oil, alcohol, etc.). A horizontal ring, a few millimetres thick, is suspended from the end of a dynamometer. The ring is then immersed in the liquid that completely wets it, before being made to emerge. A meniscus is then formed inside and outside of the ring perimeter. The value displayed on the dynamometer allows you to find the surface tension value.

This device is equipped with two suspended rings, two dynamometers and a lab jack.

Necessary equipment

Reference	Designation	Quantity	Page
PHD 008 160	Double ring and 0.1 N dynamometer	1	25
CGM 011 050	Base in A	1	36
POD 002 220	Lab jack	1	36
PHM 021 920	0.2 N dynamometer	1	35
CGM 011 393	Dual clamp holder	1	36
277	Rod	1	

Subjects approached

» Surface energy
» Surface tension measurement
» Du Nouÿ ring method

→ Du Noüy ring method for water surface tension

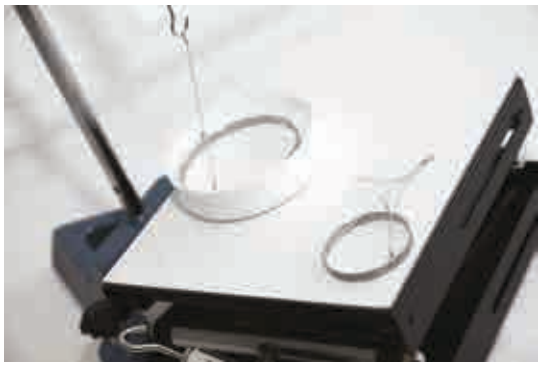
A metal ring, of known radius, fastened to a dynamometer, is immersed in a liquid that wets it completely. A force, known as the tensile force, must be overcome at the vicinity of the free surface to pull this ring out of the liquid. A small crystal container filled with water is placed on a lift holder, and the dynamometer is suspended above the liquid. The ring is suspended at the bottom end of the dynamometer, and is immersed completely by raising the lab jack. The holder is then lowered slowly to extract the ring from the liquid. The dynamometer is elongated under the effect of the surface tension forces. The tensile force is read on the dynamometer when the ring is pulled out of the liquid, to determine the surface tension value.

→ Comparing the surface tension of different fluids

With 0.1 N and 0.2 N dynamometers, you can measure the surface tension value of a large number of fluids with a varying degree of surface tension : water, saltwater, hot water, soapy water, oil, alcohol, etc. The idea is that students observe the differences in accuracy of implementation of their test protocol.

→ Dependency of the surface in contact with the fluid

We supply two rings for this experiment. As surface voltage value is dependent on the surface in contact with the fluid, it is possible to compare surface tension values for the same fluid and two different ring diameters.



EXP 100 120 Surface tension

Pendulum

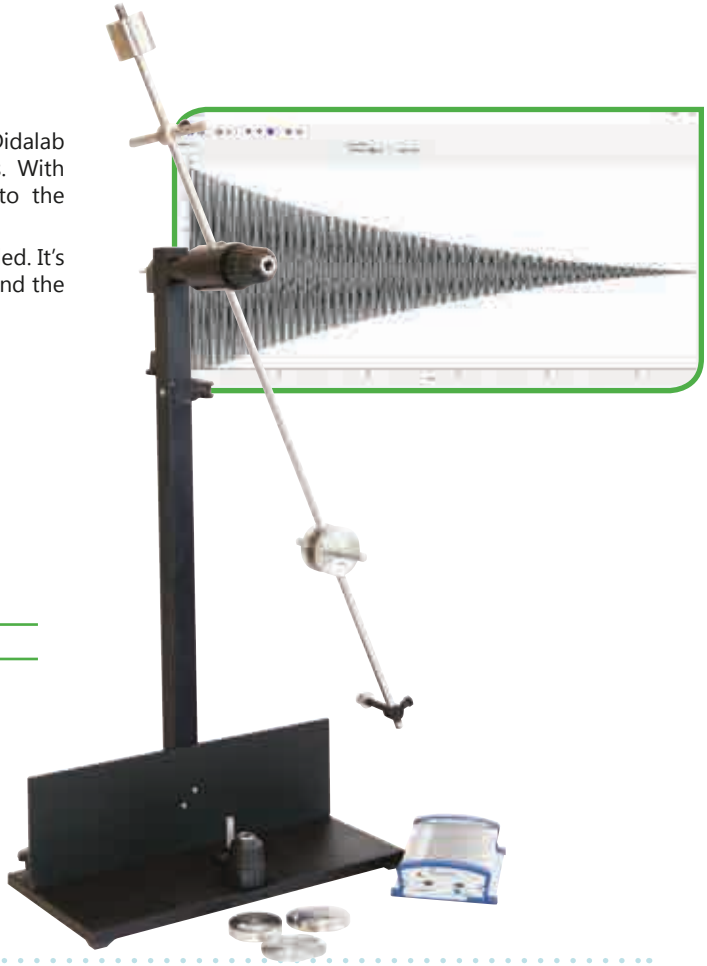
First multifunction pendulum !!!

This new version offers several functions, digital innovation and robustness.
New sensor, without contact, directly connected to the computer via USB cable.

Pendulum

A robust and innovative pendulum. The simple pendulum Didalab combines multifunctionality, digital innovation and robustness. With a contact-free sensor directly connected, via a control box to the computer by USB, you can easily recover all the data.

With the pendulum, a system of fluid and solid damping is included. It's also the basis which will allow you to build the dual pendulum and the torsion pendulum.



CONSTITUTION :

- *1 metallic stand*
- *1 PC interface with software program*
- *1 optical sensor*
- *2 USB cables*
- *1 set of weights (PHD 006 583)*

PHD 006 580	**Pendulum**

> Subjects approached

- *Pendulum study*
- *Fluid and solid damping study*

Set of solids

- *1 set of 3 solids with known surface areas (1 bar, 1 disc, 1 «H»)*
- *1 solid with an unknown surface area (1 wheel)*

PHD 006 582	**Set of solids**

> Subjects approached

- *Verification of Huygens theorem*
- *Measuring body moment of inertia*

Set of weights

Constitution :

- *4 50-g weights*
- *4 100-g weights*
- *6 200-g weights*

PHD 006 583	**Set of weights**

Dual pendulum

Nouveau

By associating 2 pendulums from this same generation, in front of each other, it is very easy to make a dual pendulum. This dual pendulum can be used for the study of coupled pendulums, with a torsion rod or a spring.

The interface is conceived to simultaneously receive the signals from the two pendulums.

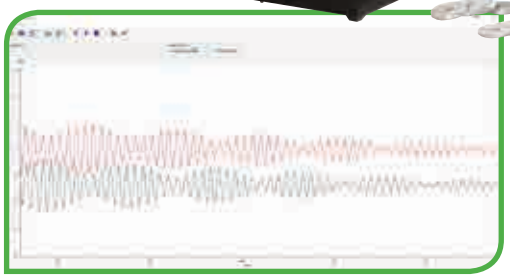
CONSTITUTION :

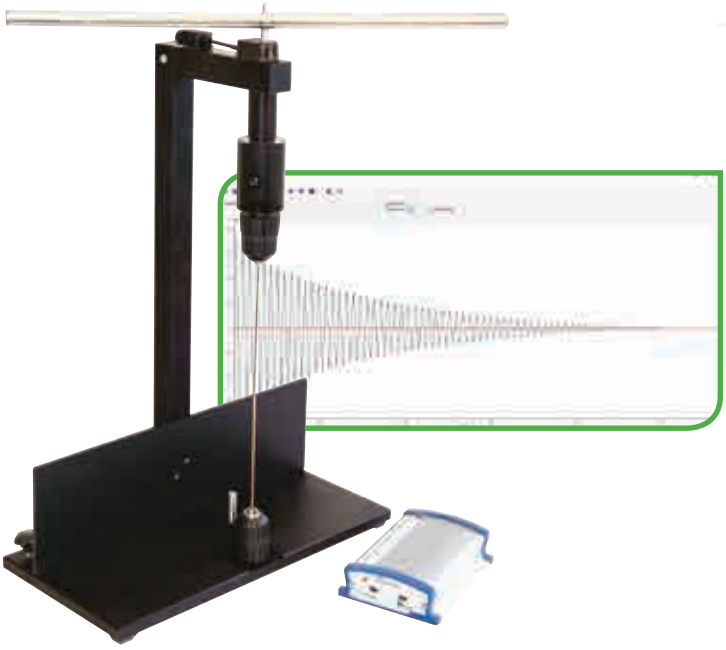
- *2 metallic stands*
- *1 PC interface with software program*
- *2 optical sensors (without contact)*
- *3 USB cables*
- *2 sets of weights*
- *1 set of coupling components (PHD 006 581)*

PHD 006 584 **Dual pendulum**

> Subjects approached

- *Sympathetic pendulum study*
- *Resonance stud*
- *Coupled system study*





Torsion pendulum

It is very easy to change your gravity pendulum in a torsion pendulum.

The gravity pendulum can be «bent» in order to study the torsion constants and the moment of inertia.

CONSTITUTION :

- *1 metallic stand*
- *1 PC interface with software program*
- *1 optical sensor (without contact)*
- *2 USB cables*
- *1 set of weights*
- *1 set of solids (PHD006582)*
- *1 set of torsion rods*

PHD 006 585 **Torsion pendulum**

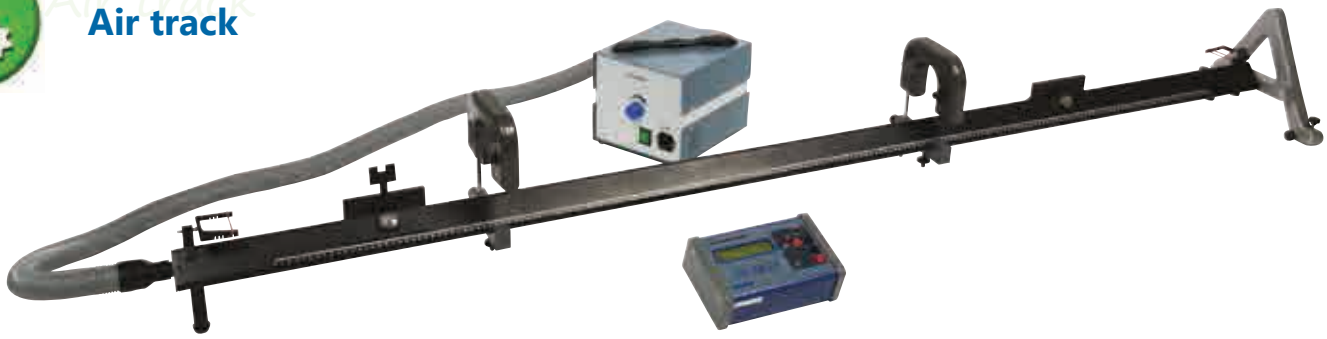
Set of coupling components

Constitution :

- *1 set of 3 rods*
- *1 set of 2 springs*

PHD 006 581 **Set of coupling components**

Air track



DESCRIPTION :

2-m bench, mm-graduated, for the study of motions with minimum friction.
It is used to :

- *Characterize kinetic energy, energy transfers by impacts, speed and acceleration*
- *Study free and forced oscillations with or without damping*
- *Study Newton's second law*
- *Study the accelerometer*

Its "A" stand, sith its 2 setting screws allows an adjustement of the tilt up to 5°.
Moreover, this stand enables to put the system in a "free fall" configuration (see picture) with a screw to adjust the verticality.

CONSTITUTION :

- *2 carts, on which you can put overloads (supplied)*
- *1 air blower*
- *1 set of accessories for both 2 configurations*

PHM 022 560	**Air track**

This air track is also available without any measurment devices (optical forks)

PHM 022 565	**Air track, alone**

ITAC Accelerometer

ITAC accelerometer is a 3-axis sensor, wireless, that uses vibrating beams technology. We've added a MEMS gyroscope in order to get the rotation information. These 2 technologies are used in a lot of today's equipment the idea here is to propose a coherent set, with an up-to-date technology that the students come across everyday.

This accelerometer is ideal for the free fall experiments (with protectiver cover), with a launcher, a pendulum, a vibrating table, or an air track (equipment to add). With the wireless transmission (bluetooth), you can use it in any conditions.

It is also possible to couple several accelerometers (network) in order to observe the movement of a mechanical wave (for example).

With the rechargeable Lithium battery life, you can experiment during 4 hours without stop. With the software, you can display and exploit all the data needed in acceleration and rotation.

CONSTITUTION :

- *Captor + Sensor*
- *2 measurement ranges (2g or 8g)*
- *Dimensions : 110 x 45 x 18mm*
- *Axis selection with program*
- *Software in French or English, operating with Windows*

OXA 100 010	**ITAC Accelerometre**

Forced oscillations and resonance

DESCRIPTION :

- *1 weight holder plate fitted to a rod with a spring*
- *Set of weights*
- *Measurement of elongations with a software*
- *1 test tube can be filled with water or oil for the study of fluid damping*
- *Discs of different diameters for the variation of friction coefficient*
- *1 motor for a near sinusoidal excitation*

INTENSIVE STUDY FOR HIGHER EDUCATION :

- *System differential equation*
- *Specific period : correlation between theory and experiment*
- *Calculation of the damping degree*
- *Maximum amplitude according to damping*
- *Quality factor of the system*

PHD 015 130	**Forced oscillations and resonance**

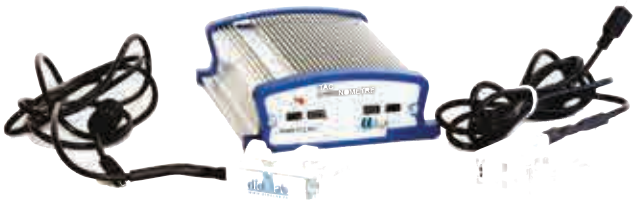
Surface tension apparatus

This package is used for the measure of surface tension.
It includes :

- *1 dual ring, hanging*
- *1 dynamometric sensor*
- *Elongations are measured with the software*
- *PC Interface box with software*

PHD 008 161	**Surface tension apparatus**
PHD 008 160	**Dual ring + dynamometric sensor**

Timing system



The electronic timing system can be used with all the kinematic experiments.

- *Measuring range : 0 to 3600 s*
- *Accuracy : 0,001 s (6 digits)*
- *Starting via program softwere*
- *Measuring mode : time interval or speed*
- *Autonomous box with softwere*
- *Supplied with 2 cells*
- *It is possible to order 4 cells*
- *Data courbe exported to other softwere*

PMM 013 961	**Timing system**
PMM 013 962	**Optical forks (x2)**

Free fall and tilted plane

Multipurpose apparatus for the study of free fall and tilted plane.
This apparatus mainly includes :

- *A dual rule constituting ther frame (L=1.5m), xith mm-graduation.*
- *A release system (for the marble or the cart) made of a powered electromagnet.*

TILTED PLANE :

To study the movement of a solid on a tilted plane, the package is composed of :

- *A marble*
- *A braking device at the end of the tilted plane*
- *A built-in tilt measuring device*
- *A 1.5 meters bench*
- *An angular rotation system for tilted plane*

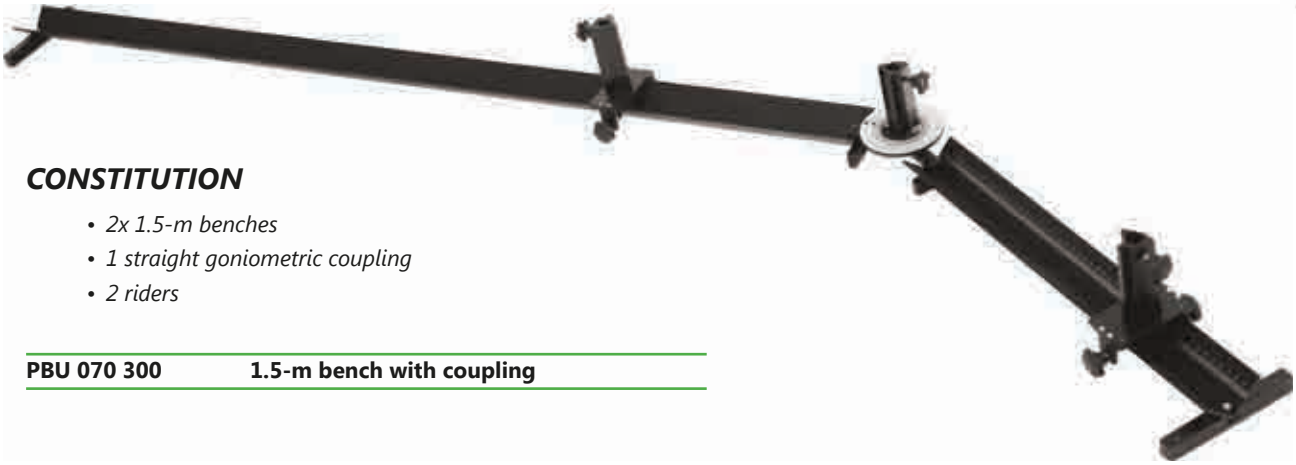
FREE FALL :

The apparatus can be vertically moved on its stand. The release of the marble is carried out by an electromagnet. A device for the marble recovery is fitted to the rule bottom.

PHM 022 410	**Freel fall and tilted plane**

PBU 070 030	**Tilted coupling**
PBU 070 035	**Straight coupling**

V-shaped universal bench



CONSTITUTION

- *2x 1.5-m benches*
- *1 straight goniometric coupling*
- *2 riders*

PBU 070 300	**1.5-m bench with coupling**

CONSTITUTION

- *2x 1-m benches*
- *1 straight goniometric coupling*
- *2 riders*

PBU 070 310	**1-m bench with coupling**

With its 2-points clamping system and its V-shaped guide, the rider is very stable and can easily stand a light or electromagnetic waves apparatus.

The graduation is displayed in the bench inside by noting the graduation at the rider's edge.

CONSTITUTION

- *1 2-m bench*
- *Stands for bench*

PBU 070 010	**2-m optical bench**

CONSTITUTION

- *Multi-diameter optical rider (8-14mm) for V-shaped bench*

PBU 070 020	**Optical rider multi-diameter**

Acoustic waves

Set for the study of acoustic waves (audible or ultrasonic) on the following fields :

- *Reflection of a transient wave on an obstacle*
- *Progressive wave refraction on an environment*
- *Progressive wave diffraction by one or two slits, an edge or a hole*
- *Progressive wave study thanks to the Kundt's tube or by reflexion*
- *Wave front division interferences*
- *Interferences with 2 coherent sources for studying the influence of the phase, the amplitude, and the beats.*

CONSTITUTION :

- *1 Kundt's tube*
- *2 micros with holder*
- *2 amplifiers*
- *2 loudspeakers (1 adaptable for the Kundt's tube)*
- *Ultrasonic double transmitter on rod*
- *Mechanical set composed of two graduated benches, a degree-gratued goniometric coupling, a set of plates and rods to build slits, screens, double slits.*
- *1 storage case*

PHD 015 600	**Acoustic waves**

Kundt's tube

Retail of the PHD 015 600 set.

PHD 015 602	**Kundt's tube**

Loudspeaker

Retail of the PHD 015 600 set.

PHD 015 615	**Loudspeaker**

Basic ultrasound bench

This apparatus is directly intended to be used by Students for the training to on propagation of sounds & ultrasounds.
The apparatus enables notably the measurement of wavelengths, the signal amplitude received according to the transmitter distance, as the reflection & interference phenomena in the presence of objects.
Used in "burst" mode, it enables the measurement of the propagation speed, as an introduction to the measurement principle of a Sonar.

CONSTITUTION :

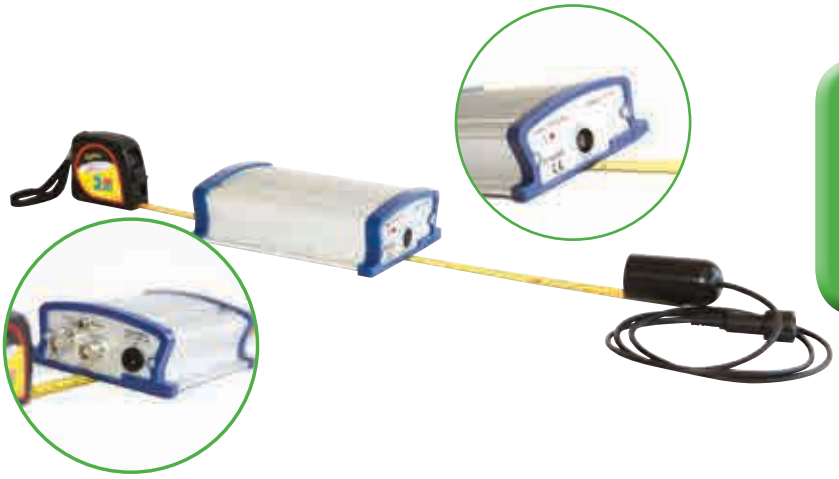
TRANSMITTER :

- *Continuous or burst mode transmission*
- *Operating frequency : 40 kHz*
- *Transmitter control voltage output*
- *Synchronization output ("burst" mode)*

RECEIVER :

- *Magnetic base*
- *BNC connection*

2-m METALLIC RULE



PHM 075 240	**Basic ultrasound bench**
PHM 075 241	**Transmitter**
PHM 075 242	**Receiver**

Amplifier

Retail of the PHD 015 600 set.

PHD 015 613	**Amplifier**

Microphone

Retail of the PHD 015 600 set.
Supplied with amplifier.

PHD 015 612	**Microphone**

Dual transmitter

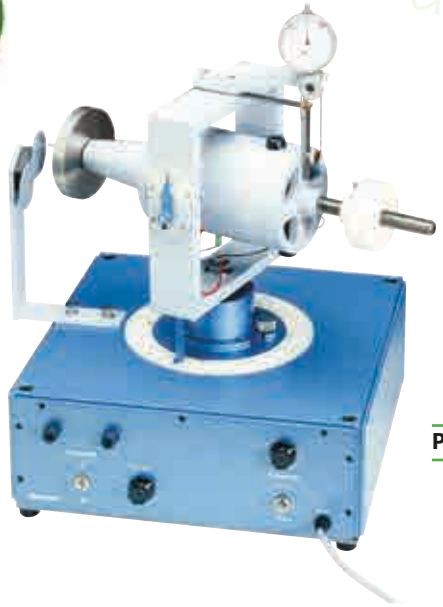
Retail of the PHD 015 600 set.

PHD 015 614	**Dual transmitter**

Ultrasonic receiver

Retail of the PHD 015 600 set.

PHD 015 616	**Ultrasonic receiver**



Gyroscope

The gyroscope is composed of :

- *A gyroscopic wheel rotating around the disk symmetrical axis*
- *A weights system for moving the system center of gravity*
- *A gyroscopic wheel made of a diam 100-mm disk weighting 930 g*
- *A motor driving the disk at a speed varying from 2 000 to 8 000 turn/min*
- *A dynamometric system for torque measurement.*
- *The vertical axis can be free (study of isolated gyroscope) or coupled to a motor to generate a precession motion (excited gyroscope).*

PHD 006 280 **Gyroscope**

Centrifugal force apparatus

The apparatus is constituted of :

- *A moving piece rotating at constant speed around a vertical rotation axis*
- *Speed can vary from 0 to 150 rev./min by potentiometer control.*
- *Speed measurement embedded*
- *Two rails, radialy fitted on the plate guide the moving piece to be studied*
- *This piece weights 150 g and can be load with 50-g overloads*
- *A thread goes through a pulley and connects the piece to a dynamometric sensor.*
- *The rotation radius can be changed by moving the dynamometer arm (adjustable from 4 to 13 cm).*
- *In adjusting the dynamometer tightening, the centrifugal force exerted on the moving piece can be exactly balanced.*

PHD 007 620 **Centrifugal force apparatus**

Pulsograph

The pulsograph is mainly constituted of two torsion pendulums (spiral springs).

Both pendulums can be isolated or coupled by the intermediary of spiral springs. There are 2 discs on a potentiometer (for which the resistance is proportionally to the angle) in order to take back the voltage signal (proportionally to the angle position of the pendulums)

Dimensions : 430 x 280 x 310 mm

Weight : 15 kg.

Power supply : mains, 220V – 50/60 Hz

PHD 015 900 **Pulsograph**

Waves propagation apparatus

This apparatus has been especially conceived for the speed characterization of a flat ultrasonic wave in several mediums It can also be used for the observation and the study of ultrasonic levitation.

CHARACTERISTICS :

- *Ø 40-mm piezoelectric transducers*
- *Measuring length : 0 to 280 mm with 1/100-mm digital display*
- *Dimensions : 500x170x190mm*
- *Harmonious frequency of the transducers : 37 kHz ± 3kHz*
- *2 BNC outputs*

TOPICS :

- *Function of a piezoelectric transducer*
- *Study of propagation of acoustic waves in the air a liquid*
- *Measures by flight time comparison*
- *Axial speed and pressure field in a standing waves system*
- *Characteristics of the nodes and antinodes*
- *Kinetics energy, Potential energy*
- *Ultrasonic levitation force*
- *Sample body levitation*

PED 023 200 **Waves propagation apparatus**

Propagation in solid / liquid / gas

Set using ultrasonic measure for the determination of the sound's propagation speed in a solid. You can use it horizontally on a rod for measures in solid or air, vertically for the levitation or the Doppler Effect.

CHARACTERISTICS

- *Piezoelectric transducer ⦰40m with BNC output*
- *Transducer harmonic frequency : 37kHz +/-3Hz*
- *Emission of a wave packet every 30ms*
- *Pulsation duration : 0.07 ms*
- *Transmitted power : 10W*
- *Speed measure precision : < 3 %*
- *Size : height 250mm, diameter 120mm*

CONSTITUTION :

- *1 holder for vertical measurements*
- *2 Piezoelectric transducers*
- *Impedance matching gel*
- *5 polyacrylate solids ⦰37mm*
- *5 aluminium solids ⦰37mm*
- *2 inox rods ⦰10mm*

PED 023 410 **Propagation in solid/liquid/gas**

Ultrasonic generator

Generator for ultrasonic systems with piezo electric transducers.

CHARACTERISTICS :

- *5 digits display for the frequency or the pulse period*
- *2 BNC outputs (transmitter, receiver)*
- *Setting of the pulse amplitude and frequency*
- *Pulse period : 0.07 ms*
- *Transmission power : 10 W*

PED 023 500 **Ultrasonic generator**

Friction measurement

DESCRIPTION

1 STAND WITH :

- *An electric winch with a very slow speed (5 tr/min)*
- *A dynamometric sensor*
- *A plate on which the solid lies, connected to the winch and the dynamometer with a thread*

THE PACKAGE IS SUPPLIED WITH :

3 PLATES DE 120 x 90 mm

- *1 glass, 1 cork, 1 aluminium with felt*

5 SOLIDS DE 100 x 40 mm

- *Steel, steel with felt, cork, aluminium, plastic*

- **3 SOLIDS : 67 x 20 mm**
- *Steel, Plastic, cork*

Dimensions : 600 x 150 x 150 mm
Weight : 1,2 kg

TOPICS :

- *Ckecking of Coulomb's law*
- *Effect of the materiel on coefficient of friction*
- *Effect of the surface state on the coeffcient of friction*

PHD 009 880	**Friction measurement**

Melde's vibrator

Apparatus conceived to generate mechanical waves from a low frequency signal.

- *Waves travel on a cord, a spring, a plate or a loop*
- *Frequency : 0 to 1 kHz – amplitude: 0 to 7 mm*
- *Input protected by a fuse*
- *Ø 10-mm rod*

PHM 022 810	**Melde's vibrator**

Stroboscope

- *Digital display : 3½ digits, LCD*
- *Flash tube : Xenon lamp*
- *Flash time : 60 to 1000 µs*
- *Operating range : 10 to 15000 flashs/min*
- *Accuracy : 0.05% + 1 digit*
- *Resolution : 0.1 FM/RPM < 1000 FPM/RPM >1.0 FPM/RPM*
- *Sample rate : 1 second*

PMM 015 002	**Stroboscope**

Ripple tank

Great size ripple tank, allowing the viewing of the wave's phenomenon on a liquid surface.

CHARACTERISTICS :

- *High quality, mostly metallic*
- *Contrasting viewing for qualitative or quantitative observations*
- *Patterns may be projected on the table, on a distance screen, or on the frosted glass of the tank*
- *Excitation with an electromechanical vibrator, with varied frequency from several one-tenth to several hundred Hertz*
- *Lighting by a 60W mechanical stroboscope, frequency-stabilized by the exciter (slow-motion viewing)*
- *Digital display of the frequency*
- *Tank's size : 314 x 363 x 30 mm*

CONSTITUTION :

- *1 Wave tank*
- *1 Stroboscope*
- *1 Electromechanical vibrator*
- *1 Set of accessories*
- *1 Carrying case*

PHM 022 690 **Ripple tank**

Electromechanical vibrator

Device for the generation of mechanical waves, from a low-frequency signal.

- *Wave propagation on a rope, a spring, a plate or a spiral spring*
- *Frequency : From 00 to 1 kHz, amplitude : From 0 to 7mm*
- *Input protected by a fusible*
- *Hold on a 10mm diameter rod*
- *Furnished with a 3m coil of rop*
- *Maximum input voltage : 6V/1A*
- *Size : diameter 100mm x 120mm. Weight : 1.26 kg*

PHM 022 800 **Electromechanical vibrator**

Vibrator additionnal kit

This set enables the study of compression waves (longitudinal waves) & the study of

- *One heavy stand with 12mm diameter rod and clamp*
- *One test spring & fastening accessories.*
- *Resonance spiral.*

PHM 022 820 **Vibrator additionnal kit**

Accessories for vibrator

Set of accessories for vibrator

- *Square Chladni's plate*
- *Round Chladni's plate*
- *Plate springs of several lengths*

PHM 022 825 **Accessories for vibrator**

Differential pulley

The differential pulley enables the underscoring of the forces reduction, thus the notion of moment.

CONSTITUTION :

- *3 grooves of 4, 6 & 12-cm diamete.*
- *fitted on ball bearing*
- *magnetic attachment*
- *Provided with one set of threads.*

PHD 005 852	**Differential pulley**

Disc for the study of moment of inertia

Ø 30-cm aluminium disc.

The aluminium disc has many hook fastening points (every 2 cm on several diameters). A graduated adjustable square enables the measurement of the distance to the shaft. The system can remain balanced, or can be blocked by rubber brake

PHD 005 580	**Disc for the study of moment of inertia**

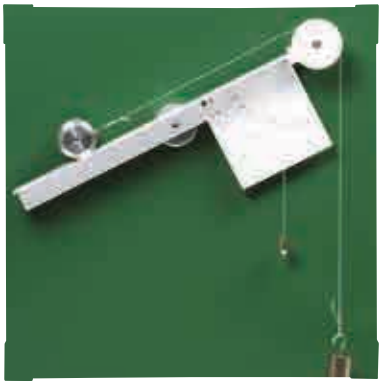
Rotating dynamics

CONSTITUTION :

- *One pulley with 2 m long thread.*
- *Shaft with pins, equidistant from the rotation centre (100, 150 & 200 mm from the centre), wich can be overloaded.*
- *One fastening rod*
- *Overload weights: 2x50 g, 2x100 g, 2x200g*

A weight can be fastened to the thread to drive the assembly down.

PHD 006 250	**Rotating dynamics**



Tilted plane fitted on magnet

This apparatus enables the measurement of the resulting force carried out by gravity, according to the tilted plane angle

- *A 250-mm movement rail, with a pulley, a protractor and a magnetic attachment system*
- *A 100-g mobile with a thread attachment system*
- *1 plumb line to read the tilting angle*

PHD 005 480	**Tilted plane fitted on magnet**

Pulleys and accessories

PHD005131	**Pulley on magnet**
PHD005141	**Axis on magnet**
PHD005891	**Pulley on shell**
PHD005781	**Pulley on rod**

Magnetic standard collection

MADE OF

- *2 1-N dynamometers*
- *3 pulleys on shaft*
- *4 pulleys on magnet*
- *Weights (0,1 - 2 x 0,2 - 0,5 - 1N)*
- *1 plumb line*
- *1 set of threads*
- *1 2-N dynamometer*
- *3 axis on magnet*
- *1 lever*
- *1 spring rule*
- *1 equilateral triangle*

PHD 005 713	**Magnetic standard collection**

Dial dynamometers

- *For measuring forces*
- *Easy to read (150-mm diameter)*
- *Very accurate (1% calibration, reading error < 1%)*
- *Can be used on a rod or magnetic board*

PHD 005 752	**1-Newton Dynamometer**
PHD 005 753	**2-Newton Dynamometer**
PHD 005 744	**5-Newton Dynamometer**

Accurate dynamometers

- *Accurate reading*
- *Fastening hook and metallic traction hook*
- *Adjustable zero*
- *Measuring range in 50 graduations on 10 mm*
- *Reading index for a better accuracy*
- *2% accuracy*

Reference	Range	Accuracy	Colour
PHM 021 910	**0,1 N**	**0,002 N**	**Silver**
PHM 021 920	**0,2 N**	**0,004 N**	**Beige**
PHM 021 930	**1 N**	**0,02 N**	**Yellow**
PHM 021 940	**2 N**	**0,04 N**	**Red**
PHM 021 950	**5 N**	**0,1 N**	**Blue**
PHM 021 960	**10 N**	**0,2 N**	**Green**
PHM 021 970	**20 N**	**0,4 N**	**Purple**
PHM 021 980	**50 N**	**1 N**	**Orange**
PHM 021 990	**100 N**	**2 N**	**Gold**
PHM 021 890	**Complete box of dynamometers**		

Plumb line

15 g load hanged on high resistance thread, 80 cm long.

PHD 005 012	**Plumb line**

Box of weights

This set includes 13 weights, from 1 g to 1000 g.
Supplied in a wooden box

PHM 012 420	**Box of weights**

Hook slotted weights

Kit of two 500-g sets of weights (that is to say 1 kg)

- *Chrome-plated brass*
- *can be directly used with dynamometers.*
- *Made of 4 100-g removable weights and 1 100-g hook holder*

PHM 022 161	**Hook slotted weights**

Lab jack

Lab jack made of anodized aluminium.

- *Minimum height : 60 mm*
- *Maximum height : 290 mm*
- *Plate : 200 x 200 mm*
- *Maximum load : 40 kg*

POD 022 220	**Lab jack**

Half-moon stand

Stand for Ø 8-mm to 14-mm rods
Height : 210 mm ; can be aligned using a Ø 10-mm rod

POD 002 192	**Half-moon stand**

Available with 120-mm height.

POD 002 193	**Half-moon stand**

A-shaped stand

- *Very good steadiness*
- *Nestable feet*
- *The horizontality can be adjusted with a setting screw*

CGM 011 050	**250-mm stand -3.4 kg**
CGM 011 060	**300-mm stand – 5.6 kg**

Clamp

2 models :

- *Double clamp : for Ø 10-mm rods*
- *Universal clamp : for Ø 3 to 16-mm rods*

CGM 011 392	**Double clamp**
CGM 011 393	**Universal clamp**

Optics

Experiments

The lens law

This comprehensive optical pack will allow you to implement the main methods for studying geometrical optics. You can determine focal distances and nodal planes for convergent and divergent lenses, mirrors and thick devices.

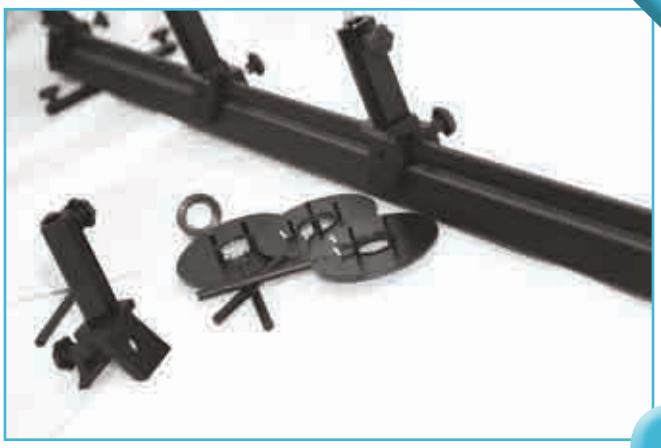
Use of standard optical systems, such as ocular lenses or collimators, will allow you to perform the various measurements and familiarise yourself with basic optical instruments, which you will then use in future experiments.

Necessary equipment

Reference	Designation	Quantity	Page
POF 010 110	2-metre optical bench	1	76
DPO 020 100	LED lantern	1	77
POF 010 124	Standard optical rider	5	76
POD 010 090	40-mm diameter component holder	3	81
POD 010 002	Millimetric metal screen	1	81
POD 069 380	Basic collimator	1	82
POD 069 400	Basic telescope	1	82
POD 069 411	+ 100 mm eye piece	1	82
POD 069 412	+ 200 mm eye piece	1	82
POD 060 500	Holder for thick device	1	84
POD 061 260	Thick device	1	84
POD 010 511	Set of optical components	1	93
POD 608 605	40 mm diameter - f= +250 mm lens	2	93

Subjects approached

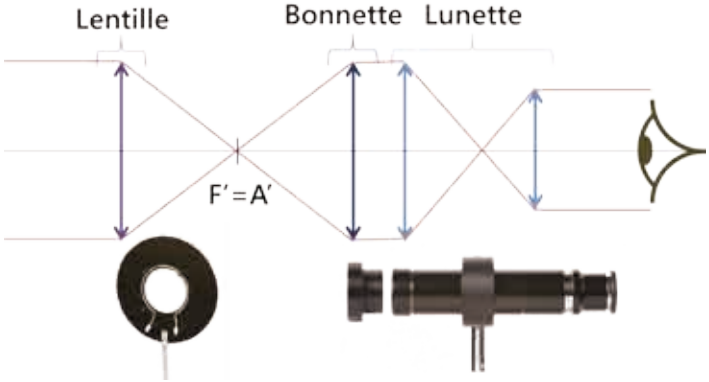
- Bessel's method
- Autocollimation method
- Silbermann's method
- Badal's method
- Conjugate points method
- Using a fixed frontal ocular lens
- Cornu's method



→ Bessel's method

Bessel's method is used to determine the focal length of a converging thin lens. This method consists in imposing a distance D between an object A (for example, via a letter fixed to the lantern) and a screen E and in searching for the two positions of the lens giving a sharp image of A on screen E. The difference between these two positions represents the distance d. By measuring distances d and D, the lens focal distance is calculated.

→ Using a fixed frontal ocular lens



Above all, the telescopic sight must be set at infinity (for example, by looking at a far-off object through the window). Once set, it allows the collimator to be adjusted. The latter acts as an object. By means of an additional lens (eye piece), affixed to the lens of the ocular lens, the latter becomes a fixed frontal sighting device.

Then place a diverging lens in front of the collimator and target the lens (previously marked with a felt-tip pen) using the sighting device, as well as the sight image via the lens. These two measurements provide the focal length of the lens.

→ Cornu's method

Two lenses are chosen to be placed in the thick system. A collimator (set to infinity) is aligned on the bench, together with the thick system to be studied and a fixed front sighting device. 3 items are targeted in turn : the reticle image, and the input and output surface of the thick system (identified by two distinct marks on each system surface). The thick system is overturned and the 3 measurements are repeated : the reticle image and the system input and output surface.

The focal distance of the thick system is calculated by applying Newton's equations (the product of the distances of two conjugate points from the respective principal foci of a lens or mirror is equal to the square of the focal length).

EXP 200 010 The lens law

Dispersion of prisms, diffraction gratings

The LEMARDELEY Spectrogoniometer, produced by Didalab, is the brand of a know-how that has never ceased to be upgraded in the last 40 years.

On the agenda of preparatory classes(*), it is used to study prisms and diffraction gratings.

Equipped with a vernier scale engraved to an accuracy of one arc minute, with an autocollimator, a micrometric lens and a collimator with micrometric slit, it is a guarantee of fast and accurate learning.

The didactic camera provided for this experiment is designed to capture the various dispersions and to use them as class demonstrations or for hands-in exercise reports.

Necessary equipment

Référence	Désignation	Quantité	Page
POD 068 070	Spectrogoniometer	1	60
POD 010 030	Didactic Webcam	1	172
POD 010 050	Low pressure mercury lamp	1	71
POD 010 058	Low pressure sodium lamp	1	71
POD 010 056	Stand for spectral lamp	1	71
POD 062 000	Paton 300 lines/mm grating	Inclued	92
POD 062 100	Paton 600 lines/mm grating	Inclued	92
POD 010 620	Hollow prism	1	94
POD 068 030	Crown glass prism	Inclued	94
POD 010 616	30-60-90° prism	1	94

Subjects approached

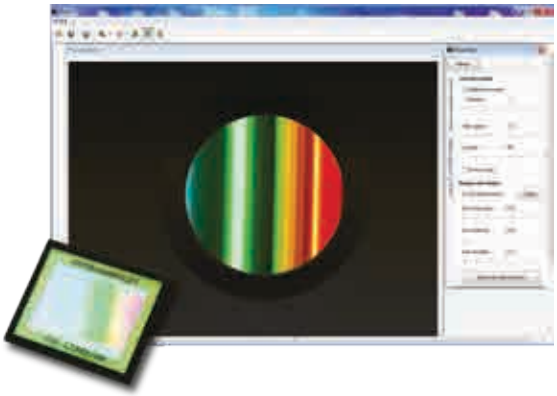
» Dispersion
» Refractive index
» Prism angle study
» Setting the goniometer
» Determining grating constant
» Spectrometry – Analysing a spectral source

→ Refractive index

A prism is a cut glass block, classically made up of three surfaces on a triangular base. This optical instrument is used to refract, reflect or disperse light. Dispersion and refraction depend on the index of the material used for the prism.

We offer a Crown glass prism (low-dispersion) and a Flint glass prism (high-dispersion), a hollow prism and a set of glass prisms with an index to be determined. Students can thus cover the main types of prisms. The goniometer's prism holder plate can be adapted to work with other prisms should you so wish.

→ Determining grating constant



A diffraction grating is an optical device made up of a series of parallel slits (transmission grating) or of reflecting stripes (reflection grating).

These features are regularly spaced, and the spacing is known as the grating constant. Light dispersion will vary according to this constant: wide for a grating with a small constant and more concentrated for a grating with a larger constant. The goniometer's micrometric slot allows accurate adjustment of the fineness of the lines observed.

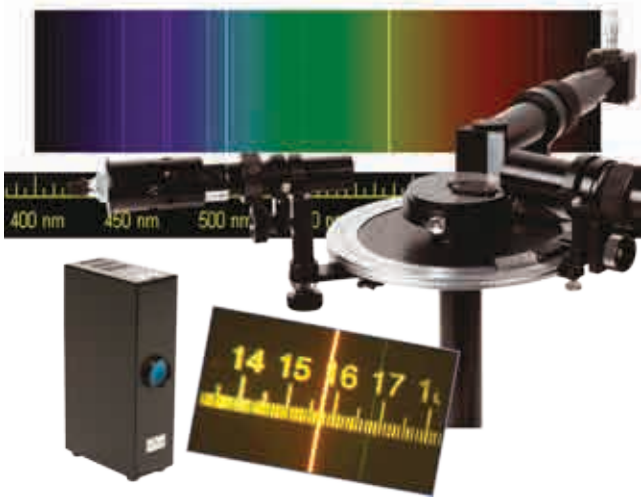
→ Spectrometry – Analysing a spectral source

You can use a micrometric lens to measure wavelengths, in the same way as you use a SPID optical fibre spectrometer.

By means of this experiment, the spectrogoniometer becomes a genuine practical aid to link the gratings theory and the operation of fibre spectrometers widely used in all establishments. Moreover, this experiment reflects on implementation of a measurement system and the protocol to be set up to attain its target aim and accuracy.

Since calculation of uncertainty is an essential part of preparatory classes (*), students can thus criticise a process that they themselves set up.

(*) : Preparortary classes (Classes Préparatoires aux Grandes Ecoles (CGPE) : two-year undergraduate intensive course in mathematics and/or physics to prepare students for national competitive examinations for admission to to the top-ranking higher education establishments.



EXP 200 020 Dispersion of prisms and diffraction gratings

Reflection - Refraction

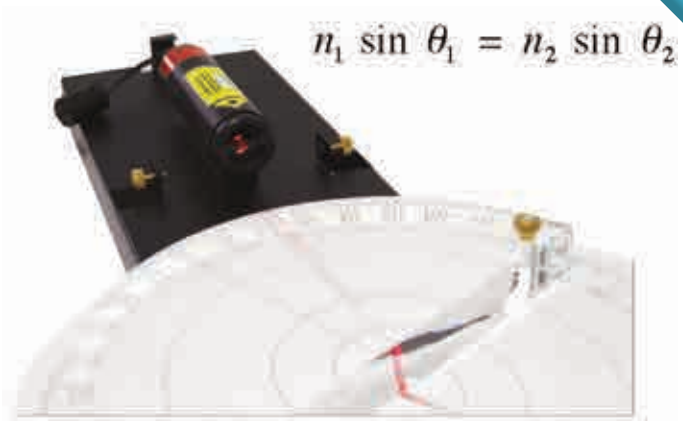
This experiment will let you view light at the surface of a diopter. You will highlight light reflection and refraction phenomena according to the medium that light passes through. Application of Snell-Descartes' law, approached during the theoretical class, takes on here an obvious playful and experimental aspect. You can also use the semi-cylindrical tank to find the refractive index of a medium and determine from it the speed of propagation of light in this medium. This experimental kit comprises a lantern, a laser diode with line generator, and a graduated mechanical assembly consisting of slits, a Plexiglas disk and a semi-cylindrical tank.

Necessary equipment

Reference	Designation	Quantity	Page
POD 063 202	Mechanics for Discoptic	1	167
POD 063 203	Laser for Discoptic	1	167
POD 060 200	Lantern for Discoptic	1	167
POD 099 000	Power supply for Lantern	1	167

Subjects approached

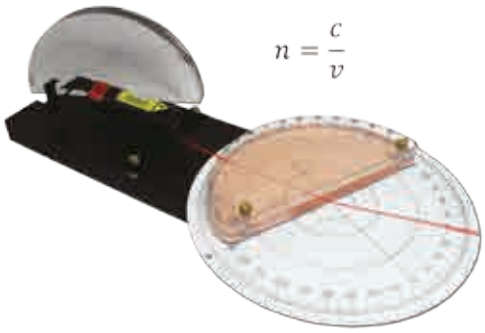
» Snell-Descartes' law
» Reflection study
» Refraction study
» Total or partial reflection
» Limit angle of refraction
» Medium index
» Reflection spectral analysis
» Notion of refractivity



→ Highlighting refraction

Refraction is the change in direction of a ray of light when it passes over the surface of two different transparent media. Snell Descartes' law can be checked by reading the incident ray angle and the refracted ray angle with the graduated disk.
The angles of three refracted rays can also be compared by placing a multi-slit at the outlet of the lantern.

→ Calculating the medium index



A liquid with an unknown refractive index is placed in the semi-cylindrical tank (sweetened water, oil, etc). Then, an incident ray is made to enter this tank by means of a laser equipped with a line generator.

The angle of the refracted ray with respect to normal is identified, thus allowing us to find the refractive index of the medium. We can then use this index to calculate the speed of light in this medium with the equation n=c/v.

→ Highlighting total reflection

The phenomenon of total reflection occurs when a ray of light reaches the surface of separation of two media with different optical indices with an angle of incidence greater than a critical value. The ray is no longer refracted but reflected. This is the principle of diffusion that we find in optical fibres. The half cylinder is placed directly at the outlet of the lantern (a beam is generated with a slit) or the laser. The ray of light will pass from a more refractive medium (Plexiglas) to a less refractive medium (air). By rotating the graduated disk, the angle of total reflection is found.

EXP 200 030 Reflection - Refraction

Camera model

The didactic digital camera model is an excellent tool for understanding how a camera works. The lenses, with fixed and variable focal lengths, are used to implement the diaphragm to allow depth of field and understanding of the optical zoom notion, while the software studies the digital zoom, the white balance setting, as well as the Bayer filter.

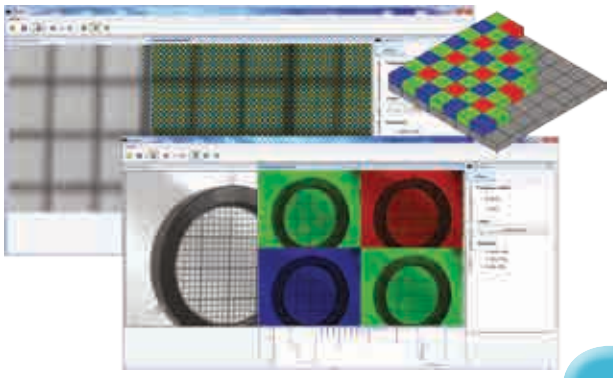
Usable on a bench with a 10mm rod or on a camera stand, the model has a reflex viewer where each item is visible and identifiable. Its comprehensive user manual will provide you with all the information you need to use your camera in your hands-on exercises and end of year projects.

Necessary equipment

Reference	Designation	Quantity	Page
POF 010 810	Digital pedagogical camera	1	169
POF 010 110	Basic component holder	1	170
POF 010 110	2-metre optical bench	1	76
POf 010 124	Standard optical rider	2	76
POD 069 140	Lantern with dimmer	1	77
POD 002 192	Half-moon stand	1	101
POD 066 500	40 mm diam. millimetric object	1	89
POD 060 260	Prism holder	1	84
POD 010 002	Millimetric metal screen	1	81
POD 061 932	Red dichroic filter	1	92
POD 061 933	Green dichroic filter	1	92
POD 061 934	Blue dichroic filter	1	92

Subjects approached

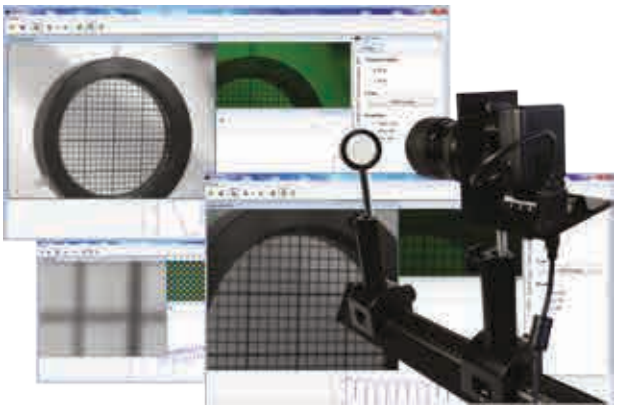
- Reflex viewer study
- Aperture, exposure, focusing
- Depth of field
- Bayer filter
- White balance setting
- Optical zoom – Digital zoom
- Studying a digital image, compression
- RAW file
- Studying photographic lenses



→ Bayer filter

A Bayer matrix, also known as a Bayer filter or a Bayer mosaic, is a type of Color Array, i.e. a matrix of coloured filters placed in front of the digital sensor to record photographs in colour. This matrix consists of 50% green filters, 25% red filters and 25% blue filters. A useful camera pixel is thus in reality a composition of 4 pixels. The "Photoo" software, supplied with the camera model, highlights this filter and helps students understand how colour functions on the sensor.

→ Optical zoom – Digital zoom



An optical zoom is possible with a variable focal length lens. A ring moving several groups of ocular lenses within the lens, is used to modify continuously the resulting focal distance and thus the magnification, thus modifying the angle of view covered by the lens and the size of the image elements.

A "digital zoom", made possible by the Photoo software, simulates a change in focal distance by image resizing techniques. A word of warning however : an overly large digital zoom shows the shape of the pixels. You can observe this with the software by zooming up to 32 times.

→ Depth of field

For a given use and setting of a camera, depth of field corresponds to the zone of the space in which the subject to be photographed must be placed in order to obtain an image that the eye (or sensor) will accept as sharp. The size of this zone depends on the shot parameters, and, in particular, the focus distance, diaphragm opening, and sensitive surface dimensions. The larger the depth of field, the more it includes the subject in its environment. On the other hand, the smaller the depth of field, the more it isolates the subject. Using the camera model, you can easily implement all these parameters on a limited area (simulated macro), for example with a small figurine.

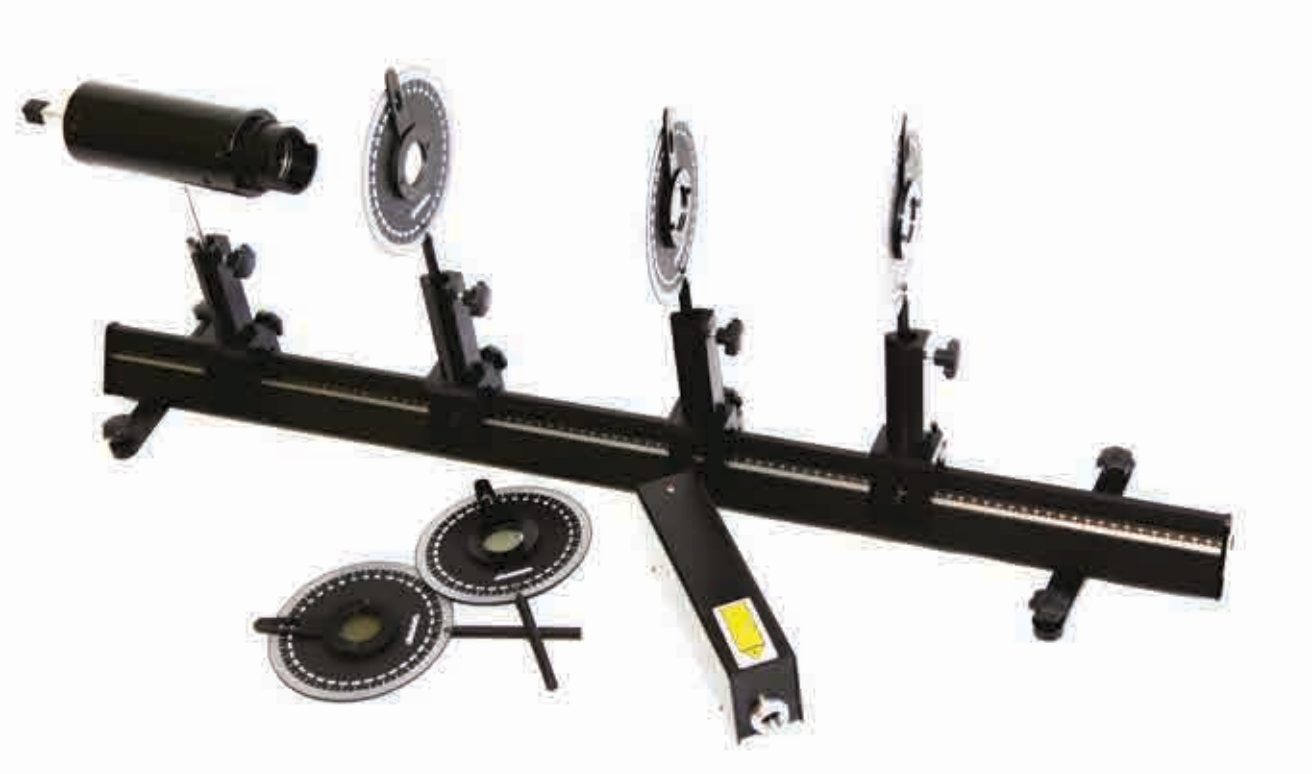
Réglage du diaphragme

EXP 200 150 Camera model

Polarisation law

Light is an electromagnetic wave, and its polarisation is characterised by the orientation of the electric (or magnetic) field in a plane perpendicular to its propagation. This comprehensive optical pack allows you to implement and study the basic principles of polarisation of light. You can study the state of polarisation of sources, verify Malus's law, and analyse the effects of various polarisation retardation plates.

Light intensities are displayed via an acquisition software connected to a USB photodiode. Using the parallel plate tank, the polarisation power of a sweet solution is studied, and Biot's law is implemented.

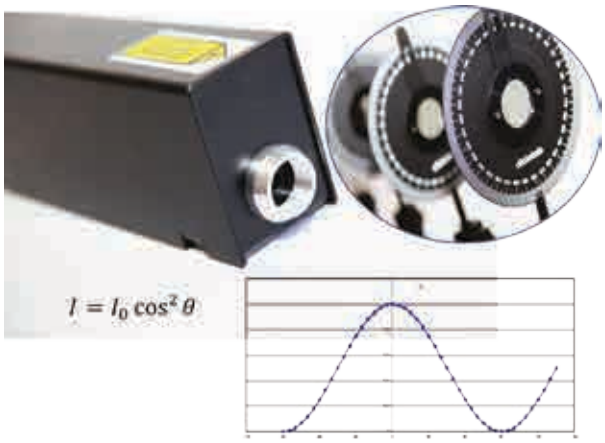


Necessary equipment

Reference	Designation	Quantity	Page
POF 010 112	1-metre optical bench	1	76
POf 010 124	Standard optical rider	6	76
POD 069 125	LED lantern	1	77
POD 013 210	He-Ne laser	1	77
POD 012 005	USB photodiode detector	1	69
POD 060 910	Pair of polarising filters	1	87
POD 060 955	430-700 nm quarter-wave plate	1	87
POD 060 965	430-700 nm half-wave plate	1	87
POD 060 961	Half-shadow polarimeter	1	87
POD 010 002	Millimetric universal screen	1	81
POD 060 450	Parallel plate tank	1	87

Subjects approached

- Malus's law
- Linear polarisation
- Random polarisation
- Biot's law
- Dextrorotatory and levorotatory substances



→ Laser polarisation and verifying Malus's law

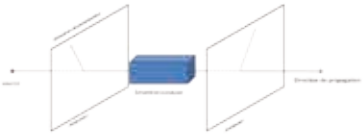
The laser is placed on the optical bench. Once laser polarisation direction has been determined, the polariser is placed according to the angle allowing maximum light intensity. A second polariser, acting as an analyser, is then placed. The photodiode detector is used to measure the light intensity received. The analyser is rotated, and the resulting light intensity read. By plotting the light intensity graph as a function of the analyser rotation angle, a sinusoidal shaped graph with extinctions is obtained. The remarkable angles are observed between the polariser and the analyser, yielding maximum light intensity values. Polarisation is linear.

→ Implementing half-wave and quarter-wave plates

The laser is placed on the bench, together with a quarter-wave plate, between the polariser and the analyser. The first polariser is placed at 90° and the quarter-wave plate at 45°, and the analyser is progressively rotated. We observe that analyser position does not affect polarisation.

The quarter-wave plate is now placed at any angle, and the analyser is rotated. We observe that we do not attain total extinction, but minimum intensity.

→ Verifying Biot's law



Some "optically active" substances are able to change light polarisation direction. The substance is said to be "dextrorotatory" when it changes polarisation direction to the right, and "levorotatory" when it changes polarisation direction to the left. Biot's law states that the angle of rotation is proportional to the concentration of active substance. This law can be verified by placing the parallel plate tank containing the active substance between the polariser and the analyser.

EXP 200 040 Polarisation law

Diffraction and Interferences

This optical pack is designed to highlight the diffraction phenomenon by a number of components : slits, lines and holes. Influence of wavelength can also be studied in the interference and diffraction phenomena. The influence of distance, slit width and spacing in an interference system can be highlighted. Using the Caliens CCD camera, the interference or diffraction figure obtained during the exercises can be compared with the theoretical curve.

Necessary equipment

Reference	Designation	Quantity	Page
POF 010 110	2-metre optical bench	1	76
POF 010 124	Standard optical rider	2	76
POF 010 126	Horizontal motion optical rider	1	76
POF 010 300	Basic Caliens camera	1	79
POD 010 025	Set of filters for the camera	1	80
POD 010 110	Basic component holder	1	81
POD 013 136	Blue laser diode	1	78
POD 013 133	Red laser diode	1	78
POD 013 132	Green laser diode	1	78
POD 066 710	Young's slits token	1	80
POD 066 700	Single slits token	1	80
POD 066 720	Multiple slits token	1	80
POD 066 730	Young's holes token	1	80
POD 010 002	Metal screen	1	81
POF 010 610	Studying a CCD sensor device	1	80

Subjects approached

- Diffraction via a slit
- Diffraction via a hole
- Young's slit interferences
- Multiple slit interferences
- Young's hole interferences
- Highlighting wavelength influence
- The wave nature of light
- Implementing a CCD sensor array

→ Implementing diffraction

The diffraction phenomenon occurs when a wave encounters an obstacle whose dimensions are of the same order of magnitude as the wavelength. The token comprising simple slits of varying widths is placed between the laser and the CALIENS camera (or screen) on a horizontal motion optical rider (allowing displacement along the slits of varying widths). The diffraction figure is displayed on the software. This figure consists of a central spot surrounded by dark areas and light spots. Laser wavelength and slit width can be determined by measuring the fringe spacing.

→ Implementing interference fringes

The interference phenomenon occurs when two coherent waves are superimposed. When a token comprising Young's slits is illuminated in monochromatic light (laser), a series of dark bright fringes is observed. Using this interference figure and, in particular, the fringe spacing value, the distance between the slits can be calculated.

→ Implementing a CCD sensor array

By placing the Caliens camera at the end of your optical bench, you ensure that your light signal reaches the CCD sensor array. The set of filters guarantees the signal is displayed unsaturated. The signal is displayed in real time. The software allows simulation of the signal obtained at a theoretical curve. You can simulate the type of slit and size, and the wavelength with which you work. The software displays the theoretical curve corresponding to these characteristics, which can be compared to the actual signal obtained. You can also use the BNC cable and an oscilloscope to compare the "analog raw signal" and the "digital signal" on the software.

EXP 200 070 Diffraction and Interferences

Newton's rings

A very slightly convex lens is placed in contact with the flat surface of a glass slide. It then forms an air wedge with a curvilinear boundary surface. If the device is illuminated with an incident light with parallel rays, concentric interference rings are formed around the contact point of the two surfaces. The distance between the interference rings is not constant since the air wedge boundary surface is curvilinear.

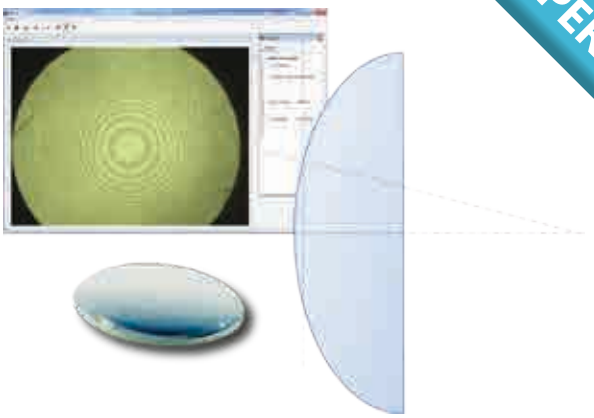
In this case we shall use a sighting device for our measurements. We can combine this device with a webcam to retrieve data on a computer.

Necessary equipment

Reference	Designation	Quantity	Page
POF 010 112	1-metre optical bench	1	76
POF 010 124	Standard optical rider	3	76
POF 010 126	Horizontal motion optical rider	1	76
POD 066 061	Newton's rings device	1	86
POD 010 030	Didactic Webcam	1	69
POD 010 057	High pressure mercury spectral lamp	1	71
POD 010 056	Stand for spectral lamp	1	71
POD 010 572	Green interference filter - 546 nm	1	70
POD 069 440	Viewfinder	1	83
POD 061 250	Dual condenser	1	85

Subjects approached

» Air wedge
» Radius of curvature



→ Radius of curvature

The Newton's rings device yields rings in view of its rotational symmetry. Another difference is highlighted by the type of reflections involved. Reflection is of the glass-air type on the spherical diopter of the lens, and of the air-glass type on the mirror. We thus have for Newton's rings :

$$\delta(P) = 2e(P) \pm \frac{\lambda_0}{2} = 2R(1 - \cos\theta(P) \pm \frac{\lambda_0}{2} \sim R\theta^2(P) \pm \frac{\lambda_0}{2}$$

If we refer to ρ as the ring radius, we observe that :

$$\rho(P) = R\theta(P) \Rightarrow \delta(P) = \frac{\rho^2(P)}{R} \pm \frac{\lambda_0}{2}$$

Newton's rings are in this case observed in transmission as the flat plate is transparent. The central ring is thus bright.

→ Air wedge

We illuminate at normal incidence, with a monochromatic parallel beam of light, a large-radius convex flat lens placed on a glass slide. Part of a ray is reflected on the glass-air interface without phase change, while the other part passes through this interface, and a fraction of this ray is reflected on the bottom slide. As this ray is reflected by a more refractive medium, this reflection produces a phase shift of π.

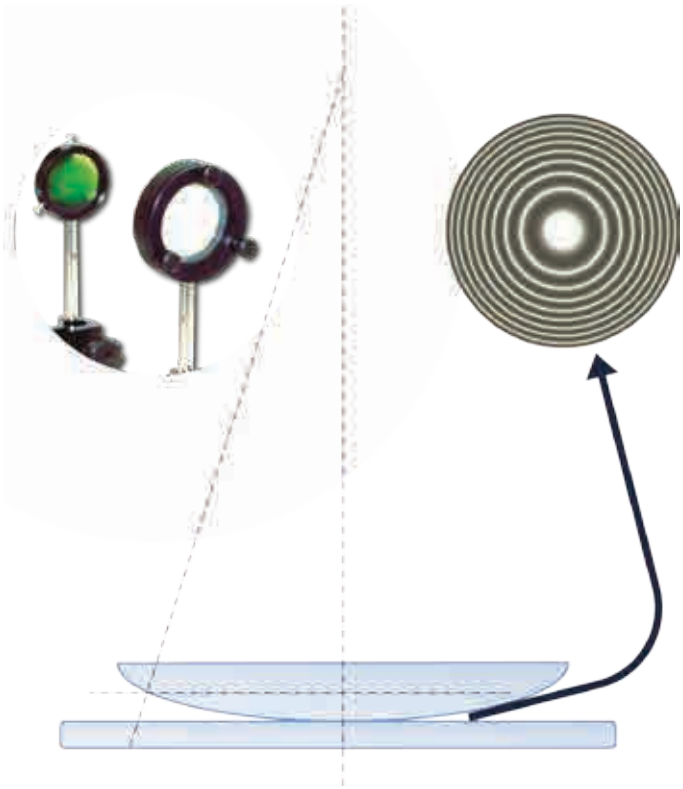
These two reflected rays, of adjacent amplitudes, interfere by yielding localised fringes (as for thin plate) in the vicinity of the lens spherical surface.

Let R be the radius of curvature on the underside of the lens. In other words r = OI is the distance between the ray and the optical axis of the system.

We obtain IJ = e = R − (R2 − r2)½ = R − R (1 − r2 / R2)½.

As r is far smaller than R, we obtain: e ≈ r2 / 2R. The optical path difference is formulated as δ = 2e + λ / 2 = r^2 / R + λ / 2.

As the system accepts an axis of revolution, fringes are rings centred on this axis. Dark rings are obtained when δ = (2k + 1) λ / 2 or for 2e = r2 / R = kλ. If the lens is in optical contact with the underside, the first ring will be dark. The following rings (the optical path difference increases by one wavelength between two rings) have radii proportional to the square root of an integer : rk = (k.λ.R)½.



EXP 200 080 Newton's rings

Michelson's experiments

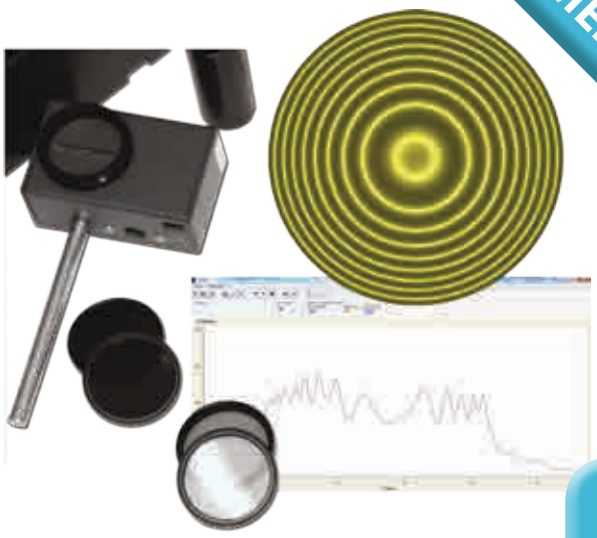
The Michelson interferometer is an optical device producing interferences by amplitude division. It consists of two flat mirrors and a semi-reflecting plate attached to a compensator. A number of experiments are possible, such as parallel beam splitters and air wedge configuration, vacuum refractive index measurement and glass slide thickness. For example, sodium beats highlight is also possible with the motor. We can equally highlight the piezoelectric effect.

Necessary equipment

Reference	Designation	Quantity	Page
POD 013 495	Michelson's interferometer	1	98
POD 013 565	Motorization for Michelson	1	98
POD 010 057	High pressure mercury lamp	1	101
POD 010 058	Low pressure sodium lamp	1	101
POD 010 056	Stand for spectral lamp	1	101
POD 069 140	Lantern with dimmer	1	77
POD 013 210	He-Ne laser	1	101
POD 013 497	Plate holder	1	98
POD 013 499	Vacuum tank + manual pump	1	99
POD 060 230	Single plate holder	1	84
POD 010 053	Condenser	1	85
POD 002 192	Half-moon stand	4	101
POD 060 130	80 mm diam. component holder	1	81
POD 608 420	Lens f= +100 mm diam. 80 mm	1	93
POD 010 020	Superior Caliens camera	1	100

Subjects approached

- Beating of a spectral lamp
- Notion of an air wedge
- Optical contact and WLF (white light fringe)
- Glass slide thickness
- Measuring vacuum index
- Fourier transform of a spectral lamp
- Michelson's study
- Rings, law in √n

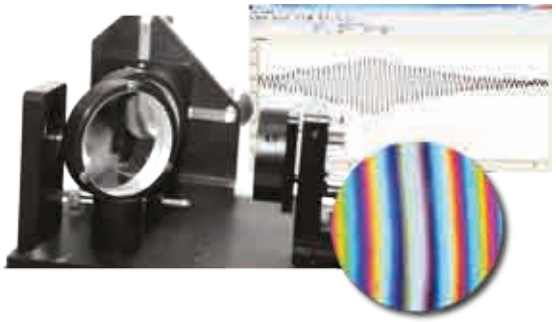


→ Rings, law in √n

Verify the theory of composition of rings of equal tilt. If we study the diameter of concentric rings, we observe that this diameter varies by a ring according to the root of its order. Thus the fourth ring will be twice as large as the first one. This study will be conducted with a sodium source (or filtered high pressure mercury).

To keep a trace of the results, we shall use the Caliens CCD detector. This will let us measure ring diameters accurately and generate a data bank with your devices when preparing hands-on exercises.

→ Notion of an air wedge



An air wedge is a name stemming from mirror positions. It also refers to the effect generated by a specific configuration of settings.

We call «air wedge» a slight tilt of M2 with respect to M1 in the immediate vicinity of the optical contact. In fact it is as though the two beams interfered after passing through an air wedge.

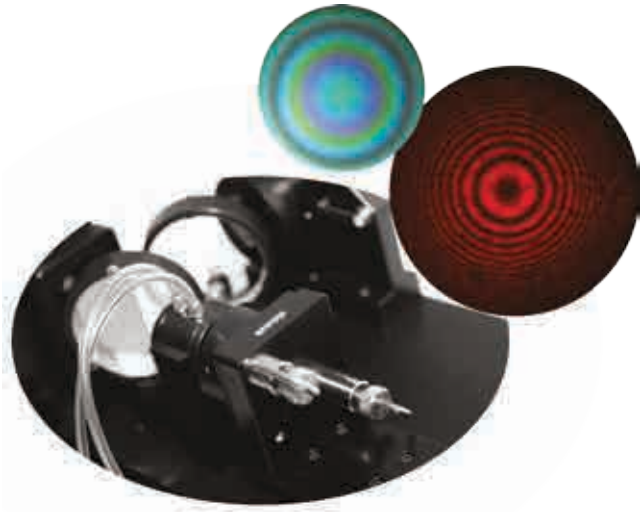
→ Measuring the air refractive index

A hermetic tank with parallel surfaces, in which a vacuum can be created, is placed in one of the arms of a Michelson interferometer, set to display rings, for laser light.

Air pumping in the tank produces a variation in optical path difference resulting in a scroll-down of the rings on the screen.

The air refractive index can be measured by counting the rings scrolled down in the centre of the figure.

In reality, we shall gradually depressurise the tank for a number of pressure values : -200, -400, -600, -800, -900 hPa (negative pressure with respect to atmospheric pressure). Each time it is opened, we shall start to record using the Caliens camera before observing the number of output oscillations.



EXP 200 090 Michelson's experiments

Mach-Zender study

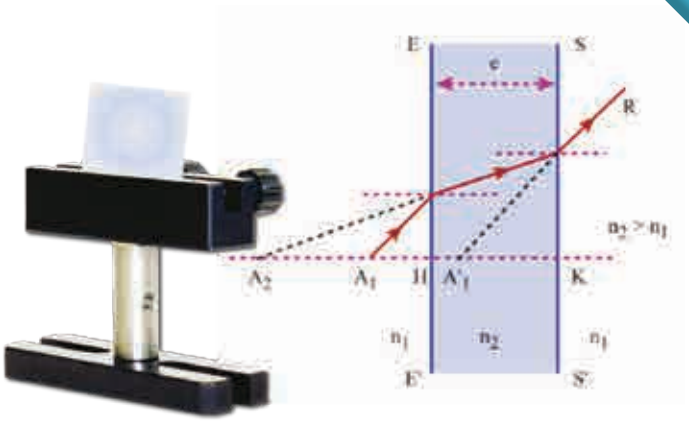
The Mach-Zender interferometer consists of two semi-reflecting plates (beamsplitters) and two mirrors. A light beam is divided into two, after which both beams are recombined by means of a semi-reflecting mirror. One of these beams will be named the Reference beam, while the other will allow us to take measurements on the vacuum index or plate thickness.

Necessary equipment

Reference	Designation	Quantity	Page
POF 020 300	Mach Zender interferometer	1	97
POD 013 210	He-Ne laser	1	101
POD 067 040	10x lens	1	101
POD 002 192	Half-moon stand	3	101
POD 010 002	Millimetric universal screen	1	81
POD 060 550	Lens holder	1	88
POF 020 305	Basic slide holder	1	96
POD 010 020	Superior Caliens camera	1	100

Subjects approached

» Glass slide thickness
» Mach-Zender study
» Two-beam interferences

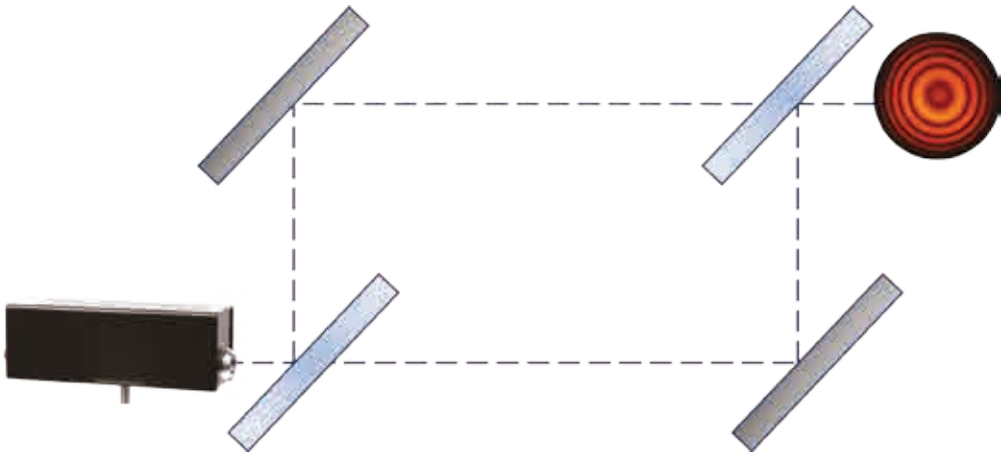


→ Glass slide thickness

A thin slide is added, followed by a thicker slide, to one of the arms of the Mach-Zender interferometer.

This slide will introduce into the system a medium with a different optical index, which will modify the optical path of the beam passing through it. We thus propose viewing the impact of this modification on the interference figure. In this case, the beam propagated on arm 1 crosses a thin slide that modifies its optical path with respect to the previous case. This new distance is written as : D'1 = D1 + e (n-1), where n stands for the slide index and e its thickness.

→ Two-beam interferences



The Mach-Zender interferometer is a two-beam interferometer. It operates as follows :

The coherent light beam from a laser source is divided into two partial beams by an optical component. These beams follow different paths, are deflected by mirrors, before coming together again and being superimposed by another optical component. Superimposition of light waves leads to an interference image. If the optical path, i.e. the product between the refractive index and the geometrical path, of one of the beams varies, then a phase shift will occur with the second beam. The result is a modification of the interference image, allowing conclusions to be drawn regarding the modification of the optical path. Unlike Michelson's interferometer, partial light beams are not reflected on themselves but each follow a specific path until they meet again. Consequently, measurements taken on transparent materials, as for example measurement of the refractive index, are easier to understand and thus clearer for students.

EXP 200 100 Mach Zender study

Fabry-Pérot study

The Fabry-Perot interferometer consists of two parallel semi-reflecting plates (beamsplitters), separated by a distance L (The plate reflection coefficient is greater than 90%). A ray of light entering between the two plates is reflected very many times before it leaves.

On each reflection, a portion R of the intensity is reflected and a portion (1 – R) is transmitted. The outgoing rays of light interfere at infinity or in the focal plane of a lens.

Multiple interference can be constructive only if all rays are approximately in phase, particularly if there is a large number of rays and thus if R is large.

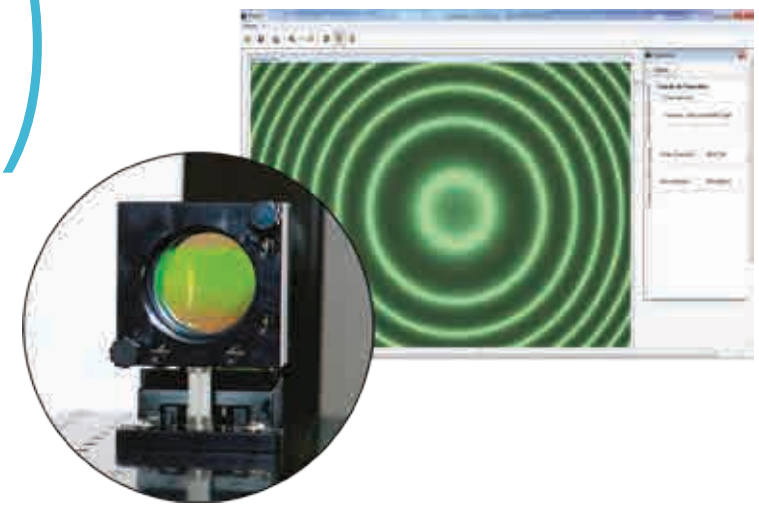
Rays are in phase only for some specific θ angles depending on λ and L.

Necessary equipment

Reference	Designation	Quantity	Page
POF 020 200	Fabry Pérot interferometer	1	97
POD 013 210	He-Ne laser	1	101
POD 067 040	10x lens	1	101
POD 002 192	Half-moon stand	2	101
POD 010 002	Millimetric universal screen	1	81
POD 010 057	High pressure mercury lamp	1	101
POD 010 572	Green interference filter - 546 nm	1	70
POD 010 056	Leg for spectral lamp	1	101

Subjects approached

» Interferences
» Fabry Pérot study
» Wavelength
» Spectrometry



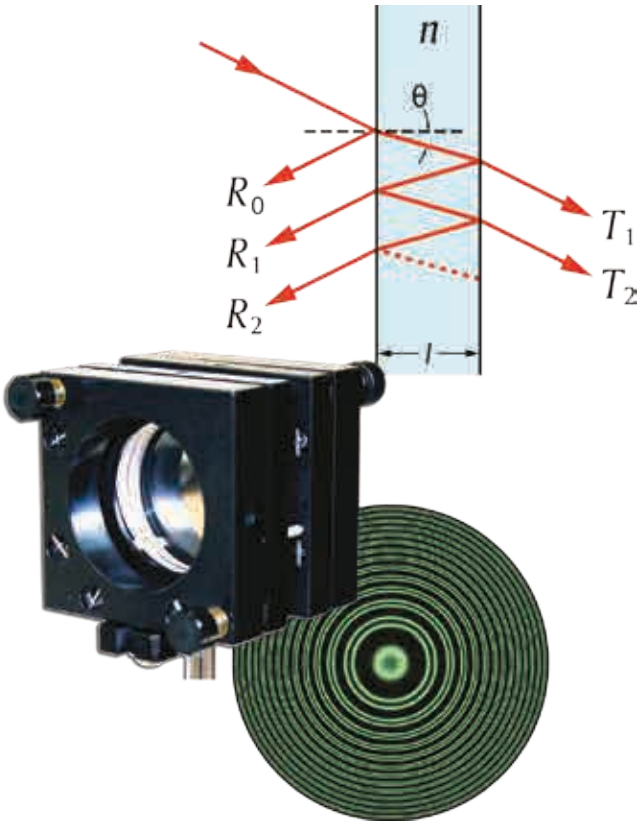
→ Spectrometry

The mercury vapour lamp (Hg) contains a spectral doublet made up of two wavelengths very close to one another.

Use of a Fabry-Perot interferometer allows these two wavelengths to be clearly distinguished and their spectral gap to be measured.

For this purpose, we shall use an interference filter in order to select only this doublet amongst the spectral range of the mercury lamp.

→ Fabry Pérot study – Fineness



To be able to separate the different rings more efficiently, they need to be as fine as possible. This is equivalent to refining the peaks in the previous curve, i.e. reduce Δλ with respect to δλ. Thus, a good quality interferometer will exhibit a far lower Δλ than δλ .

For simplicity's sake, we will use the following value, known as fineness :

$$F = \frac{\delta\lambda}{\Delta\lambda}$$

The greater the fineness, the finer the rings. To increase fineness, the surfaces making up the cavity can be made highly reflective. Indeed, we can show that fineness increases at the same time as the surface reflection coefficient.

Consequently, commercially available Fabry-Pérot interferometers can have finenesses of a few dozens or a few hundreds. In research, this can even attain a few hundred thousands.

This high degree of fineness is a major asset of this type of interferometers with respect to Michelson's interferometer, which has a fineness of 2.

Fineness can be linked to photon lifetime in the cavity and to the free spectral range in FSR frequency :

$$F = 2\pi N$$

Thus, the number of oscillations N carried out by light in the cavity increases at the same time as fineness :

$$F = 2\pi\tau ISL$$

EXP 200 110 Fabry-Pérot study

Spectrometry – Spectrophotometry

The SPID spectrometer is designed to study simple components belonging to the light spectrum of various light sources: spectral lamps, steady sources, lasers, standard lamps, etc. It is also used to study filters, solid or not, in transmission or absorption. An absorption model allows you to implement with ease Beer Lambert's law and to observe chemical kinetic curves.

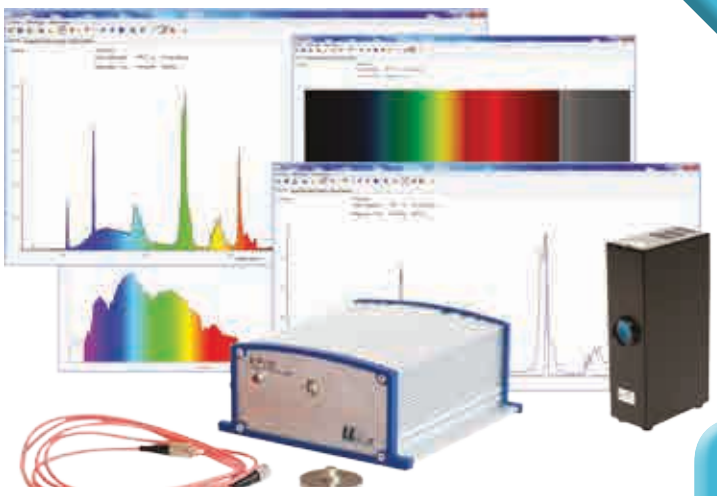
Supplied with feedback material, this device will also provide you with ideas to implement your own hands-on exercises.

Necessary equipment

Reference	Designation	Quantity	Page
POF 010 361	Superior Spectrophotometer	1	66
POD 010 050	Low pressure mercury lamp	1	71
POD 010 058	Low pressure sodium lamp	1	71
POD 069 140	Lantern with dimmer	1	77
POD 010 110	Single component holder	1	81
POD 002 192	Half moon stand	3	101
POD 060 230	Basic slide holder	1	84
POD 010 572	Green interference filter - 546 nm	1	70
POM 052 022	Red filter	1	172
POM 052 023	Blue filter	1	172
POM 052 024	Yellow filter	1	172
POM 052 025	Green filter	1	172

Subjects approached

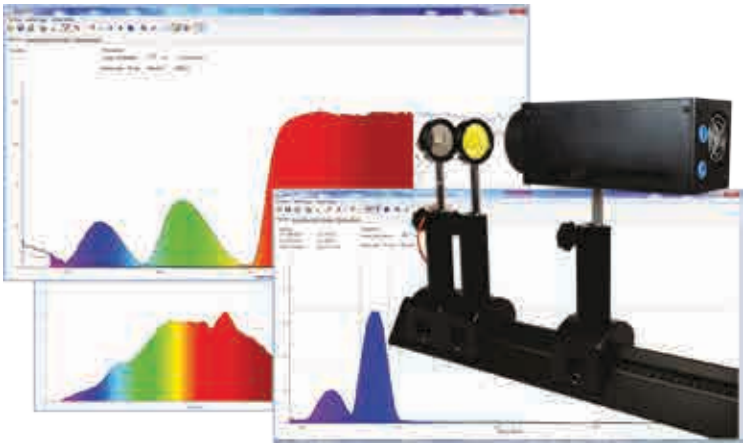
- 3D chemical kinetics study
- Coloured filter spectrum study
- Line spectrum study
- Beer Lambert's law
- Solar spectrum
- Wien's law
- Reflection spectrum analysis
- Sodium absorption peak
- Colour temperature
- Device calibration and uncertainty



→ Spectrum studies

Optical fibres allow great freedom of movement. Used for demonstrations during classes, they will let you move from source to source easily. The simple, intuitive software, with its multi-station system, allows measurement and superimposition of curves. It is ideal for showing the gases making up different bulbs, such as mercury in energy saving light bulbs. Combined with a video projector, the SPID spectrometer will prove indispensable in your classes. Three display modes, simple, coloured and spectroscope mode, are available.

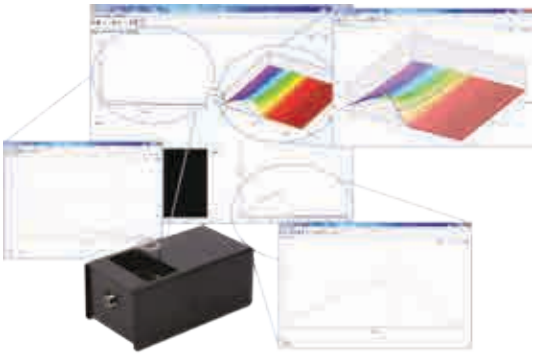
→ Coloured filter spectrum study



To study colour filters, all you need is a continuous spectrum source, normally a halogen, two optical stands and a fibre-holder token delivered with the spectrophotometer. The software allows you to create a reference and to implement solid or liquid filters by simply positioning them in front of the motionless fibre. The transmission or absorption curve is immediately displayed on the screen. You can show colour synthesis in a new way and study the principle of interference filters.

→ 3D chemical kinetics study

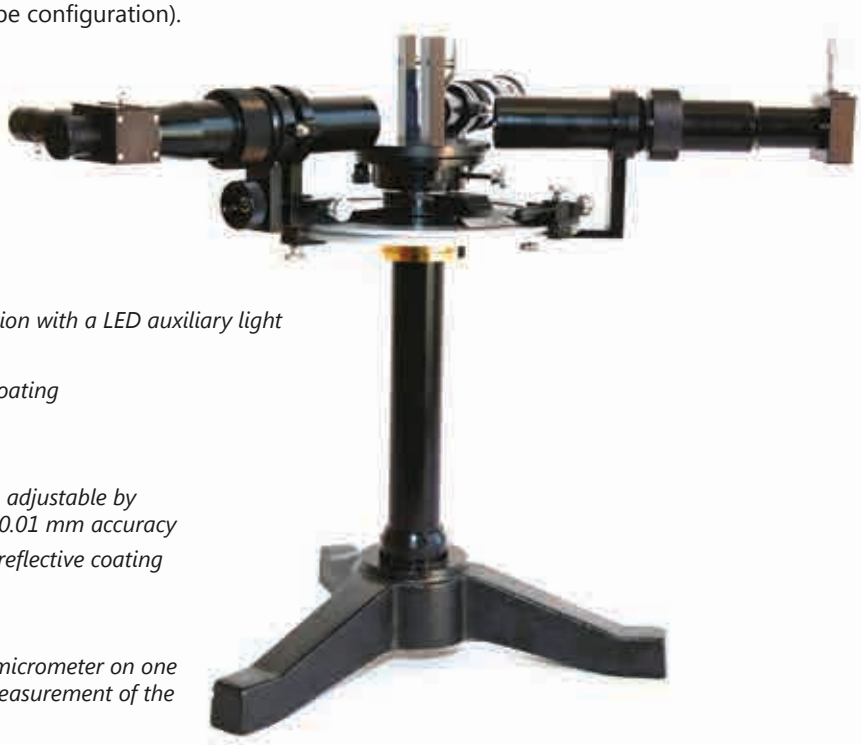
Previously, your students were not necessarily able to build up a scientific approach using kinetics. You had to teach them a Lambda max. Henceforward, you can ask them to choose themselves a lambda according to the data of the product to be studied, before going back to the exact lambda max that they are now able to measure. All this is thanks to the fact that the spectrophotometer observes all wavelengths in real-time and displays them in 3D. You can now browse through your acquisition at any time and at all wavelengths.



EXP 200 140 Spectrometry – Spectrophotometry

Lemardeley/Didalab Spectrogoniometer

This apparatus is used for the study of dispersive systems like prisms and/or gratings (in its goniometric configuration).
It also measures wavelengths (spectroscope configuration).
Angular accuracy : 1 Arc min



COMPONENTS

AUTOCOLLIMATING TELESCOPE

- *Adjustable focus by knurled screw*
- *Focus length : 450 mm*
- *Sliding eyepiece*
- *Adjustable to infinity by autocollimation with a LED auxiliary light*
- *Reticle, cross, orientable*
- *Achromatic lens, with antireflective coating*

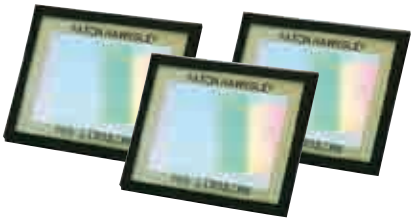
COLLIMATOR

- *Adjustable to infinity, one source slot, adjustable by knurled screw, symmetrical opening, 0.01 mm accuracy*
- *Achromatic lens, Ø 30 mm, with antireflective coating*

MICROMETRIC TELESCOPE

- *Projection of a divided & numbered micrometer on one side of the prism (reference for the measurement of the wavelength)*
- *Adjustable focus by knurled screw*
- *Achromatic lens, Ø 30 mm, with antireflective coating*

CONSTITUTION



- *1 spectrogoniometer*
- *1 adjustable table*
- *1 grating holder*
- *1 300-lines/mm grating*
- *1 600-lines/mm grating*
- *1 transformer*
- *1 setting mirror*
- *1 teaching software*

POD 068 079	**Lemardelay/Didalab Spectrogoniometer**

Spectrogoniometer

This spectrogoniometer includes the same components that ref-POD068079 spectrogoniometer with the addition of two equilateral prisms. One is made of Crown, the other of Flint. There is also a plate to hold the prism. This plate is already horizontally adjusted and presents a cover to avoid light disturbances for each of the 3 spectrogoniometer's arms.

POD 068 070	**Spectrogoniometer**

Goniometer

This goniometer includes the same components that ref-POD068049 goniometer with the addition of two equilateral prisms. One is made of Crown, the other of Flint. There is also a plate to hold the prism. This plate is already horizontally adjusted and presents a cover to avoid light disturbances for each of the 2 goniometer's arms.

POD 068 040	**Goniometer**

Goniometer Lemardelay

Lemardeley's goniometer presents the same characteristics as the above spectrogoniometer but without the micrometric telescope for the wave length measures.

CONSTITUTION

- *1 goniometer*
- *1 adjustable table*
- *1 grating holder*
- *1 300-lines/mm grating*
- *1 600-lines/mm grating*
- *1 transformer*
- *1 setting mirror*
- *1 teaching software*

POD 068 049	**Lemardelay/Didalab goniometer**

Equilateral prisms

The prisms lay on a 40-mm equilateral base and are 48-mm high.
The 2 useful sides are much polished, the other sides have a matt aspect.

POD 068 020	**Extra-Dense Flint prism (n=1,75)**
POD 068 030	**Crown prism (n=1,52)**

Paton Gratings

These accuracy gratings display a great uniformity of lines on the whole working area.
This sensible working area, 45 mm x 31 mm, is protected by a glass plate.
Compatible with our slides-holders.

POD 061 980	**Grating 100 tr/mm**
POD 061 990	**Grating 200 tr/mm**
POD 062 000	**Grating 300 tr/mm**
POD 062 100	**Grating 600 tr/mm**

Gratings

These accuracy gratings display a great uniformity of lines on the whole working area.
This sensible working area, 36 mm x 24 mm, is protected by a glass plate.
Compatible with our slides-holders.

POD 062 810	**Grating 100 tr/mm**
POD 062 820	**Grating 300 tr/mm**
POD 062 830	**Grating 600 tr/mm**
POD 062 200	**Grating 1 200 tr/mm**

Digital Goniometer

The goniometer is mainly used for experiments on prism or grating deviation.
Accuracy: 20 seconds of Arc.

COMPONENTS

AUTOCOLLIMATING TELESCOPE

- *Adjustable focus by knurled screw*
- *Focus lenth : 450 mm*
- *Sliding (helicoidal) eyepiece*
- *Adjustable to infinity by autocollimation with a LED auxiliary light*
- *Reticle, cross, orientable*
- *Achromatic lens, with antireflective coating*

COLLIMATOR

- *Micrograduated slot source, with symmetrical opening, 0.01 mm accuracy.*
- *Adjustement wiht knurled ring*
- *Achromatic lens, with antireflective coating*

DISPLAY

- *Display : degree, minute, seconds*
- *Manual settings at 0° and 180°*

CONSTITUTION :

- *1 goniomètre*
- *1 réseau 300 tr/mm*
- *1 réseau 600 tr/mm*
- *1 plateau réglable*
- *1 Support de réseau*
- *1 transformateur*

POD 068 090	**Digital Goniometer**

Accessories

Here after , all the available accessories for our goniometers and spectrogoniometers

POD 068 115	**Prism holder**
POD 068 120	**Grating holder**
POD 068 110	**Adjustable table**

Basic Goniometer

Goniometer specially adapted to high schools experiments (prism and grating deviations. It has a telescope and a collimator (focus lengths 178 mm). This device is made up of a Ø 127 mm graduated plate.

Its movement is independant from the aiming telescope's and the deviation marking is read thanks to a vernier with a precision of 1 min of arc. Manually adjustable for fast rotation, or by micrometric screw for finer adjustement.

SUPPLIED WITH THE FOLLOWING ACCESSORIES

- *1 Flint prism*
- *1 prism holder*
- *1 grating holder*
- *1 magnifing glass*
- *1 wrench for the adjustment of the optical axis*

POD 068 010	**Basic Goniometer**

Fibre optic spectrometer

Spectrometer for the quantitative study of transmission and absorption spectra, transmission curves and measures of colorimetry and chemical kinetics.
Czerny Tuner setting.

With its pedagogical software for the measure and assessment, you can analyze the spectrum, save in real time for a 380 to 83 nm wavelength range.
The light, absorbed by an optical fiber is sent to a CCD sensor via 2 mirrors and a reflection grating.

- ***Study of transmission spectrum, ray spectrum, continuous spectrum (sun, glowing lamp, candle)***
- ***Study of absorption spectrum and variation of absorbance along a time.***
- ***Detections, photometric measures***

CHARACTERISTICS :

- *Spectral range : 380 - 830 nm*
- *Wavelength accuracy : 0.25 nm.*
- *Passing band : 1 nm*
- *Transmission : from 0 to 100 %, 0.1 % res.*
- *Absorption : from 0 to 2 .5 Å, 0.1 % res.*
- *Optical setting : Czerny Turner*
- *Sensor : CCD, 2048 pixels*
- *Power supply : via USB connecting cable (connection to the computer)*
- *2-m optical fiber*
- *Dimensions : 315x175x322 mm*
- *Weight : 6.6 kg*

POD 010 070	**Fibre optic spectrometer**

Fibre optic spectrophotometer

CHARACTERISTICS :

- *Spectral range : 380 - 830 nm*
- *Wavelength accuracy : 0.25 nm.*
- *Passing band : 1 nm*
- *Transmission : from 0 to 100 %, 0.1 % res.*
- *Absorption : from 0 to 2 .5 Å, 0.1 % res.*
- *Optical setting : Czerny Turner*
- *Sensor : CCD, 2048 pixels*
- *Power supply : via USB connecting cable (connection to the computer)*
- *Power connecting cable for the absorption module*
- *Lamp : Quartz halogen 6 V/10 W*
- *2-m optical fiber*
- *Dimensions : 315x175x322 mm*
- *Weight : 6.6 kg*

POD 010 040	**Fibre optic spectrophotometer**

Spectrometer, for High school

The optical fiber guides the light, which is analysed by the spectrometer. You can observe the spectrum of any light source : ray spectrum, continuous spectrum (sun, glowing lamp, candle), fluorescent spectrum...

French conception and manufacturing.

Intuitive software.

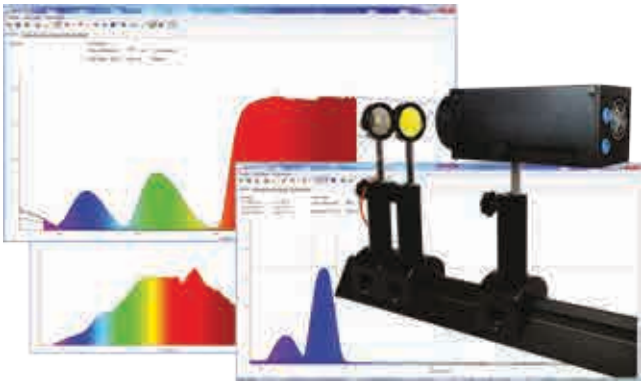
Complete documentation with examples of experiments.

TECHNICAL CHARACTERISTICS

- *Spectral range : 350 - 900 nm.*
- *Transmission : from 0 to 100 %.*
- *Resolution < 1,5 nm.*
- *Précision : 1 nm*
- *Absorption 0 a 2,5 Å*

CONSTITUTION

- *Spectrometer with optical fiber*
- *2-m optical fiber, 50 µm*
- *USB cable*
- *Software operating with Windows, in French or in English*
- *1 fiber connector holder, Ø 40 mm*



POF 010 350 **Spectrometer, for High school**

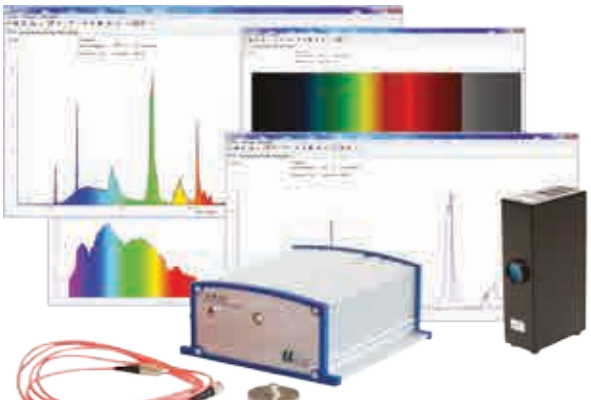
Absorption module

The absorption module turns your spectrometer into a spectrophotometer. Thus, you can implement BEER-LAMBERT's law and 3-D kinetic chemistry.

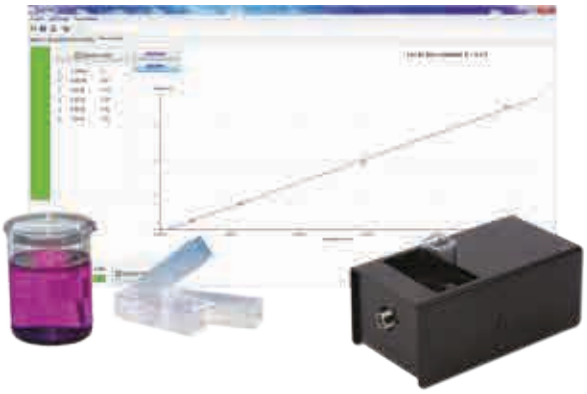
POD 010 043 **Absorption module**

→ Spectrum studies

Optical fibres allow great freedom of movement. Used for demonstrations during classes, they will let you move from source to source easily. The simple, intuitive software, with its multi-station system, allows measurement and superimposition of curves. It is ideal for showing the gases making up different bulbs, such as mercury in energy saving light bulbs. Combined with a video projector, the SPID spectrometer will prove indispensable in your classes. Three display modes, simple, coloured and spectroscope mode, are available.



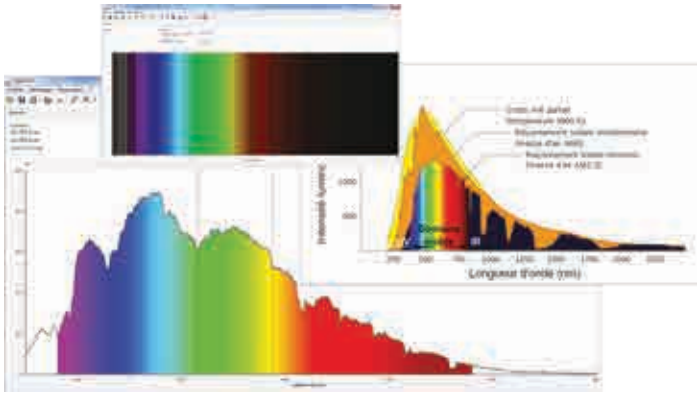
→ Beer Lambert law



The spectrophotometer is furnished with a little absorption module, which you connect to the optical fiber. This absorption module hasn't got cover, it is made of a collimating system which ensure that a beam strictly parallel goes through the cuve and the studied chemical solution. As the spectrophotometer has a continuous looking on all the wavelengths, you get a fast and reliable device for your experiments. You change the tanks and gets the measurements in a software's tab (where you have previously select a measured wavelength). The curve plots along the time and you can check the concentration of the unknown chemical solution thanks to the curve's slope.

→ Sun's spectrum

Fraünhofer lines are the dark areas that you can see on the sun spectrum viewed from Earth. These dark areas correspond to the absorption lines of several elements in the atmosphere. They provided the first wavelength references and afford, still today, calibration and specific measurements on optical devices. Fraünhofer lines are observable with the spectrophotometer. You just have to point the sun with the optical fiber, without a glass between the fiber and the sun.



High school Spectrophotometer

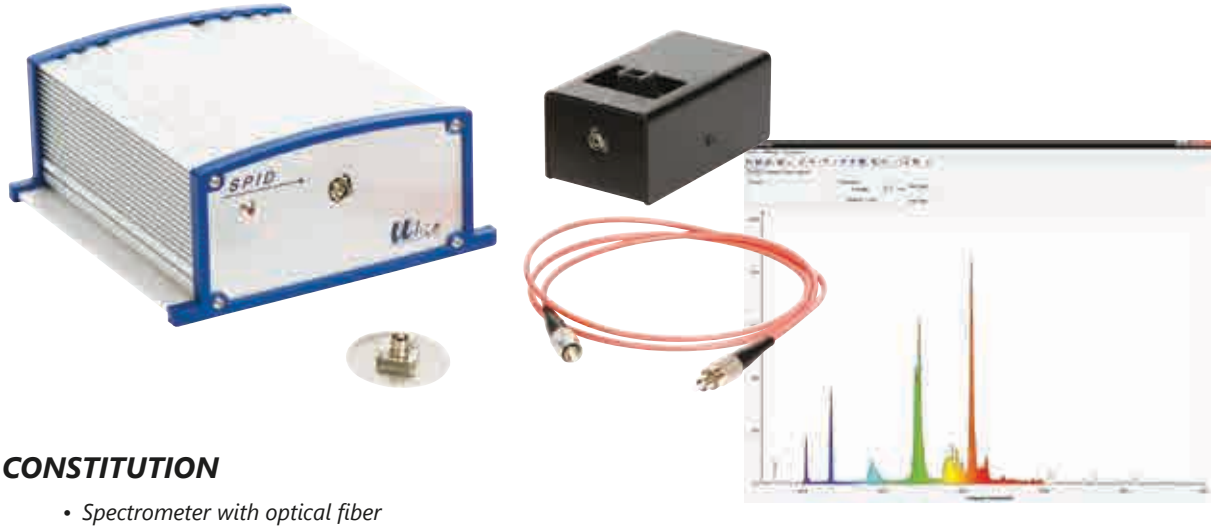
The optical fiber guides the light, which is analysed by the spectrometer. You can observe the spectrum of any light source : ray spectrum, continuous spectrum (sun, glowing lamp, candle), fluorescent spectrum...

With the absorption module, you can make spectrophotometric chemical dosings, check the Beer-Lambert's law, find the concentration of a chemical solution and characterize all absorption spectrum : Chlorophyll, colouring agents, Copper suphate, Iodine...

You can also observe the variation of absorbance along a time (kinetics) with one or several wavelengths.

French conception and manufacturing. Intuitive software.

Complete documentation with examples of experiments.



CONSTITUTION

- *Spectrometer with optical fiber*
- *2-m optical fiber, 50 µm*
- *Absorption module*
- *Set of 100 tanks*
- *USB cable*
- *Software operating with Windows, in French or in English*
- *1 fiber connector holder, Ø 40 mm*

> Curriculum

- *Observation of the bandwidth of colour filters*
- *Study of light sources*
- *Kinetic study of a chemical liquid*
- *Implementation of BEER-LAMBERT's law.*

POF 010 360	**High school Spectrophotometer**

Superior Spectrophotometer

This spectrophotometer gets all the features of the reference POF 010 360 above, but also gets Colorimetry, Linear sensitivity and Luxmeter optional extras.

LINEARITY SENSITIVITY + COLORIMETRY :

For the calibration of your CCD sensor, drawing of the Planck's curves and implementation of Wien's law.

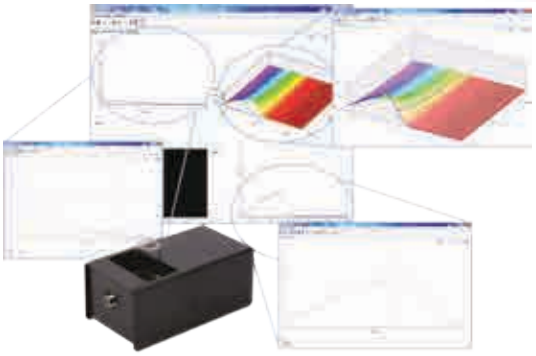
LUXMETER :

To measure the light intensity of your light source. Fitted in a ⌀40-mm lens holder for easier handling.

POF 010 361	**Superior Spectrophotometer**

→ 3D chemical kinetics study

Previously, your students were not necessarily able to build up a scientific approach using kinetics. You had to teach them a Lambda max. Henceforward, you can ask them to choose themselves a lambda according to the data of the product to be studied, before going back to the exact lambda max that they are now able to measure. All this is thanks to the fact that the spectrophotometer observes all wavelengths in real-time and displays them in 3D. You can now browse through your acquisition at any time and at all wavelengths.



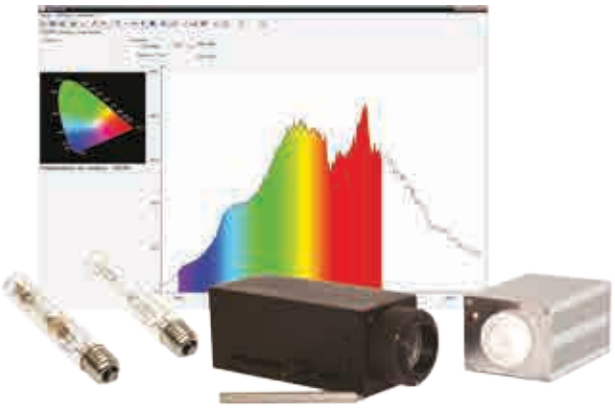
→ Experimental Study – Calibration of an instrument

The SPID spectrometers are supplied already calibrated. This calibration is done in our workshops in Elancourt, France. Nevertheless, we give your students the opportunity, without any risk of damage for the SPID, to have a practical experimental approach and entirely calibrate the spectrometer, and thus, be able to criticize one or several parts of their process according to the new measures they get. To make this calibration, you'll need at least 3 spectral lamps (Mercury, Helium, Cadmium for example). It is a very good implementation of a practical work on the inaccuracies in measurements and calibration processes.

→ Colorimetry

The colour temperature is a characteristic of the light's colour which are used for the illumination, by comparison to an ideal material emitting light by heat. It shows the temperature of a source from its colour (measured in Kelvin). If your spectrometer has the adequate calibration (factory settings), you can, thanks to the software, get the colour temperature of a light source and compare it, for instance, to manufacturer data. You can also study the fluctuations of this one according to the affixed filter in front of the source.

Most of the light sources don't produce exactly the same spectrum than the black body, at a fixed temperature. We talk about "proximal temperature colour": the one which is the closest, in specific observing conditions and for the same luminance, to the light that you want to study. After analysing the light in the CIE (XYZ) system (main window), its position is displayed on the Chromaticity diagram or on the Locus spectrum.



UV wideband spectrophotometer

This spectrophotometer, has the same design than the POF 010 360. With its extended bandwidth, it allows you to study UV spectra. As the spectrophotometer is also linearly calibrated for studying Wien's law.

TECHNICAL CHARACTERISTICS

- *Spectral range : 200 - 950 nm.*
- *Wavelength resolution < 1,5 nm.*
- *Transmission : from 0 to 100 %, resolution 0.1%.*
- *Absorption : 0 to 2 Å*
- *Optical assembling : Cezerny turner*
- *detector : Linear silicium CCD*

POD 010 045 **UV wideband Spectrophotometer**

Tanks for SPID

Set of 100 tanks for the spectrophotometer.

POD 010 044 **Set of 100 tanks**

Quartz tank

Set of 2 tanks, made of quartz, specially designed for the UV spectrometer.

POD 010 065 **Quartz tank**

UV collimator

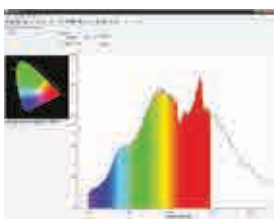
Used to double the light flow captured by a fiber.
Lens made of UV glass

POD 010 079 **UV collimator**

UV optical fiber

POD 010 078 **UV optical fiber**

Linear sensitivity and colorimetry



In our workshop, we can linearly calibrate the spectrometers and spectrophotometers. Indeed, our spectrometers cannot correctly implement Wien' law because of their own non-linear wavelength response. With this calibration, specific for each product, you will be able to get colour temperature.

POF 010 390 **Linear sensitivity and colorimetry**

Optical fork

- *Study of the absorption of chemical solutions outside of a 10-mm tank.*
- *Accepts all kind of beakers up to 13-mm diameters*
- *Observation of the bandwith of the spectrum of colour filters*
- *Measures the effect of the dip of a filter on the spectral answer*

POF 010 365	**Optical fork**

Optical fiber

POD 010 062	**2-meters optical fiber – 50µm**
POD 010 066	**2-meters optical fiber – 100µm**

Collimator for optical fiber

Can double the light flow received by a fiber.

POD 010 072	**Collimator for optical fiber**

USB Photodiode detector

This new photodiode detector has a USB output. It is used for accurate measures, static or slowly variable. It is mainly used for experiments about polarization, interferences or diffraction. You can very easily export all the data to other programs (via .txt files for example) and easily and quickly follow up the results.

CARACTERISTIQUES :

- *Ultra-linear sensitive cell, with signal amplifier (1 to 20)*
- *4-mm diaphragm*
- *Ø 10-mm stainless steel rod*
- *USB output*
- *USB cable*
- *Anti-saturation adapter.*

POD 012 005	**USB Photodiode detector**

Pedagogical webcam

This 3-Millions pixels CCD camera is used to take the place of the human eye during practical works session and show to the whole classroom with a video-projector or an interactive whiteboard.

With its pedagogical software, in French or in English, you will be able to measure light intensity profiles, objects (with calibration)...

Set on a Ø 10-mm rod, it can be used in a lot of positions with or without is adjustable lens.

Implement your experiments very easily, save the results, capture the pictures one by one, up to 43 pictures/second (1024*768) in burst mode.

POD 010 030	**Pedagogical webcam**

OSRAM power supply for spectral light

Standard power supply for OSRAM 9-pin spectral lamps.
Available in 2 versions: single or double.

- *Powered by 220 V - 50 Hz*
- *Fuse protection*
- *Comes with a socket crankcase*
- *Setting of the socket on a rod of 10 mm diameter (adjustable height)*
- *Set rod/socket adaptable to optical base or bench.*

In the double version, a switch allows an alternative use of the light Spectral lamps.

POD 068 330	**Single power supply for spectral light**
POD 068 340	**Double power supply for spectral light**

OSRAM 9-pin spectral light

9-pin socket Spectral lamps

- *Height 107 mm, diameter 21mm.*
- *Supplied with spectral characteristics.*
- *Very high spectral quality*

POD 068 440	**Sodium Spectral lamp (Na)**
POD 068 400	**Mercury Spectral lamp (Hg)**
POD 068 360	**Cadmium Spectral lamp (Cd)**
POD 068 450	**Neon Spectral lamp (Ne)**
POD 068 380	**Helium Spectral lamp (He)**
POD 068 370	**Cesium Spectral lamp (Cs)**
POD 068 480	**Zinc Spectral lamp (Zn)**
POD 068 420	**Mercury/Cadmium Spectral lamp**
POD 068 320	**Additional socket crankcase**

Interference filters on component-holder

Interference filters are made of thin layer deposit.
Extremely selective filters around an accurate wavelength.
Supplied with compenent-holder and individual calibration.
Allowance : ± 2 nm ; width 10 nm – min 35 %

POD 010 571	**Blue filter – 436 nm**
POD 010 572	**Green filter – 546 nm**
POD 010 573	**Yellow Filter – 578 nm**
POD 010 574	**Red filter – 633 nm**

Spectral Lamps high and low pressure

- *Adapted ventilation*
- *2P+E power outlet with fuse*
- *No risk of burning*
- *Economical*
- *Usable on the lamp base or on optical bench*

POD 010 050	**Low pressure mercury lamp**
POD 010 051	**Spare low pressure Spectral lamp**
POD 010 057	**High pressure mercury lamp**
POD 068 505	**Spare high pressure Spectral lamp**
POD 010 058	**Low pressure Sodium lamp (18W)**
POD 068 495	**Spare Sodium Spectral lamp 18W**

ECO27 Power supply for spectral lamp

A power supply specialy adapted to ECO27 Spectral lamps.

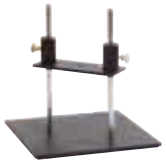
- *Optimal safety*
- *Economical*
- *Adapted ventilation*

POF 010 060	**ECO27 Power supply for spectral lamp**

ECO27 Spectral lamps

These Spectral lamps have an excellent value for money.
They allow the acquisition of rare gases at lower cost !

POF 010 061	**Sodium Spectral lamp ECO27**
POF 010 062	**Mercury Spectral lamp ECO27**
POF 010 063	**Cadmium Spectral lamp ECO27**
POF 010 064	**Hg/Cd Spectral lamp ECO27**
POF 010 065	**Zinc Spectral lamp ECO27**
POF 010 066	**Mercury/Zinc Spectral lamp ECO27**
POF 010 067	**Helium Spectral lamp ECO27**
POF 010 068	**Neon Spectral lamp ECO27**



Stand for spectral light

POD 010 056	**Stand for spectral light**

Accessories for spectral lamp

Fixing the lamp with a very simple screw thread system

POD 010 052	**Iris diaphragm**
POD 010 053	**Condenser**
POD 010 055	**Froster glass**

Banc en V universel

Nous vous proposons un nouveau genre de banc. Il est utilisable en mécanique, en optique, électricité. Vous en servez pour vos montages d'interférences, puis avec l'accouplement goniométrique vous mettez en œuvre les ondes centimétriques, démontez et remontez avec le tripode et c'est un plan incliné pour la chute d'une bille.

Ce banc en aluminium, vous apporte un nouvelle manière d'aborder la gestion de votre matériel de travaux pratiques en vous apportant de la pluridisciplinarité.

COMPOSITION

- *2 bancs de 1,5 mètre*
- *1 pied tripode en métal*
- *1 accouplement goniométrique*

PBU 070 500	**Banc 1,5 mètre mécanique**

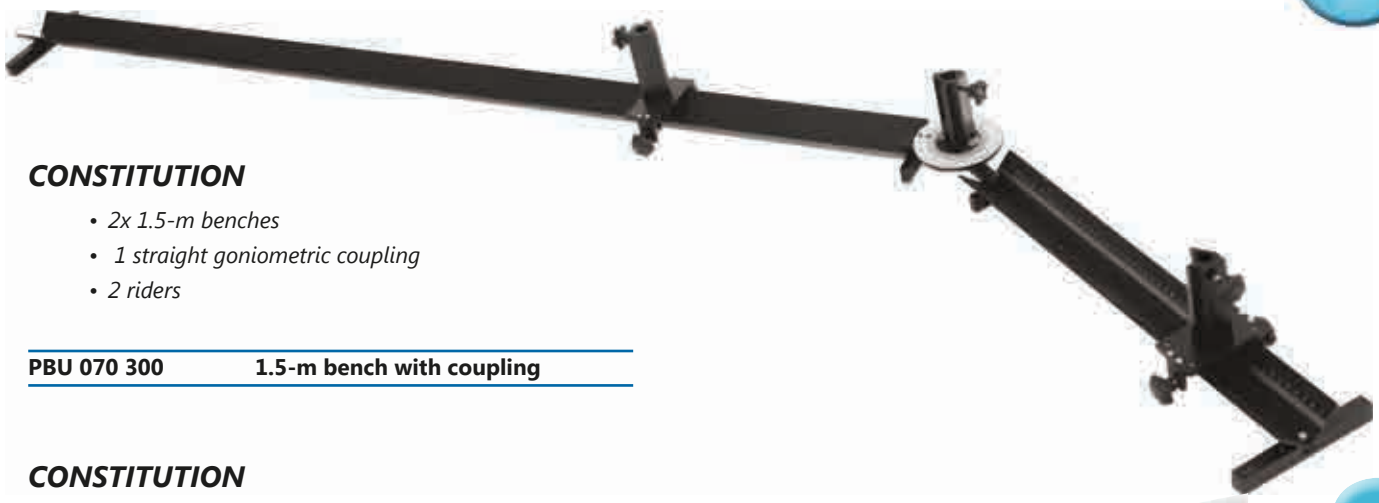
L'accouplement goniométrique est utilisable de deux manières.

Soit de manière analogique, c'est-à-dire un curseur sur un disque graduée.

Soit de manière numérique, en le couplant dans vos expériences.

PBU 070 030	**Tilted coupling**
PBU 070 035	**Straight coupling**

V-shaped universal bench



CONSTITUTION

- *2x 1.5-m benches*
- *1 straight goniometric coupling*
- *2 riders*

PBU 070 300	**1.5-m bench with coupling**

CONSTITUTION

- *2x 1-m benches*
- *1 straight goniometric coupling*
- *2 riders*

PBU 070 310	**1-m bench with coupling**

With its 2-points clamping system and its V-shaped guide, the rider is very stable and can easily stand a light or electromagnetic waves apparatus.

The graduation is displayed in the bench inside by noting the graduation at the rider's edge.

CONSTITUTION

- *1 2-m bench*
- *Stands for bench*

PBU 070 010	**2-m optical bench**

CONSTITUTION

- *Multi-diameter optical rider (8-14mm) for V-shaped bench*

PBU 070 020	**Optical rider multi-diameter**

Prismatic optical bench, higher quality, with accessories

CONSTITUTION :

- *1 prismatic bench, 2m*
- *4 optical rider*
- *1 optical rider, with horizontal and vertical motion*
- *1 LED lamp*
- *3 lens-holders, for Ø 40-42 mm lenses*
- *1 collimator*
- *1 telescope*
- *1 white screen*
- *1 set of 8 components (lenses and mirrors)*

POD 010 831	**Prismatic optical bench, higher quality**

Superior Optical bench, prismatic profile

- *Massive aluminium bench - Very high stability*
- *mm-graduated rule on the whole length*
- *3 support points, two of wich are adjustable (stands are supplied)*
- *Compatible with nearly all prismatic staples*

POD 068 056	**2-m prismatic bench**
POD 060 060	**Stand (spare) for optical bench**

Optical rider

- *All metallic optical rider*
- *Large display windows*
- *Metallic index with micrometric precision*
- *Column height : 80 mm - Inside diam : 10 mm*

POD 060 080	**Optical rider**

Optical rider with vertical motion

- *All metallic optical rider - Inside diam : 10 mm*
- *Large display windows - Metallic index with micrometric precision*
- *Vertical motion : 20-mm range with knurled screw*
- *ideal for precision settings (telescope, viewfinders, ...) ...*

POD 060 100	**Optical rider with vertical motion**

Optical rider with horizontal motion

- *Motion range : +/- 50 mm, with micrometric screw*
- *Accuracy : 1/10 mm*
- *Column height : 110 mm - Inside diam : 10 mm*
- *Ideal for precision settings (diffraction, optical fiber ...)*

POD 060 090	**Optical rider with horizontal motion**

Optical rider with vertical and horizontal

- *Horizontal motion range : +/- 50 mm*
- *Accuracy 1/10e mm*
- *Advantages of the 2 previous devices*
- *Ideal for two-dimensions settings (diffraction, optical fiber ...)*

POD 060 110	**Optical rider with vertical and horizontal**

Prismatic optical bench, for High school

Banc prismatique équipé permettant la réalisation de toutes les expériences de focométrie.

CONSTITUTION :

- *1 prismatic bench, 2m*
- *3 optical rider, standard*
- *1 optical rider, wide base*
- *1 optical rider with vertical motion*
- *1 optical rider with horizontal motion*
- *1 LED lamp*
- *2 lens-holders, for Ø 40-42 mm lenses*
- *1 simple telescope*
- *1 simple collimator*
- *1 Translucent screen with millimeter graduation*
- *1 set of 8 components (lenses and mirrors)*

POF 010 105	**Prismatic optical bench, for High school**

Prismatic optical bench, with accessories

CONSTITUTION :

- *1 prismatic bench, 2m*
- *3 optical rider, standard*
- *1 optical rider, wide base*
- *1 LED lamp*
- *2 lens-holders, for Ø 40-42 mm lenses*
- *1 translucent screen*
- *1 set of 8 components (lenses and mirrors)*

POF 010 100	**Prismatic optical bench with accessories**

DidaFirst prismatic bench

New economical range of high quality optical benches, for your optical experiments

POF 010 110	**2-m prismatic bench**
POF 010 112	**1-m prismatic bench**
POF 010 114	**Stand for optical bench**
POF 010 115	**Goniometer coupling**

Optical rider

All metallic optical rider. Width : 50 mm
For diam 8-mm to diam 14-mm rods
Height of the column : 100 mm

POF 010 124	**Optical rider**

Wide optical rider

All metallic optical rider. Width : 100 mm
For diam 8-mm to diam 14-mm rods
For a better stability for heavier components

POF 010 125	**Wide optical rider**

Optical rider with horizontal motion

All metallic optical rider
For diam 8-mm to diam 14-mm rods
Motion range : ±12.5 mm

POF 010 126	**Optical rider with horizontal motion**

Optical rider with vertical motion

All metallic optical rider.
For diam 10-mm rods.
Motion range : 20 mm

POF 010 122	**Optical rider with vertical motion**

Extension Arm

Distance between axes is approx. 85 mm
Shaft diameter = 12 mm - Height of the column = 29 mm

POD 060 295	**Extension Arm**

12-V LED lamp

- *Dual condenser*
- *Pulling convergence adjustment.*
- *Fitted out with two slots, Ø 50 mm, for frosted glass & metal "d"-shaped objects (provided).*
- *Distance rod axis / object indicated*
- *Diam 10-mm rod*
- *Supplied with mains transformer*

DPO 020 100	**12-V LED lamp**
DPO 020 101	**LED 3W - E27**
DPO 020 102	**LED 7W - E27**

Light with intensity variator

- *Halogen lamp with built-in fan, with the light intensity variation*
- *Aspheric lens*
- *Filament can be vertically or horizontally oriented*
- *Thread ring at the front for objects or filters*
- *diam 10-mm rod*
- *Power : 100 W*

POD 069 140	**Light with intensity variator**

He-Ne Lasers

These Lasers are manufactured by Ulice/Didalab and have a very good value for money !!!

- *Output power : 1 mW max*
- *Ray diameter : 0,5 mm*
- *Divergence : < 2 mrad*
- ***Directivity of the beam adjusted in our workshop***
- ***A microscope lens can be screwed directly on the laser***
- *Power supply : 12-V mains transformer*
- *130-mm Stainless steel rod, 10-mm diam*
- *Wavelength : 632,8 nm*

POD 013 210	**Laser HeNe – non-polarized**
POD 013 213	**Laser HeNe – linear polarization**

Laser kit

Complete kit with all the components useful for diffraction experiment.

- *1 Laser (ref POD 013 210)*
- *1 x10 eyepiece (ref POD 067 040)*
- *1 basic slide's holder (ref POD 060 230)*
- *1 laser diffraction kit (ref POD 062 900)*

POD 013 245	**Laser kit**

Lasers

Homogenous and circular beam
Directivity of the beam adjusted in our workshop
On the end, you can fit out a microscope's lens.
Supplied with diam 10-mm rod and mains power supply.

Different wavelengths available :

POD 013 133	**Red laser – 650 nm**
POD 013 136	**Blue laser – 405 nm**
POD 013 132	**Green laser – 532 nm**

Adjustable laser diode

Beam ajdustable from 1-mm diam. to 12-mm diam with setting lens.
supplied with diam 10-mm rod and mains power supply.

POD 013 135	**Adjustable laser diode – 650 nm**

Line generator

This optical device is used to turn a incident laser beam into a line, rotating at 360° by the use of a glass cylinder,.
Set on Ø 10-mm rod.

POD 060 220	**Line generator**

Beam splitter

This device enables the incident beam to be divided into two emergent beams of identical light intensity, through a half-reflecting plate & a rotating mirror (thus the reflected beam emergence angle is adjustable and the path difference also)
Supplied with diam 10-mm rod.

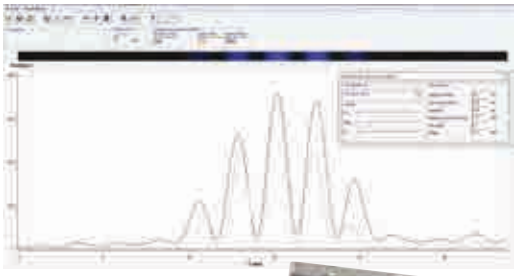
POD 060 210	**Beam splitter**

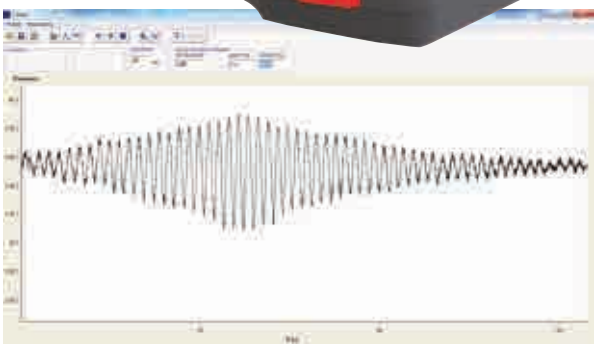
Glasses for Laser protection

Norm EN208.

POD 020 500	**for 600 / 760-nm lasers**
POD 020 510	**for 200 / 540-nm lasers**

Caliens Camera, Higher Education





ADVANTAGE :

- Implementation of a "coherent" sensor, for Fourier transforms data acquisition
- Use of the sensor for spectrometric settings
- Michelson or Fabry-Perot Interferograms recording
- Interferences, Diffraction with a hole, a slit ...
- Study of a CCD sensor with an oscilloscope

CONSTITUTION :

- *1 CCD camera*
- *1 complete software (to be downloaded)*
- *1 set of filters*
- *1 USB cable*
- *1 Ø 10-mm rod*
- *Cables and carrying case*

TECHNICAL CHARACTERISTICS :

- *Sensor : 2048 pixels (14-µm wide) (sensitive zone : approx. 30 mm).*
- *Adjustable integration time : 2 ms to 5 000 ms*
- *adaptable on a bench or an optical stand*

POD 010 020 Caliens camera, Higher education

Caliens camera, for high school

With the high school Caliens camera, you can sample and analyze light images, with a complete software, user friendly.

Your diffraction and interferences measures are easy, precise, and intuitive, due to cursors and quick visualization.
You can adjust the integration time for a better precision and convenience.

With the simulation function, you can model very easily the effect of the wavelength on an interference image.

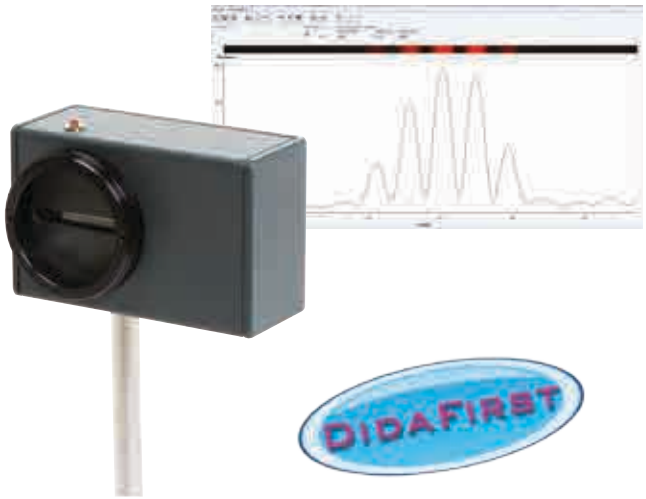
CONSTITUTION :

- *CCD camera*
- *Software, (operating with Windows)*
- *USB cable*
- *Diam 10-mm stainless steel rod*

TECHNICAL CHARACTERISTICS :

- *2 048-pixels CCD sensor*
- *Adjustable integration time*

POF 010 300 Caliens camera, for high school



Set of 4 filters

In order to experiment with the Caliens camera, with no environment difficulty.
2 polarizers and 2 filters with neutral density (0.9)

POD 010 025 **Set of 4 filters**

Study of a CCD sensor

Now, with this additional cable, you can explain the principle of CCD photosensitive sensors and show the relation between the light received by the sensor and the electrical measure.

This cable retrieves the "raw" signals of the sensor, clock, trigger and the signal on an oscilloscope or a C.A.O interface

POF 010 610 **Study of a CCD sensor**

Diffraction and interference objects

Ø 40-mm glass plates.

Young's slits

- *3 double slits*
- *Width of slits : 70 µm*
- *Distance between slits : 200, 400, 500 µm*

POD 066 710 **Young's slits**

Slits

- *7 slits and wires on a glass plate*
- *Widths : 30, 40, 60, 80, 100, 150, 200 µm*
- *Accuracy : 1 µm*
- *Space between slits : 5 mm*

POD 066 700 **Slits**

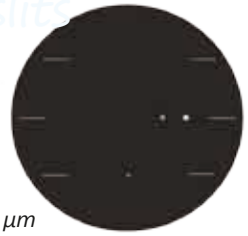
Multiple slits

- *4 sets of slits (same width)*
- *Width of the slits : 40 µm*
- *Space between slits : 100 µm*
- *Number of slits : 3, 4, 6, 14*

POD 066 720 **Multiple slits**

Young's holes and slits

- *6 single holes : Ø 20, 30, 50, 100, 200, 500 µm*
- *3 double holes : Ø 70, distance : 100, 200, 500 µm*
- *2 squares : 70 x 70 µm ; 200 x 200 µm*
- *1 rectangle : 70 x 200 µm*



POD 066 730 **Young's holes and slits**

Lens holder Ø 40/42mm

- *Fully metallic*
- *Fast implementation of the component*
- *Perfect centering through four retaining lugs*
- *Component maintained by springs at the protected ends*
- *Two sides :*
  - *A Ø 40 mm*
  - *Another Ø 42 mm for lenses placed in protective rings*
- *Mounted on Ø10-mm rod*

POD 010 090	**Lens holder Ø 40/42mm**

Permanent Frame Ø 40mm

System ideally designed for the setting and protection of delicate components of Ø 40 mm.

- *Fully metallic*
- *Adequate for any component with a thickness up to 5mm*
- *Second side to mount components of Ø 42 mm*
- *Mounted on Ø10-mm rod*

POD 010 095	**Permanent Frame Ø 40mm**

Simple Lens holder Ø 40mm

Easy and quick fixing system with three nylon screws.
Allows the attachment of all components of Ø 40 mm.
Mounted on Ø10-mm rod.

POD 010 110	**Simple Lens holder Ø 40mm**

Lens holder Ø 80mm

- *Fully metallic*
- *Fast implementation of the component*
- *Perfect centering through four retaining lugs*
- *Component maintained by springs at the protected ends*
- *Two sides :*
  - *A Ø 80 mm*
  - *Another Ø 90 mm for lenses placed in protective rings*
- *Mounted on Ø10-mm rod*

POD 060 130	**Lensholder Ø 80mm**

Lens holder Ø 80 mm

Ideally for holding fragile components or definitively setting of Ø 80-mm lenses.

- *fully metallic*
- *adequate for any component with a thickness up to 5 mm*
- *mounted on Ø 10-mm rod*

POD 010 080	**Lens holder Ø 80 mm**

Screens

15 x 25 cm screens mounted on a rod of 10 mm de Ø.

POD 010 002	**Metal screen with millimeter graduation**
POD 010 006	**Translucent screen**
POD 010 007	**Translucent screen with millimeter graduation**

Simple Telescope

- *Achromatic lens with 173 mm focal length, antiflash processing*
- *Pulling adjustment*
- *View range : from 400 mm to infinite*
- *Supplied with 10x eyepiece with crosshair and 10x micrometer eyepiece.*
- *Mounted on Ø10-mm rod*

POD 069 400	**Simple Telescope**

Additional lenses

POD 069 411	**Lens +100 mm**
POD 069 412	**Lens +200 mm**

Accuracy viewfinder telescope

- *Achromatic lens, focal length : 173 mm with anti-reflective coating.*
- *Focus with high accuracy helicoid*
- *Very easy focus*
- *rotating cross hair*
- *supplied with 10x-eyepiece*
- *set on a Ø 10-mm rod*
- *can be turn into a accuracy viewfinder by adjoining an additional lens (ref POD 069 421 or POD 069 422)*

POD 069 420	**Accuracy viewfinder telescope**

Simple collimator

- *Achromatic lens, 120 mm, glareproofed*
- *Adjustment by pulling*
- *Crosshair*
- *Mounted on Ø10-mm rod*

POD 069 380	**Simple collimator**
POD 069 385	**Collimator with lighting**

Accuracy collimator with lighting

- *Achromatic lens with focal length 230mm, glareproofed*
- *Adjustment with knurled ring*
- *Lighted crosshair*
- *Auxiliary lighting 6V – 2,4 W*
- *Mounted on Ø10-mm rod*

POD 069 395	**Collimator with lighting**

Autocollimating viewfinder telescope

- *High optical quality :*
  - *Achromatic antiglare lens*
  - *Lens precision*
  - *High quality team splitter*
  - *Reticle with adjustable cross*
- *Implemented with a knurled ring*
- *Very large focal length of 162 mm*
- *Auxiliary illumination device 6 V-2, 4 W retractable*
- *Mounted on Ø10-mm rod*

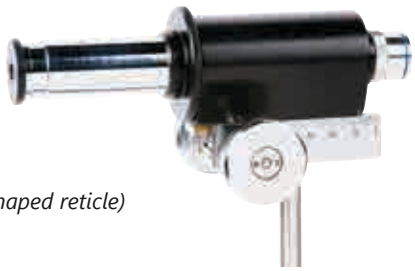
POD 068 101	**Autocollimating viewfinder telescope**

Additional lenses

POD 069 421	**Lens +100 mm**
POD 069 422	**Lens +200 mm**

Viewfinder

- *Accurate measurement of focal lengths*
- *High precision crank & pinion*
- *Objective 4x*
- *Comes with two 10x eyepieces (1/10e mm micrometric eyepieces with across-shaped reticle)*
- *Rack equipped with an engraved vernier with millimeteric precision*
- *Precise measurement of the position of the viewfinder*



POD 069 440	**Viewfinder**

Laurent's polarimeter

The Laurent polarimeter is a darkness analyser, enabling an accurate measurement of the polarization direction and angle of a polarized light through an optical medium, and to find the liquid 's content... Actually, some isotropic transparent bodies, crossed by one rectilinear polarized monochromatic light beam, rotate the polarization plane around the beam propagation direction.

This polarimeter is supplied with a Sodium spectral lamp.
The strong metallic stand has a slightly oblique sheath for tubes (max length 220 mm).
Supplied with 2 polarimetric tubes : 100 mm and 200 mm

CHARACTERISTICS :

- *Measuring range : 2 graduated rings (0-180°)*
- *Glass tubes : 100 mm and 200 mm, diam 15 mm*
- *Path : 1°*
- *Precision : 0,05° (with vernier)*
- *Dimensions : 200 X 360 X 450 mm- Weight : 10 kg*
- *Light source : Sodium spectral lamp (589nm)*
- *Power supply : 230V - 50/60Hz*

POD 068 570	**Laurent's polarimeter**

Polarimetric tubes

- *Metallic ring*
- *For all kinds of liquids.*
- *The 2 different lengths show that the rotating angle is in direct proportion of the length of solution column (test tube)*

POD 068 560	**Set of 2 shutters**
POD 068 531	**10-cm Polarimetric tube**
POD 068 541	**20-cm Polarimetric tube**

Simple plate and grating holder

This stand enables to set any type of strip or slide with a thickness up to 5 mm.
It is equipped with screw in nylon to avoid scratches.
Mounted on Ø10-mm rod.

POD 060 230	**Simple plate and grating holder**

Simple plate and grating holder

This stand is suitable for any kind of prisms.
It is fitted out with one fastening device to prevent falls.
This stand is also suitable for gratings & slides.
Set on Ø-10 mm rod.

POD 060 260	**Simple plate and grating holder**

Adjustable prism and grating-holder

This stand is suitable for any kind of prisms.
It has got 3 locking screws enabling the plate horizontal adjustment.
It is fitted out with a fastening device to prevent falls.
This stand is also suitable for gratings or slides.
Set on Ø 10-mm rod.

POD 060 250	**Adjustable prism and grating-holder**

Slide holder

This support plan has an aperture of 35 mm. It is designed for fixing and adjusting slides or any other plane component (blades, filters, objects ...) up to thicknesses of 3 mm.
Delivered without slide.

POD 060 280	**Slide holder**

Holder for thick devices

A system designed for fixing any component with a diameter between 30 and 60 mm.
Mainly used with lenses, this device can support any optical element with a minimum edge of 10mm.

POD 060 500	**Holder for thick devices**

Thick device

This device includes two lenses fitted out with a 50 mm assembly. It is particularly suitable to study thick systems focometry (Cornu, h / tan alpha Davanne and Martin ...)
Length : 65 mm Thickness : 55 mm
Focal length : +250mm

POD 061 260	**Thick device**

Dual condenser

This unit, made of 2 lenses, is specially used to collect the maximum of light, generated by intense light source (halogen,LED lamps, spectral lights).

- *Focal length : 85 mm*
- *Operating diameter : 75 mm.*
- *High temperature resistant*

POD 061 250	**Dual condenser**

Condenser

Ø 50-mm condenser. Focal length : +44 mm
on Ø 10-mm rod

POD 010 053	**Condenser**

Iris diaphragm

Iris entirely made of metal. Continuous and regular opening.
Adjustable from 1.5 to 30 mm ; 12 fins.

POD 069 410	**Iris diaphragm**

Diffraction holes on barrel

8 holes diffraction mounted on a cylinder frame of 70-mm Ø.
Ball bearing indexing system allowing accurate placement of each of the eight holes with respect to the axis of the mount.

Holes diameters :

- 0,1 mm	- 0,15 mm	- 0,2 mm	- 0,3 mm
- 0,5 mm	- 0,7 mm	- 1 mm	- 1,5 mm

POD 013 015	**Diffraction holes on barrel**

Adjustable slot

Adjustable spacing of 0-8 mm. Effective length of 42 mm.
Intended for experiments that do not require the knowledge of the opening.
This slot can be mounted horizontally or vertically.

POM 051 540	**Adjustable slot**

Precision adjustable slit with drum

- *Slit with symmetric opening*
- *Stainless Steel Lips*
- *Opening up to 4 mm over a height of 15 mm*
- *Aperture adjustment by one hundredth of a micrometer screw*
- *Reading the micrometer corresponds to the actual width of the slot*

POD 070 310	**Precision adjustable slit with drum**

Young's Slit

3 double slits on a component holder.

- *Width of slits : 70 µm*
- *Distance between slits : 200, 400, 500 µm*

Diam : 40 mm - Mounted on Ø 10-mm rod

POD 013 012	**Young's Slit**

Fresnel mirrors

This device generates an interference field by superimposition of two reflections generated by each mirror.
Each mirror has a size of 45 x 40 mm.
One mirror is fixed, the other one has a tilting adjustment device.

POD 013 020	**Fresnel mirrors**

Lloyd mirrors

The interference fringes can be obtained with a single mirror Lloyd device. It's composed of a Ø 50 mirror with aluminized surface adjustable by 3 screws.

The fringes are produced by the point source and its image. Experience shows that the first fringe is black : reflection under grazing incidence is a changing sign reflection.

POD 013 080	**Lloyd mirrors**

Newton ring device

Newton rings are obtained by superimposition of two reflections generated on accurately separated dioptres.
Three adjustment screws constrain the material.
The interference rings can be observed according to the generated deformations

POD 066 061	**Newton rings by transmission**

Fresnel dual-prism

Made of glass plate, processed in order to form two prisms with very slight angle & braced together by the edge.
The angle at the top of the prism is about 0.6°.
The dual-prism, 20 x 20 mm, is fastened to a rotating bracket enabling the perfect positioning of the dual-prism edge in parallel with the source slot.

POD 013 040	**Fresnel dual-prism**

Billet dual-lens

Constituted of two half-lenses, Ø 30 mm, fitted out on bracket, adjustable on both directions of the orthogonal plane, regarding their optical axis.

Focal length 100 mm.

POD 060 750	**Billet dual-lens**

Pair of polarizing filters

The polarizing filter can be positioned degree by degree.
The active zone of the 35 mm diameter polarizing filter is protected on both sides by glass plate. In cross polarization & analysis position, extinction is better than 99.9% on visible spectrum overall.

Provided by pair (2 polarizing filters fitted out on rod)

POD 060 910	**Pair of polarizing filters**

½ & ¼ waves retardation plates

Retardation plates have different propagation velocities of the light wave depending on the positionning, they are specially cut in order to have the waves on the slow axis delayed, of either one half wavelength or on quarter wavelength.

633 nm plates (polarized He-Ne laser, Ref. POD 013 220) are made of monocrystallin quartz, Ø 15 mm, which ensures near-perfect behaviour (98% efficiency).

560 nm plates, Ø 35 mm, are made of polymeric material, 85% efficient. 430-700 nm blades have an effective diameter of 18 mm.

POD 060 920	**Quartz ¼ plate - 633 nm**
POD 060 930	**Quartz ½ plate - 633 nm**
POD 060 955	**¼ plate - 430 à 700 nm**
POD 060 965	**½ plate - 430 à 700 nm**

Half-darkness analyzer

The half-darkness analyzer is used for the measurement of the polarization rotating power by unknown medium or solution.

It's made of one polarizing filter followed by one half-wave plate, halved according to its diameter in order to take half of the working area. The rotation measurement is carried out by balancing luminosity.

POD 060 961	**Half-darkness analyzer**

Mica plate

Mica plate, Ø 30 mm.
Housed in Ø 90 mm frame, fitted on Ø 10 mm rod.
Thickness : 100 µm

POD 060 970	**Mica plate**

Parallel sides tank

Tank internal dimensions : 70 x 30 x 25 mm.

The glass tank can resist to most liquids & chemical solutions.

This tank enables to carry out experiments on absorption or polarization by liquids.

POD 060 450	**Parallel sides tank**

Direct vision prism

The direct vision prism is intended for projection without spectrum deviation.
The internal Amici prism can rotate up to 360 ° to select the axis of decomposition of light.
The effective height of decomposition is 45 mm.

POD 068 282	**Direct vision prism**

Amici Prisms

The Amici prism is a set of three prisms in Crown and extra-dense flint.
This arrangement is specially designed to disperse light in the observation axis without any adjustment.
Effective heigth : 45 mm

POD 068 282	**Amici Prisms**

X-Y displacement lens holder

This lens holder allows accurate positioning of the microscope lens in a plane perpendicular to the optical axis, either in the vertical or horizontal direction.
Each of the two axes has a bar of ± 2 mm.
Mounted on Ø10-mm rod.
Supplied without lens.

POD 060 550	**X-Y displacement lens holder**

Lens holder with angular displacement

This lens holder allows precise angular positioning of a microscope lens.
The very sensitive adjustment screws allow a lens adjustment of ± 4 °.
Mounted on Ø10-mm rod.
Supplied without lens.

POD 060 560	**Lens holder with angular displacement**

Achromatic lenses

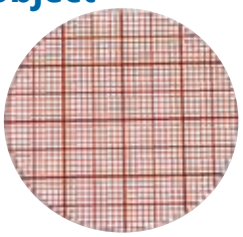
POD 067 020	**4 x Lens**
POD 067 040	**10 x Lens**
POD 067 080	**40 x Lens**

Oculars

POD 067 705	**Micrometric ocular, 10x, 0.1 mm**
POD 067 725	**Ocular with 90° haircross**

Ø 40-mm Millimetric object

Plastic token , translucid, with millimetric graph.



POD 066 500	Ø 40-mm Millimetric object

Circular frosted glass plate

Frosted glass plate, 2 mm thick.
Frosted glasses diffuse light in all directions. Therefore, they are used for creating homogeneous background (before an object, for instance).

POD 066 385	Ø 50-mm Circular frosted glass plate

Arrow token, Ø 40 mm

This token presents an object and a frosted glass.
It is made in an intrinsically dispersing, one side is printed.
The object is an arrow in which one side is positive, the other negative. This allows to see the horizontal and the vertical inversion.
The graduation, every 5 mm, can be used to measure magnification.

POD 069 156	Arrow token, Ø 40 mm

OPTIQUE

Diffraction and interference objects

Ø 40-mm glass plates.

Young's slits

- *3 double slits*
- *Width of slits : 70 µm*
- *Distance between slits : 200, 400, 500 µm*

POD 066 710	Young's slits

Slits

- *7 slits and wires on a glass plate*
- *Widths : 30, 40, 60, 80, 100, 150, 200 µm*
- *Accuracy : 1 µm*
- *Space between slits : 5 mm*

POD 066 700	Slits

Multiple slits

- *4 sets of slits (same width)*
- *Width of the slits : 40 µm*
- *Space between slits : 100 µm*
- *Number of slits : 3, 4, 6, 14*

POD 066 720	Multiple slits

Young's holes and slits

- *6 single holes : Ø 20, 30, 50, 100, 200, 500 µm*
- *3 double holes : Ø 70, distance : 100, 200, 500 µm*
- *2 squares : 70 x 70 µm ; 200 x 200 µm*
- *1 rectangle : 70 x 200 µm*

POD 066 730	Young's holes and slits

Heat-absorbing filters

The use of these filters is necessary for detectors (photodiodes, CCDQ). They are also recommended for the protection of fragile components from the light generated by incandescent light bulbs (infrared rays).

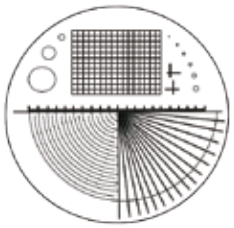
POD 061 201	Ø 40-mm heat-absorbing filter
POD 061 200	Ø 50-mm heat-absorbing filter
POD 061 202	Ø 80-mm heat-absorbing filter

Calibration objects

Accuracy object for the calibration of many optical systems.
Fitted on Ø 40-mm rings.

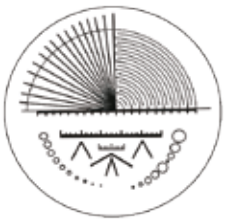
Plusieurs sérigraphies sont disponibles :

Accuracy token



POD 066 600	**Accuracy token**

Complet accuracy token



POD 066 610	**Complet accuracy token**

Calibrated tickness token

POD 066 620	**Calibrated tickness token**

Millimetric crosshair token

POD 066 630	**Millimetric crosshair token**

«d»-shaped object

This token integrates both the object and the frosted glass, thus it is ideal for geometrical optics experiments using the projection of an object with an homogeneous light.
- 2-mm thick - "d"-shape object, silk-screened.

POD 066 400	**diam 40-mm object**
POD 066 410	**diam 50-mm object**

«d»-shaped object

The "d" shape does not present symmetry axis. Therefore, it is adapted for observing all image inversions. As the "d" size is known, this shape enables the widening measurements.
The shape object is made of black metal token.

POD 069 150	**diam 50-mm object**

Hand spectroscope

Full metal, this spectroscope enables the observation of different spectrum (continuous spectrum or lines spectrum).

Lens focusing by pulling.
Slot width adjustment by knurled ring.

POM 052 310	**Hand spectroscope**

5-slots slide

Slide with one set of 5 single slots, different thickness.

POM 052 035	**5-slots slide**

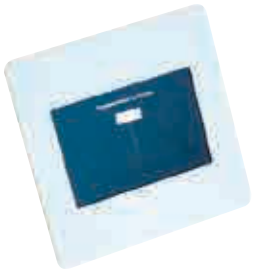
Set of 3 holes

Set of 3 slides with Ø
1, 2, 4-mm diam holes

POM 052 034	**Set of 3 holes**

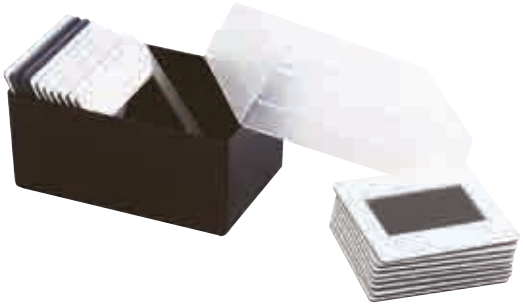
Double slit slide

The double slit generates one phenomenon of interference between the diffraction figures of each slit.
This experiment is called Young slits experiment.
The slide contains two slits of 50 µm, with a gap of 0.1 mm.



POM 052 820	**Double slit slide**

Kit for laser diffraction



Set of slides including :

- *Six slides of 1 to 6 slits*
- *Three gratings to match the slits*
- *Diffraction grating 80 lines / mm*
- *Diffraction grating 300 lines / mm*
- *Single slit – Tapered*
- *Double slit – Tapered*
- *Metal gauze - 300 mesh*
- *Circular apertures 1.0, 0.60, 1.40, 0.30 mm nominal diameter*
- *Hologram*
- *2 Polaroids*

POD 062 900	**Kit for laser diffraction**

Laser slides

Set of 3 slides, with :

- 6 wires (thin lines) widths.
- 3 dual slots, 1 triple slot, 1 quadruple slot, 1 octuple slot.
- 2 disks, 3 squares, 1 single & double cross, 1 test slot.

The set is also available in negative, lines becoming slots

POM 052 653	**Slides with black lines on a transparent background**
POM 052 654	**Slides with slots on a black background**

Set of four image objects

Set of four image objects in a slide frame.
Dimensions : 50 x 50 mm²

- 1 Scale, 15 mm with scale divisions of 0.1 mm
- 1 Photograph
- 1 F diaphragm
- 1 Number 1 diaphragm

POD 066 650	**Set of four image objects**

Paton's gratings

These accuracy gratings display a great uniformity of lines on the whole working area. The sensible working area, 45 mm x 31 mm, is protected by a glass plate.

Compatible with our slide-holders.

POD 061 980	**100-lines/mm gratings**
POD 061 990	**200-lines/mm gratings**
POD 062 000	**300-lines/mm gratings**
POD 062 100	**600-lines/mm gratings**

Sine grating

Holographic processing on the whole working area with a 1000 lines/mm pattern.

POD 068 135	**Sine grating**

Gratings

These gratings have a great uniformity of lines on the whole working area. The working area (dim 36x24 mm)is protected by a glass plate.

Compatible with our slide-holders

POD 062 810	**100-lines/mm grating**
POD 062 820	**300-lines/mm grating**
POD 062 830	**600-lines/mm grating**
POD 062 200	**1200-lines/mm grating**

Copy of Rowland's grating

Copy of a Rowland grating on a collodion foil between two glass plates in a metal frame.

Number of lines : 600 lines/mm

Grating constant : 1,7 µm

Dimensions : 50 x 50 mm.

POD 062 850	**Copy of Rowland's grating**

Dichroic filters

This range of filters is identically processed as interference filters. Ø 40 mm dichroic filters select very efficiently & very accurately a colour range (colour synthesis, filters characteristics).

POD 061 932	**Red filter**
POD 061 933	**Green filter**
POD 061 934	**Blue filter**
POD 061 935	**Cyan filter**
POD 061 936	**Magenta filter**
POD 061 937	**Yellow filter**

Interference filters on component-holder

Interference filters are made of thin layer deposit. Extremely selective filters around an accurate wavelength. Supplied with compenent-holder and individual calibration. Allowance : ± 2 nm ; width 10 nm – min 35 %

POD 010 571	**Blue filter – 436 nm**
POD 010 572	**Green filter – 546 nm**
POD 010 573	**Yellow Filter – 578 nm**
POD 010 574	**Red filter – 633 nm**

Set of 8 components

40-mm Ø lenses, focal lengths : -500,-200, +100, +200, +500 mm and Ø 40-mm mirrors, flat, convex -200 and concave +200 mm

POD 010 511	**Set of 8 components**

Protection rings

Set of 10 plastic rings, Ø 42mm for Ø 40-mm lens protection

POD 010 500	**Protection rings**

Ø 40-mm lenses

Reference	Designation
POD 608 630	f = + 50 mm
POD 608 602	f = + 100 mm
POD 608 634	f = + 150 mm
POD 608 603	f = + 200 mm
POD 608 607	f = + 300 mm
POD 608 642	f = + 500 mm
POD 608 610	f = - 100 mm
POD 608 611	f = - 200 mm

Ø 40-mm mirrors

Reference	Designation
POD 608 715	Plane mirror
POD 608 720	f = + 50 mm
POD 608 724	f = + 100 mm
POD 608 716	f = + 200 mm
POD 608 728	f = - 100 mm
POD 608 717	f = - 200 mm

OPTIQUE

Ø 80-mm lenses

Reference	Designation
POD 608 420	f = + 100 mm
POD 608 402	f = + 200 mm
POD 608 428	f = + 250 mm
POD 608 405	f = + 500 mm
POD 608 444	f = + 1 000 mm
POD 608 452	f = + 2 000 mm
POD 608 456	f = - 100 mm
POD 608 411	f = - 200 mm

Ø 80-mm mirrors

Reference	Designation
POD 608 415	Plane mirror
POD 608 414	f = + 100 mm
POD 608 416	f = + 200 mm
POD 608 480	f = - 100 mm
POD 608 417	f = - 200 mm

Lens, focal length + 5mm

Fitted in a metallic frame to avoid any damage
Frame diam : 40 mm - Ø 10-mm rod.
Compatible with our lens-holder (POD 010 090).

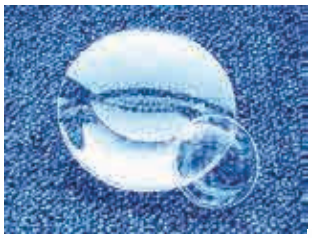
POD 608 615	**Lens, focal length + 5mm**

Condensation's lens

This lens in intended to condense the maximum light. It has a very short focal length according to the diameter & special aspheric area to avoid some aberrations.

Compatible with all our lens-holders

POD 070 331	**Ø 40-mm lens– f =+ 46 mm**
POD 070 332	**Ø 80-mm lens– f =+ 91 mm**



Fresnel's lens

This plastic small scaled lens, Ø 38 mm, includes 6 sections duplicating a convex lens curve.
Focal length : 18 mm.

POD 070 330	**Fresnel's lens**

Equilateral prisms

These prisms have an equilateral stand, 40 mm-side, 48-mm height. Both working sides are highly polished as the other sides are dull.

Supplied with the technical charactersitics of the glass.

POD 068 020	**Extra-dense Flint prism (n= 1,75)**
POD 068 030	**Crown Prism (n= 1,52)**

Prisms

Particulary economical prisms, intended to demonstration experiments, underscoring the light dispersion.
Made of standard optical glass (index near to 1.52). 40 mm height, 40 mm.
Available with an 40-mm equilateral base or a 30-60-90° base (50-mm hypotenuse).

POD 010 615	**Equilateral prism**
POD 010 616	**30-60-90° prism**

Hollow prism

Equilateral prism, 60-mm side and 65-mm height.
This is a hollow glass prism with hole to allow fluids to be added.
Comes with a stopper.

POD 010 620	**Hollow prism**

Glass plate

BK7 plate, optical polishing, 2 sides with parallelism less than 1 µm
Dimensions : 80 x 50 mm. Thickness : 15 mm

POD 010 240	**Glass plate**

Clear chamber

The clear chamber device enables the superimposition of the image given by the microscope to the paper plate on which the drawing is carried out.

Therefore the reproduction is very accurate & scaled.

POD 066 140	**Clear chamber**

Micrometer, 1/10-mm lens

Micrometer, 1/10-mm lens

Engraved on Ø 15 mm glass plate and mounted in a metallic holder.
Dimensions : 76x26 mm
Micrometer lens

POD 067 621	**Micrometer, 1/10-mm lens**

High accuracy lenses, Ø 40 mm

High accuracy lenses, Ø 40 mm
We also have high accuracy lenses, answering to higher requirements.

- *Diameter tolerancing : +0,0/-0,10 mm*
- *Center thickness tolerancing : +0,1 mm*
- *Focus tolecrancing : ± 1%*
- *Conception wavelength : 587,6 nm*

Reference	Type	Focale (mm)	δ	Epaisseur au centre (mm)	Verre
POD 608 500	PCX	+ 40	+ 25	8.70	N-SF11
POD 608 501	PCX	+ 60	+ 16.67	9.31	N-BK7
POD 608 502	PCX	+ 80	+ 12.5	8	N-K5
POD 608 503	PCX	+ 100	+ 10	7	N-K5
POD 608 504	PCX	+ 200	+ 5	5	N-K5
POD 608 505	PCX	+ 300	+ 3.33	5	N-BK7
POD 608 506	PCX	+ 400	+ 2.5	5	N-BK7
POD 608 507	DCX	+ 40	+ 25	8.5	N-SF11
POD 608 508	DCX	+ 60	+ 16.67	8.8	N-BK7
POD 608 509	DCX	+ 80	+ 12.5	8	N-K5
POD 608 510	DCX	+ 100	+ 10	8	N-K5
POD 608 511	DCX	+ 120	+ 8	7	N-BK7
POD 608 512	DCX	+ 200	+ 8	8	N-K5
POD 608 513	DCX	+ 400	+ 2.5	8	N-BK7

> Please, ask us if you need specific glass objects (prisms, cube, plate ...)

Storage box for optical components

You can use this box to protect and store your optical components.
You can put up to 10 storage drawers. These drawers can store up to 20 Ø 40-mm components

- *Aluminium box*
- *Navy blue velvet inside*
- *Key lock (supplied with 2 keys)*
- *Folding handle for a easier storage*
- *Dim: 280x213x203 mm*

Supplied without drawer.

POD 010 520	**Storage box for optical components**

Storage drawer

Can store up to 20 Ø 40-mm components

- *Navy blue velvet inside*
- *Can be put in the optical storage box (ref : POD 010 520)*
- *Dim : 195 x 250 x 19 mm*

POD 010 521	**Storage drawer**

Student Interferometer

These apparatus are used for the basic experiments. They are an easy and economical alternative solution to the top of the range Michelson interferometer.

You can make your experiments with a laser or a white lamp. Lighter and smaller, this interferometer is easy to install for the students.

Ideal device to understand the interferometers basics at low cost !

Progressive Michelson interferometer

This Michelson interferometer is light and easy to set. It allows a quick and efficient understanding for the student, at a lower cost.
Conceived like the superior quality model (ref POD 013 490), it includes a couple of beamsplitters (beamsplitter/ compensating plate) and two mirrors with λ/10-accuracy. It can be used as well with a white lamp (halogen for example) as with a laser.
You can also add a motorization (ref POD 013 365)

DIDAFIRST

- *Planeity of the diam 50,8-mm beamsplitters (separator and compensator) : λ/10*
- *Planeity of the diam 25,4-mm : λ/10.*
- *Travel : 25 mm with a micrometric stop.*
- *Adjustment of the optical components with accuracy screws.*
- *Fixed mirror ajustable.*
- *Heat absorbing filter.*
- *Plate with 4 antivibratory feet*

POF 020 110	**Progressive Michelson interferometer**

Michelson motorization

We need the motorization for the analysis and recording of interferograms (interference gratings)

These interference images give us a lot of information about the light source.

Synchronous motor : 1 turn/ 18 minutes (that is to say 463nm/s)

POD 013 565	**Michelson motorization**

Basic glass plate holder

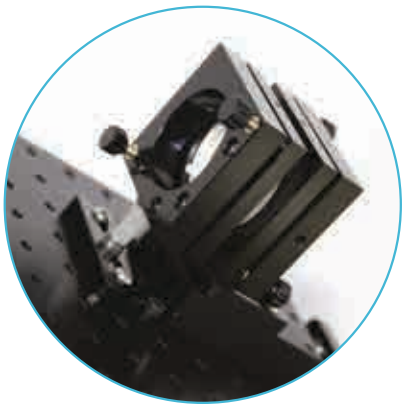
Basic glass plate holder specially conceived for the experiments using Progressive Michelson or Mach Zender interferometers.

POF 020 305	**Basic glass plate holder**

Fabry-Perot interferometer

This elementary Fabry-Perot enables to implement spectrometry manipulations at the best price.

Made of two mirrors with a reflexion coefficient higher than 0.9, it can be used either with white light or a laser.



- *Planeity of the diam 50,8-mm mirrors : λ/10 - Reflective power R>0.9*
- *Travel : 25 mm with a micrometric stop.*
- *Adjustment of the optical components with accuracy screws.*
- *Plate with 4 antivibratory feet.*

POF 020 200	**Fabry-Perot interferometer**

Fabry-Perot etalon

Set of mirrors (λ/10, ⍉50,8mm, reflection coefficient higher than 0.9), mounted on a 3-points adjustable holder (1 fixed point, 2 adjustable points). The etalon's recess is fixed. Nevertheless, you can choose to change this one before the experience, with an Allen key. Three nylon stops prevent contact between the two mirrors.

The set is mounted on a ⍉10mm rod. It can be used on a bench or on an optical stand.

POF 020 250	**Fabry-Perot etalon**

Mach-Zender interferometer

This small Mach-Zender is ideal to introduce 2 paths interferences concept and to change from the classical Fabry-Perot and Michelson interferometers. It is entirely flexible and you can easily implement experimental procedures about the functioning and the concept of the Mach-Zender, before going further with experiments including glass plate or the air index.

You have the possibility to adjust the gap between the two paths and thus, use several accessories like a vacuum tank or a glass plate.

- *Set of beam splitter/mirror λ/10, ⍉50,8mm*
- *Adjustment of optical devices with precision screws*
- *Optical table with 4 vibration absorbing feet.*

POF 020 300	**Mach-Zender interferometer**

Michelson interferometer, Higher education

ADVANTAGES

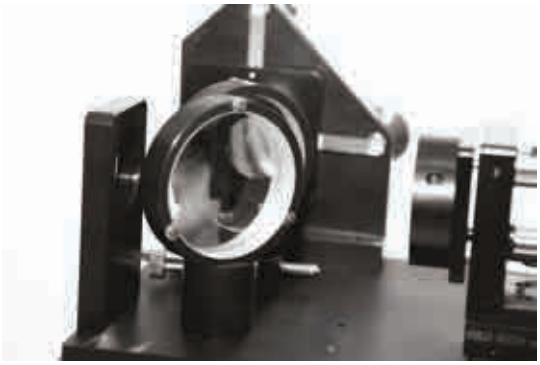
- *Very good robustness of the mechanical systems*
- *High luminosity*
- *Very good accuracy of the adjustment systems*
- *Very stable apparatus*
- *5 years warranty for the mechanical parts*

TECHNICAL CHARACTERISTICS :

- *diam 80-mm beamsplitters, with anti-relfective coating*
- *diam 40-mm mirrors*
- *Planeity of the beamsplitters and mirrors : λ/20*
- *We put the orientation and lead systems of the compensator beamsplitter outside for a simplified access.*
- *The mobile mirror is mounted on a traverse plate, guided by a ball bearing*
- *Traverse travel : 25 mm with a micrometric stop and with a digital display (micrometric accuracy).*
- *Adjustement of the mobile mirror with a dual path screw, with unscrewing system*
- *Adjustement of the fixed mirror made by a spring plate system, for a fine setting*
- *Diam 50-mm heat-absorbing filter, moveable, at the input of the apparatus, against infrared beams, in order to avoid any overheating of the optical parts*
- *Screws and setting systems are made of stainless steel*
- *Main plate is made of massive steel, on antivibratory feet*

Subjects approached :

- *Interferences phenomenon study*
- *Waveslength measurement*
- *Light's speed determination*
- *Fluted spectrum study*
- *Sodium doublet finding*
- *Glass plate's thickness measurement*
- *Medium's index measurement*



POD 013 495	**Michelson interferometer**

Michelson motorization

We need the motorization for the analysis and recording of interferograms (interference gratings)

These interference images give us a lot of information about the light source.

Synchronous motor : 1 turn/ 18 minutes (that is to say 463nm/s)

POD 013 565	**Michelson motorization**

Glass plate holder

Used to find the thickness of a thin glass plate

POD 013 497	**Glass plate holder**

Michelson interferometer motorized

ADVANTAGES

- *Very good robustness of the mechanical systems*
- *High luminosity*
- *Very good accuracy of the adjustment systems*
- *Very stable apparatus*
- *5 years warranty for the mechanical parts*

TECHNICAL CHARACTERISTICS :

- *diam 80-mm beamsplitters, with anti-relfective coating*
- *diam 40-mm mirrors*
- *Planeity of the beamsplitters and mirrors : λ/20*
- *We put the orientation and lead systems of the compensator beamsplitter outside for a simplified access.*
- *The mobile mirror is mounted on a traverse plate, guided by a ball bearing*
- *Traverse travel : 25 mm with a micrometric stop and with a digital display (micrometric accuracy).*
- *Adjustement of the mobile mirror with a dual path screw, with unscrewing system*
- *Adjustement of the fixed mirror made by a spring plate system, for a fine setting*
- *Diam 50-mm heat-absorbing filter, moveable, at the input of the apparatus, against infrared beams, in order to avoid any overheating of the optical parts*
- *Screws and setting systems are made of stainless steel*
- *Main plate is made of massive steel, on antivibratory feet*

OPTIQUE

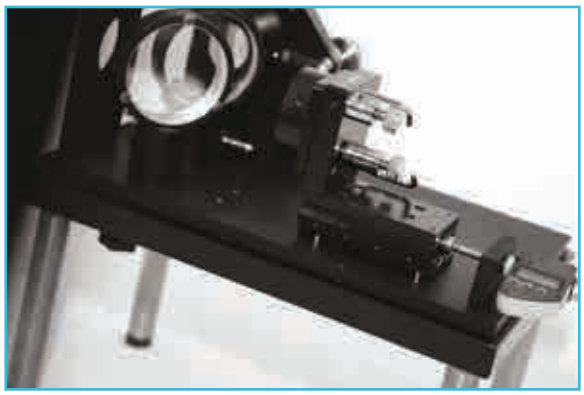
MOTORIZATION :

We need the motorization for the analysis and recording of interferograms (interference gratings)
These interference images give us a lot of information about the light source

Synchronous motor : 1 turn/ 18 minutes (that is to say 463nm/s)

Subjects approached :

- *Interferences phenomenon study*
- *Waveslength measurement*
- *Light's speed determination*
- *Fluted spectrum study*
- *Sodium doublet finding*
- *Glass plate's thickness measurement*
- *Medium's index measurement*



POD 013 496	**Michelson interferometer**

Vacuum tank + hand pump

Vacuum tank, for the determination of vacuum refraction index (with the hand pump) of a specific gas refraction index

- *Usable length : 50 mm*
- *Usable diam : 34 mm*

POD 013 499	**Vacuum tank + hand pump**

Lighting Kit

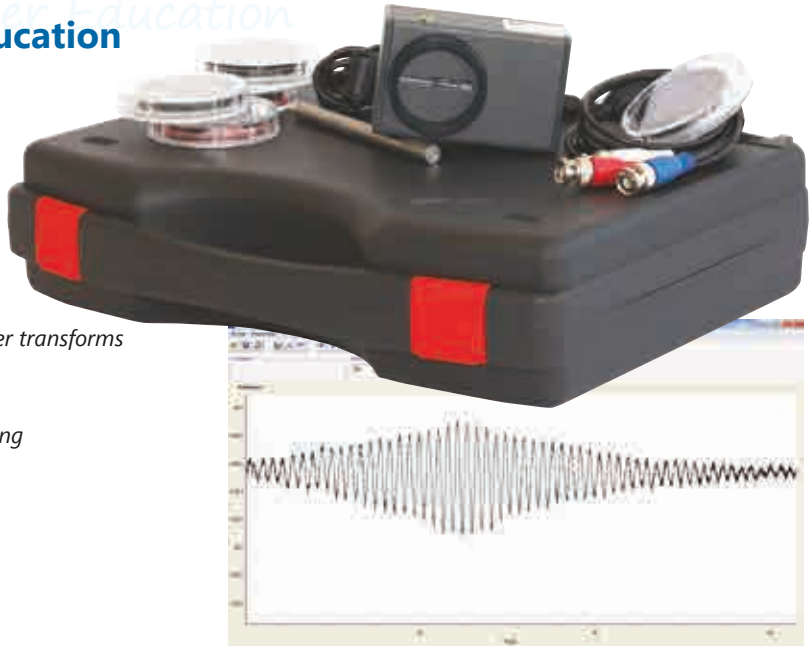
This set is specially used to get optimum lighting conditions enabling the interference fringes observation with the Michelson interferometer

CONSTITUTION :

- *1 0,50-m bench* *(POF 010 113)*
- *1 adjustable halogen light* *(POD 069 140)*
- *3 Optical rider* *(POF 010 124)*
- *2 Ø 80-mm lens holders* *(POD 060 130)*
- *1 Ø 80-mm lens, f=+150 mm* *(POD 608 424)*
- *1 Ø 80-mm lens, f=+250 mm* *(POD 608 428)*
- *1 Iris Diaphragm* *(POD 060 410)*
- *1 Optical stand* *(POD 002 192)*
- *1 Condenser* *(POD 061 250)*

POD 013 492 **Lighting Kit**

Caliens Camera, Higher Education



ADVANTAGE :

- *Implementation of a "coherent" sensor, for Fourier transforms data acquisition*
- *Use of the sensor for spectrometric settings*
- *Michelson or Fabry-Perot Interferograms recording*
- *Interferences, Diffraction with a hole, a slit ...*
- *Study of a CCD sensor with an oscilloscope*

CONSTITUTION :

- *1 CCD camera*
- *2 polarizers*
- *2 filters with neutral density (0.9)*
- *1 filter with neutral density (3)*
- *1 USB cable*
- *1 complete software (to be downloaded)*
- *1 Ø 10-mm rod*
- *Cables and carrying case*

TECHNICAL CHARACTERISTICS

- *Sensor : 2048 pixels (14-µm wide) (sensitive zone : approx. 30 mm).*
- *Adjustable integration time : 2 ms to 5 000 ms*
- *adaptable on a bench or an optical stand*

POD 010 020 **Caliens camera, Higher education**

Piezoelectric kit

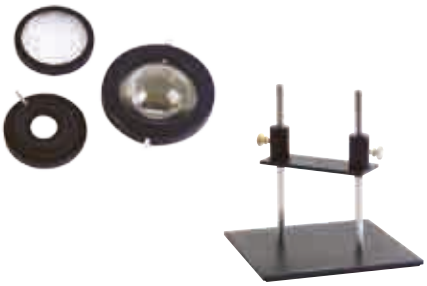
You put this piezoelectric device between the micrometric screw and the magnetic base. Its resonance frequency is 4.6 kHz. You can easily settle its magnetic case on the Michelson table, without damaging the optics.

POD 013 560 **Piezoelectric kit**

Spectral lamps high and low pressure

- *Adapted ventilation*
- *2P+E power outlet with fuse*
- *No risk of burning*
- *Economical*
- *Usable on the lamp base or on optical bench*

POD 010 057	**High pressure mercury lamp**
POD 068 505	**Spare high pressure Spectral lamp**
POD 010 058	**Low pressure Sodium lamp (18W)**
POD 068 495	**Spare Sodium Spectral lamp 18W**



Accessories for spectral lamp

Fixing the lamp with a very simple screw thread system

POD 010 052	**Iris diaphragm**
POD 010 053	**Condenser**
POD 010 055	**Froster glass**

He-Ne Lasers - 632,8 nm

These Lasers are manufactured by Ulice/Didalab and have a very good value for money !!!

- *Output power : 1 mW max*
- *Ray diameter : 0,5 mm - Divergence : < 2 mrad*
- ***Directivity of the beam adjusted in our workshop***
- ***A microscope lens can be screwed directly on the laser***
- *Power supply : 12-V mains transformer*
- *130-mm Stainless steel rod, 10-mm diam*

POD 013 210	**Laser HeNe – non-polarized**

Achromatic lenses

POD 067 020	**4 x Lens**
POD 067 040	**10 x Lens**

Glasses for Laser protection

Norm EN208.

POD 020 500	**for 600 / 760-nm lasers**
POD 020 510	**for 200 / 540-nm lasers**

Optical stand

Stand for Ø8-mm to Ø 14-mm rods. Height : 210 mm
You can align several stands using a Ø10-mm rod.

POD 002 192	**Optical stand**

Height : 120 mm

POD 002 193	**Optical stand**

Thermodynamics

Heat capacity

An amount of water, of known volume, is heated by means of resistors. Electrical heat production is thus known. Based on increase in temperature and thermal energy, the specific heat capacity of water can be calculated. Moreover, this value is corrected to allow for calorimeter heat capacity. Hot metal samples are placed in a calorimeter filled with water at low temperature.

Sample heat capacity is determined based on increase in water temperature. When parts are in contact with each other and have different heat quantities, heat is distributed until all parts have the same temperature. If heat capacities and initial temperatures are known, then final temperature can be predicted. Conversely, final temperature can be used to obtain heat capacity when the initial temperatures are known.

Necessary equipment

Reference	Designation	Quantity	Page
PTD 039 505	Dewar calorimeter	1	112
PMM 062 603	0-30V/0-10A power supply	1	154
PMM 062 900	Digital multimeter	1	158
PTD 039 504	Metal cubes	1	112
PEM 080 100	Set of 2 1-metre leads (1 red/1 black)	3	139

Subjects approached

» Determining the specific heat capacity of water or a liquid.
» Determining calorimeter heat capacity
» Determining the specific heat capacity of aluminium, iron and brass
» Joule's law

→ Calorimeter heat capacity

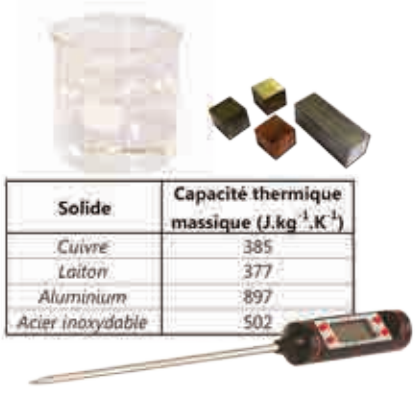
Place a certain amount of water in the Dewar flask calorimeter. Close it and insert the temperature probe. Wait for thermal balance to be attained and note the temperature. Sample exactly the same amount of hot water and measure its temperature. Then, quickly pour this amount of hot water into the calorimeter. Close the latter, stir regularly and note the balance point temperature. As the calorimeter is adiabatic, the water is thermally insulated from the outside environment.

→ Joule's law and resistance influence

Pour a known amount of water (known weight and volumes) at ambient temperature into the calorimeter. Read water temperature and place the chosen resistances in the sockets provided on the calorimeter cover. Switch on the power supply and set current to the required value, then stir. After a few minutes, read the new temperature value. Based on the energy conservation law and by plotting the straight line linking thermal energy as a function of time, we find the value of the resistance applied to the calorimeter.

→ Measuring brass specific heat capacity

Heat water in a recipient in which a metal mass (e.g. brass) is immersed. The mass is placed on an insulator so that it is not in contact with the recipient walls. Stop heating before the water boils. Read water temperature, which is also metal temperature, and quickly plunge the mass into the calorimeter water (body of water taken from the tap at a known temperature that is generally ambient). Wait for thermal balance by stirring and measuring balance point temperature. After a few minutes, temperature will balance at a certain value, varying according to the material.



Solide	Capacité thermique massique ($J.kg^{-1}.K^{-1}$)
Cuivre	385
Laiton	377
Aluminium	897
Acier inoxydable	502

EXP 300 030 Heat capacity

Gas critical point study

This experiment is designed to study gas compressibility and liquefaction (in this case the gas is sulphur hexafluoride). The device allows you to attain critical temperature and pressure.

In hands-on exercises, it will be used to build the isotherm network in Clapeyron's graph.

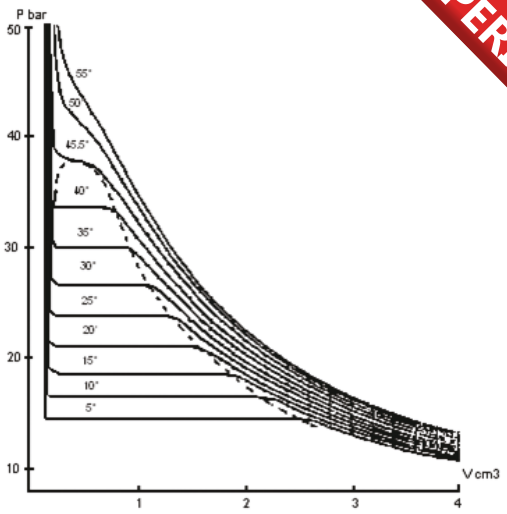
During your course demonstrations, we shall show gas liquefaction and monitor changes in respective liquid-gas volumes during compression. We shall also show continuity of gas and liquid states above the critical point by conducting the classic critical point bypass experiment.

Necessary equipment

Reference	Designation	Quantity	Page
PHD 009 950	Critical point device	1	110
PHD 009 660	Thermostatic bath	1	111
PHD 008 898	Vacuum pump	1	111
PHD 009 953	Vacuum trap	1	111
PTM 041 365	Digital thermometer	1	162

Subjects approached

» Clapeyron's graphs
» Law of corresponding states
» Bypassing the critical point
» Saturated vapour pressure curves
» Critical point
» Amagat's diagram
» Critical opalescence



→ Clapeyron's graphs

Once water has been made to circulate in the plexiglas tube, set the thermostat to the required temperature. Once temperature has stabilised, start compressing the gas inside the test tube using the flywheel beneath the device. Once pressure has stabilised, read the values for Volume (V) and pressure (p). Continue to increase compression slowly and stage by stage. For each stage, read V and p, until you attain 45 bar. Repeat this exercise for increasing temperatures until 50°C is attained. You can then plot Clapeyron's graphs.

→ Bypassing the critical point

Set temperature to 42°C and go to the vicinity of the critical point, i.e. roughly 35 bar. Lower pressure using the flywheel until the liquid disappears. A liquid-gas transition will occur. Then reheat the system up to 48°C. Once this temperature has been attained, compress the gas again up to 45 bar. No meniscus is observed. Then cool down to 42°C.Then, lower pressure to return to the original position (i.e. 35 bar). A liquid-gas transition will once again take place.

As you carry out these stages, fluid will in turn be in vapour state, hypercritical state and liquid state without it being possible at any time to observe a transition between these states.

→ Critical opalescence

Critical opalescence is a phenomenon observed at the interface of a fluid at the vicinity of the critical point. For this, set temperature so it attains 45°C, and increase pressure using the flywheel to approach the critical point. Once these 2 conditions have been reached, lower pressure: the light crossing the medium formed around the critical point is scattered and assumes a bluish tinge.

EXP 300 040 Critical point study

Thermal conduction

This comprehensive pack is designed to implement the fundamental law linking heat flow to temperature gradient and to the surface crossed by the heat flow.

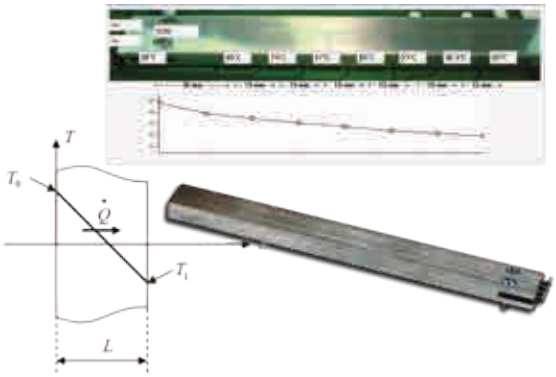
One end of a metal bar is heated electrically. Temperate air circulation allows temperature at the second end to be kept at a markedly constant value. A series of eight temperature sensors is distributed along the metal bar to be studied. Thanks to an acquisition system and its software, the temperature of each sensor is recovered as a function of time, as well as heat flow in Watt. All data acquired over time can be used.

Necessary equipment

Reference	Designation	Quantity	Page
PTD 009 915	Thermal conduction device	1	113
PTD 009 919	Steel bar	1	113

Subjects approached

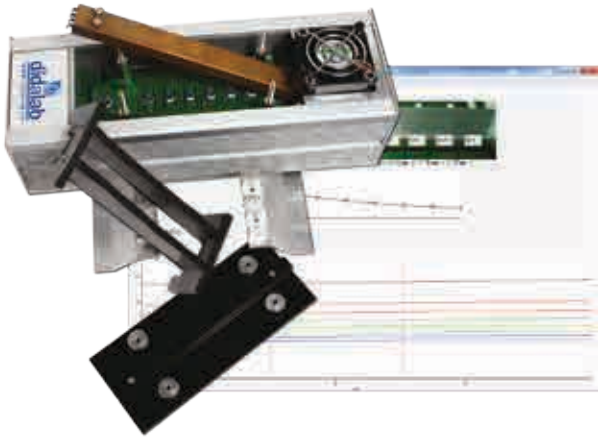
» Heat transfer
» Thermal conduction
» Thermal resistance
» Fourier's law
» Material properties



→ Conductivity in steady-state conditions

Place the bar to be studied in the box. Close the box with the set screws so as to approach optimum adiabatic conditions. Then start heating and cooling. The temperatures of the 8 sensors and the heat flow will be displayed. After roughly fifteen minutes, the steady state is achieved : temperature is constant as a function of time at all points of the space. The straight line representing the temperature gradient is displayed, i.e. temperature as a function of the position of each sensor. Via the leading coefficient or the ordinate at the origin of this line, you can find the material conductivity value using Fourier's law.

→ Studying the transient state

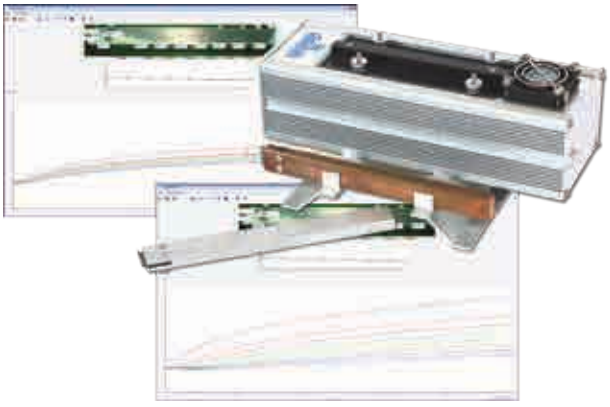


Place the bar to be studied in the box and start an acquisition. In this state, temperature has not yet attained balance point temperature. The software displays the temperature of each sensor as a function of time. With knowledge of material density, the material diffusivity value can be found with the heat distribution equation.

→ Comparing different materials

We supply a copper bar and an aluminium bar (a steel bar is available as an option) to compare the conductivities of the different materials. The bars can be interchanged with no problem. The 3 materials can be studied during a hands-on exercise of 2 hours most.

We can also work on the return to the original state following heating or on continuous heating without cooling.



EXP 300 050 Thermal conduction

Critical Point apparatus – SF6 Isotherms

DESCRIPTION OF THE APPARATUS

Accuracy apparatus for the study of gas compression and liquefaction. Here, we use Sulfur hexafluoride (SF6) because its critical point can be easily and safely reached.

Robust and pedagogical design

HIGHLIGHTS :

- *Very good visibility of the gas state shift*
- *Display of the pressure on a computer*
- *Use of a gas with physical and chemical properties that are*
- *ideal for measures.*
- *Robust and secure*
- *You can make the gas fill by yourself*
- *Many teaching subjects approached*

MAIN COMPONENTS :

SF6 gas :
Gas with critical parameters easily reached

- *Critical pressure : 37,6 bars*
- *Critical temperature : 45,5 °C*

TEST TUBE :
Component where the gas is compressed by the mercury rise.

- *Thick Pyrex*
- *Capacity 4 cm3*
- *Graduation : 1/20 cm3*
- *Fitted on a stainless steel chamber*
- *Can resist to a high pressure*

THERMOSTATIC JACKET :

Component around the test tube where the water circulates, in order to modify temperature conditions.

MANOMETER :

Displays the pressure in the decompression chamber, and thus, the pressure that the mercury exerts on the gas.

> Subjects approached :

- *lapeyron's graphs*
- *Law of corresponding states*
- *Bypassing the critical point*
- *Saturated vapour pressure curves*
- *Critical point*
- *Amagat's diagram (Critical opalescence)*

CONSTITUTION OF THE PHD 009 950 REFERENCE :

- *1 Apparatus for the study of Critical Point*
- *1 SF6 cartridge*
- *2 supple pipes for water circulation*
- *1 set of Allen keys for the assembly and dismantling of the apparatus*
- *1 User manual*

OTHER CHARACTERISTICS :

- *Supplied unfilled for transportation security*
- *Weight : 9 kg*

PHD 009 950	**Critical point Apparatus**

Vacuum pump

Paddle pump (Mains AC 220 V), enabling to get high quality vacuum in the minimum time.
This pump requires oil filling up (provided).

Single-stage "Standard" vacuum pump.
Residual vacuum : 0,03 mbar - flow: 2,5 m3/h,
Weight : 4 kg.

PHD 008 898	**Vacuum pump**

Vacuum trap

The vacuum trap is indispensable to carry out the filling of the Critical Point apparatus

When making vacuum into the Critical Point apparatus, the vacuum trap avoids the introduction of mercury inside the vacuum pump & therefore its damaging.

It is constituted of a 250-ml vacuum filtration flask, a 1-m long vacuum pipe (8 x 21), enabling the link between the apparatus & the vacuum pump.

PHD 009 953	**Vacuum trap**

SF6 cartridge

The SF6 (Sulphur hexafluoride) is used with Critical Point Apparatus.
The cartridge enables the gas refilling of the apparatus after several utilizations.
The cartridge ensures 8 possible fillings up.
(Depending on the utilization, the apparatus must be filled up every 6 months / maximum one year).

PHD 009 940	**SF6 cartridge**

Thermostatic bath and circulation

The system includes one tank, one thermostat & one water circulation at fixed temperature.

This equipment is indispensable for all experiments on isotherm layouts, as well as experiments requiring water circulation temperature control.

Heat element : 1050 W.
5 to 60 °C, ± 0,05 °C
Provided with methacrylate tank, contents : 8 liters.

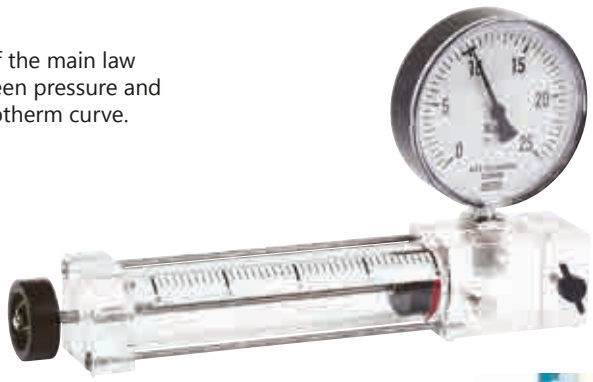
PHD 009 660	**Thermostatic bath and circulation**

PV=cste experiment

This apparatus enables the confirmation of the Boyle-Mariotte's Law, one of the main law of thermodynamics for real gas. Experiment showing the relationship between pressure and volume of a gaz, at constant temperature, and thus the drawing of a gas isotherm curve.

CHARACTERISTICS

- 1 graduated cylinder, with a piston.
- The piston operates one manometer, Ø 100 mm.
- Apparatus length: 350 mm



PHM 032 760	**PV=cste experiment**

Dewar calorimeter

CONSTITUTION OF THE CALORIMETER :

AN ALUMINIUM CONTAINER :

- *Total contents : 800 ml - Working contents : 500 ml*
- *Concentric to a Dewar vase with broad neck*
- *Protected by a metal casing with 2 locking hooks.*

A WHITE PLASTIC COVER WITH :

- *A square opening for the stirring rod, blocked in rotation by its square section rod.*
- *A central closing with Ø 38-mm de Ø protection cap, for the insulation of foreign components after they have been put in the calorimeter.*
- *A Ø 8-mm opening for the thermometer.*

A 500-ml BEAKER :

- *Ø 100 mm - Height 100 mm – Can replace the aluminium container, for thermo-chemical reactions*
- *A SQUARE SECTION STIRRING ROD*
- *With a semi-circular blade (30-mm radius).*

A SET OF RESISTANCES :

- *Robust diam 40-mm holder, with 2 Ø 4-mm security sockets, with 2 conductive rods at the end of which you put the resistance (1, 2, 3, 5 Ohms)*

DIGITAL THERMOMETER :

- *Range : -50° à 300°C*

CHARACTERISTICS :

- *Contents : 500 ml*
- *Water value of the calorimeter + stirrer : 14,7 Cal/degree*
- *Radiation gains or losses : very low*
- *External dimensions : Ø 170 mm- Height : 215 mm*
- *Aluminum mass heat : 0,214 kcal. kg-1. K-1*
- *Glass mass heat : 0,186 kcal. kg-1. K-1*

Supplied with user manual

PTD 039 505	**Dewar Calorimeter**

THERMODYNAMIQUE

Dewar calorimeter

Same characteristics as the above calorimeter (ref PTD039505)

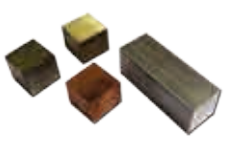
CONSTITUTION

- *1 aluminium container*
- *1 plastic cover*
- *1 500-ml beaker*
- *1 stirrer*
- *1 thermometer*

PTD 039 501	**Dewar calorimeter**

Metallic cubes

4 metallic cubes made of aluminium, cooper, steel, brass, with the same weight.
All the cubes have the same base surface (20 x 20 mm)



PTD 039 504	**Metallic cubes**

Spare beaker

Spare 500-ml beaker for the calorimeters ref : PTD 039 505 and PTD 039 501

PTD 039 502	**Spare beaker**

Thermal conduction apparatus

This apparatus shows up the fundamental law connecting the heat flow rate, the temperature gradient and the surface crossed by the flow.
Measure the conduction of metals and other materials

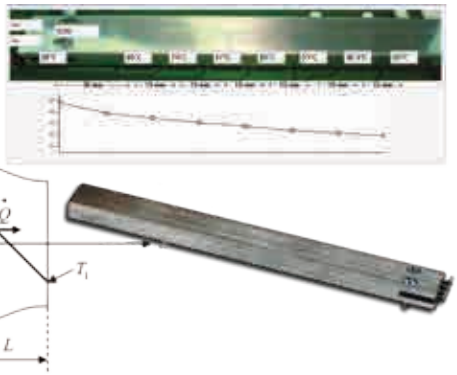
CONSTITUTION :

- *1 cooper bar*
- *1 Aluminium bar*
- *Cooling circuit*
- *1 acquisition box*
- *1 software*
- *1 USB cable*
- *1 HDMI cable*
- *1 12V power supply*

CONCEPT :

A metallic bar is electrically heated at one of its end. An air circulation system cools then keeps the same temperature at the other end.

A set of 8 temperature sensors are put along the bar and send data to a computer, through a built-in interface with USB output.



PTD 009 915	**Thermal conduction apparatus**
PTD 009 919	**Steel bar**

Clement Desormes apparatus

A big tank is full of air with a pressure a little higher than the atmospheric pressure. The tank is opened during a short time.

During the tap opening, the gas expends up to atmospheric pressure in a adiabatically expansion and cools. Then the internal air comes back to the room initial temperature (room temperature) and the pressure rises.

Thermal capacities Cv and Cp are calculated using the pressure and volume changes.

A marble oscillates on a gas volume in a tube. The oscillation is hold by directing the escaping gas back inside the apparatus. The adiabatic coefficient of the gas is found using the oscillation period.

CHARACTERISTICS :

- *1 Jar*
- *1 Stopper with electronic manometer*
- *1 stopper with a pipe and electromagnet*
- *1 Steel marble*
- *1 circular magnet*
- *1 Pressure sensor*

PHD 009 400	**Clement Desormes apparatus**

4-arms star

The 4 metallic rods are in : aluminium, brass, copper and iron

At the end of each rod there is a cavity, intended to receive paraffin or a match. When the center is heated up, the paraffin melts and drops down at different moments.

PTM 039 015	**4-arms star**

Vaccum plate

Ø 250 mm plate, neoprene insulation.
The plate is equipped of one airproof electrical crossing (2 safety Ø 4 mm sockets) and is supported by 3 feet.
Equipped with 2 taps (one for the pump, one for the vacuum-breaker).

PHM 032 071	**Vaccum plate**

Vacuum bell jar

Ø 200-mm vacuum bell with knob, made of «SIMAX» borosilicate glass, with 20 mm grinded edge.

PHM 032 151	**Vacuum bell jar**

Dasymeter

The dasymeter is an apparatus intended to illustrate the non-null weight of the air.
When located inside the vaccum bell, the air trapped inside the polystyrene ball exerts a weight, that tips up the scales.
The scales come back to balance under the atmospheric pressure.

PHM 032 780	**Dasymeter**

Pressure of air apparatus

This apparatus is a transparent cylinder, Ø 90 mm, 110 mm high, grooved for maintaining one cellophane leaf.

Set upon the vacuum cover, it can demonstrate the force exerted by the atmospheric pressure.

PHM 032 321	**Pressure of air apparatus**

Vacuum pump

Paddle pump (Mains AC 220 V), enabling to get high quality vacuum in the minimum time.
This pump requires oil filling up (provided).

Single-stage “Standard” vacuum pump.
Residual vacuum : 0,03 mbar - flow : 2,5 m3/h,
Weight : 4 kg.

PHD 008 898	**Vacuum pump**

Electricity

Microwave study

The microwave study package is an outstanding tool for understanding wave phenomena. It also offers an excellent comparison with geometric optic experiments.

This system allows you to implement diffraction, interference and polarisation experiments, as well as to install a Michelson.

You can also study standing waves and plot the radiation pattern of a horn antenna.

All data captured by these two receivers are legible directly on the power pack digital display.

Necessary equipment

Reference	Designation	Quantity	Page
PED 022 160	Detection kit	1	127
PED 022 162	Paraffin prism	2	127
PBU 070 300	Bench with coupling and 2 riders	1	72
PED 022 163	Slits and multi-slits	1	127
PED 022 164	Metal screen	2	127
PED 022 165	Wooden screen	1	127
PED 022 166	Polarisation comb	1	127
PED 022 167	Separator	1	127
POD 002 192	Half-moon stand	4	36
PMM 063 802	Digital oscilloscope	1	152
PEM 063 961	Female adapter	1	139
PEM 010 021	Male-male BNC black lead	1	139

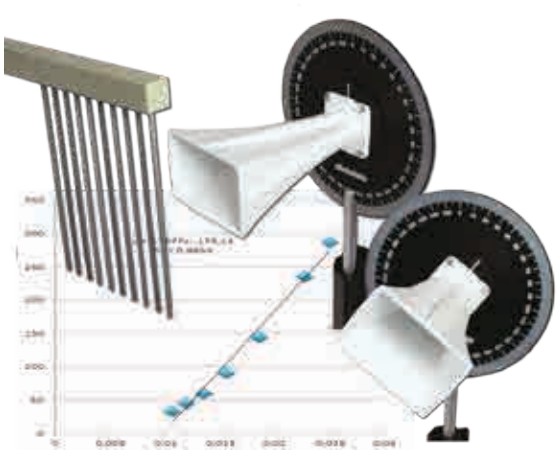
Subjects approached

» Microwave linear propagation
» Reflection, absorption and transmission
» Polarisation
» Refraction
» Diffraction and interference
» Michelson
» Standing waves
» Tunnel effect

→ Diffraction - Interferences

We speak of interferences when two waves of the same type meet and interact with each other. While this phenomenon frequently appears optically with light waves, it also occurs with electromagnetic waves of other wavelengths. The bench and its goniometric coupling allow you to implement easily all interference and diffraction operations. Slits can be adjusted to implement a number of different widths, both in single and double slits.

→ Polarisation

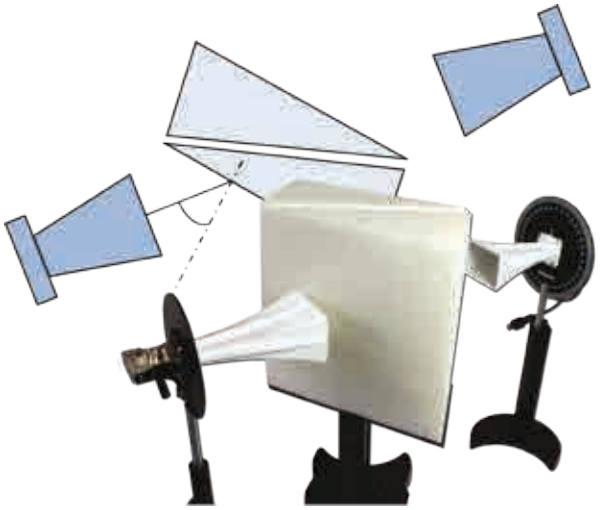


It can be proved that diodes are polarised linearly by using the comb, consisting of parallel metal bars with 0.5 cm spacing. When the bars are vertical, the wave passes, but when they are horizontal, the wave ceases to pass. Using the receiver graduation system, Malus's law can be quantitatively performed. The digital display is used to read each value directly.

ELECTRICITY

→ Tunnel effect

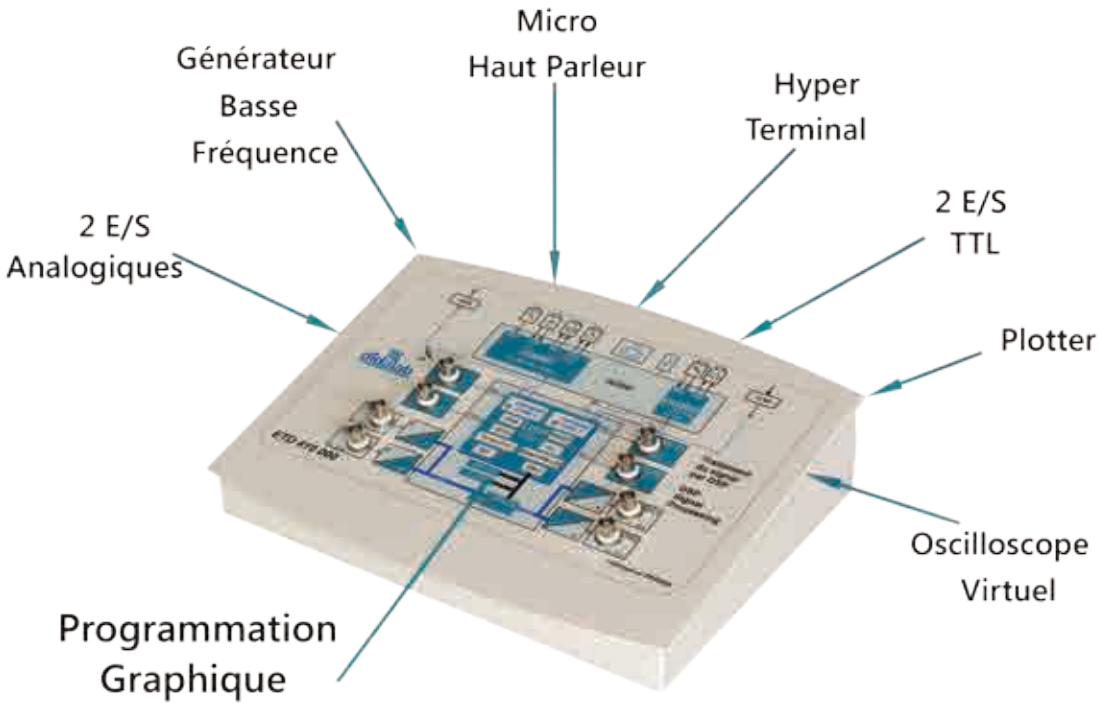
A tunnel effect case with the paraffin prisms and the detection kit can be shown. The first prism is placed in a configuration where the receiver no longer receives signals (total reflection). The diffracted signal is no longer or only barely perceived by the receiver. When the second prism is added behind the first, we observe that the receiver once again picks up a signal. This signal is transmitted by tunnel effect.



EXP 400 010 Microwave study

Real-time data processing

- Highly ergonomic, ultra-fast, user-friendly and intuitive learning
- Graphic programming
- Real-time virtual oscilloscope with up to 32 channels simultaneously
- A catalogue with more than 500 functions available
- Optional enrichment of the catalogue by means of blocks created by the user
- The FIBULA Graphic environment offers a high-level conceptual vision, in most cases making the hardware layer unnecessary

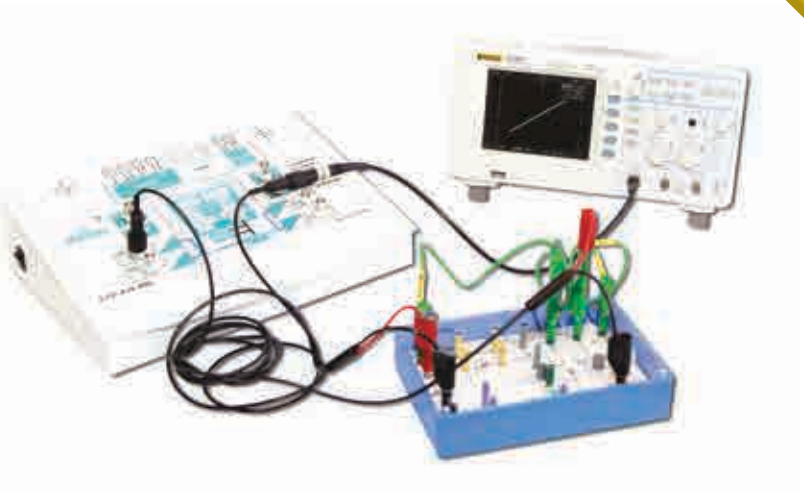


Necessary equipment

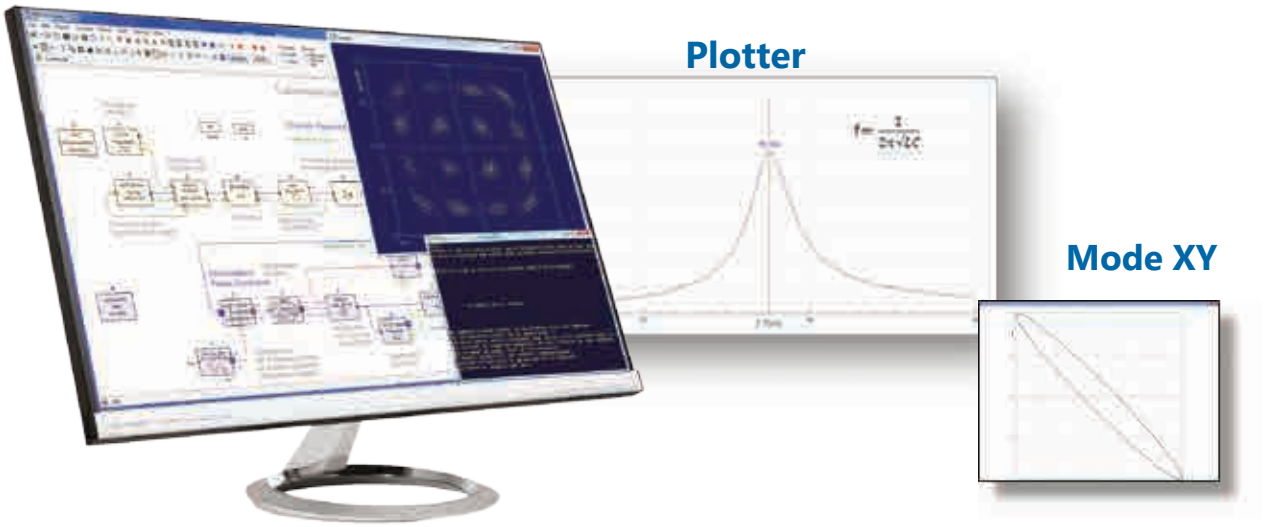
Reference	Designation	Quantity	Page
ETD 410 B	Signal processing package	1	129
EMD 019 040	Function generator	1	146
PMM 063 802	2 x 100 MHz Oscilloscope	1	152
PED 025 300	Integrated RLC circuit	1	135
PEM 010 180	BNC/2x Ø4-mm lead	2	139
PEM 080 020	0.5 metre black leads	1	139

Subjects approached

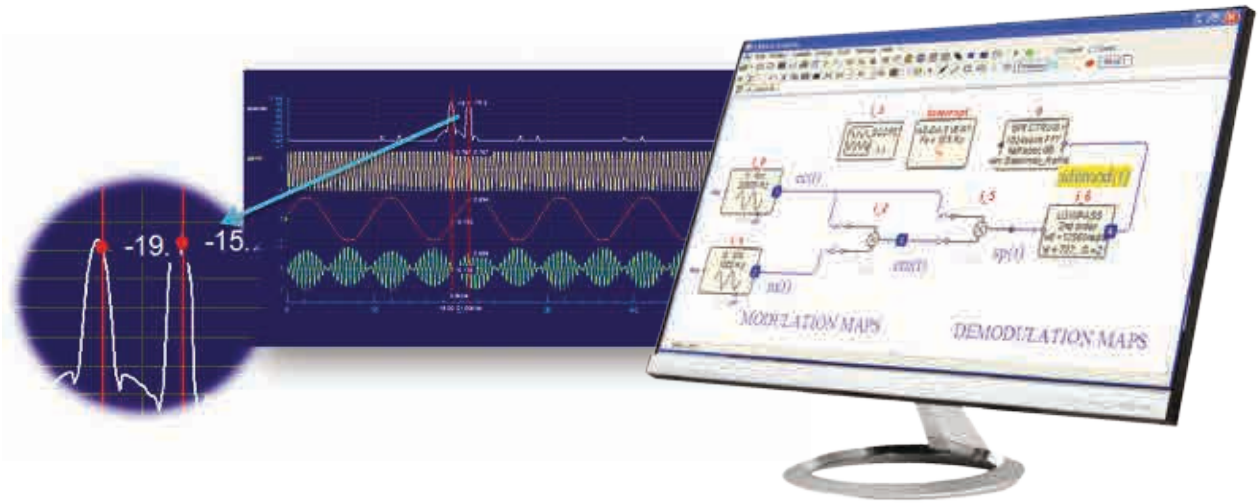
» Quantification
» Shannon's theorem
» CAN - CNA
» Fourier series
» Spectral analysis
» Analog filtering
» Digital filtering
» Bode – Nyquist
» Modulation – Demodulation



→ RLC circuit resonance



→ Continuous analog modulation : AM



EXP 400 020 **Real-time data processing**

Basic electricity laws

An RLC circuit is a linear circuit containing an electrical resistor, a coil (inductance) and a capacitor (capacitance).

To study capacitor behaviour in DC and AC circuits, voltage is measured at the capacitor terminals, and current is determined from voltage drop in a serial-connected ohmic resistor.

In a circuit, potential differences at the resistor terminals as well as current strength can be calculated by applying the two Kirchoff laws: the node law and the mesh law.

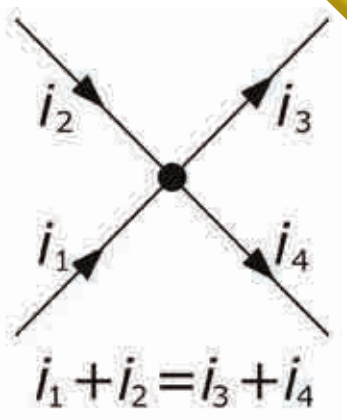
This experiment pack thus offers you a complete set of basic components for easy implementation of the principal basic laws of electricity.

Necessary equipment

Reference	Designation	Quantity	Page
PEM 015 600	Universal board	2	134
PEM 015 701	DC study	1	134
PEM 015 721	AC study	1	134
PEM 015 630	Component holder – Set of 12	1	134
PEM 015 640	4P jumper	2	135
PEM 015 760	Operational amplifier	1	135
PMM 062 460	Triple adjustable power supply	1	155
PEM 080 010	Black leads - 50 cm – set of 10	1	139
PEM 080 011	Red leads - 50 cm – set of 10	1	139
PMM 062 690	12 MHz function generator	1	156
PMM 063 805	2 x 70 MHz digital oscilloscope	1	152
PEM 063 700	BNC /Ø 4-mm sockets adapter	2	139

Subjects approached

- Kirchhoff's law
- Ohms's law
- RLC circuit
- DC study
- AC study
- Operational amplifier



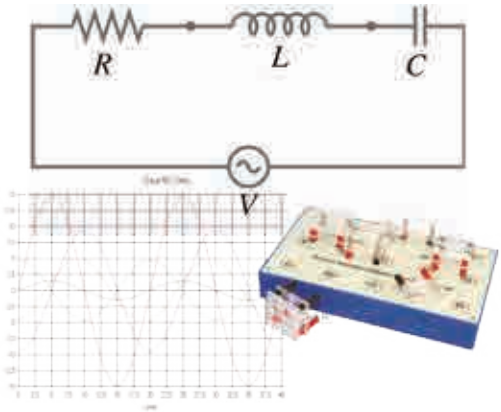
→ Kirchoff's law

At any node (junction) in an electrical circuit, the sum of currents flowing into that node is equal to the sum of currents flowing out of that node. Current is an algebraic value (positive or negative) defined with respect to wire orientation. For example, if current in an incoming wire is 3 A, this means that this wire has an outgoing current of - 3 A.

According to the node law, we obtain : i1+i2=i3+i4.

The node law is valid only if the electric field flow encircling each node remains zero or constant. It is thus not valid electrostatically.

→ RLC circuit



In electrokinetics, an RLC circuit is a linear circuit containing an electric resistor, a coil and a capacitor.

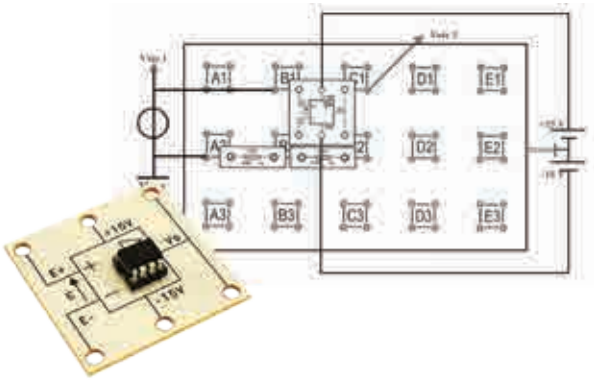
There are two RLC circuit types, serial and parallel, according to the interconnection of the three component types. Behaviour of an RLC circuit is normally described by a second order differential equation (where RL or RC circuits behave as first order circuits).

Using a signal generator, oscillations can be injected into the circuit, and, in some cases, a resonance can be observed, characterised by a current increase.

ELECTRICITY

→ Operational amplifier – Non-inverting

In this study, the operational amplifier used is considered perfect and functions in "linear mode" as it uses a feedback on the AOP inverting input. Feedback on the inverting input will allow a negative feedback : all output voltage increases will reduce AOP input differential voltage. Consequently, the voltage difference between the two amplifier inputs is kept to zero. Moreover, as input impedance is infinite, no current circulates in these inputs. Voltage Ve is thus obtained at the output of the non-charged voltage divider bridge formed by R2 and R1.



EXP 400 030 **Basic electricity laws**

Biot-Savart law

The 3-axis digital teslameter means you can now acquire the magnetic field easily. The software allows you to retrieve the field values directly on your computer, thus helping you produce your hands-on exercise reports faster. In this experiment pack, we propose a study of the Biot-Savart law via two major classics, namely the Helmholtz coil and the solenoid coil.

Necessary equipment

Reference	Designation	Quantity	Page
PAM 067 365	Digital teslameter	1	130
PAM 067 370	Helmoholtz coils	1	130
PAM 067 375	Solenoid coil	1	130
PEM 080 100	Set of 2 1-metre leads (1 red /1 black)	1	139
PMM 062 603	Simple adjustable power supply	1	154

Subjects approached

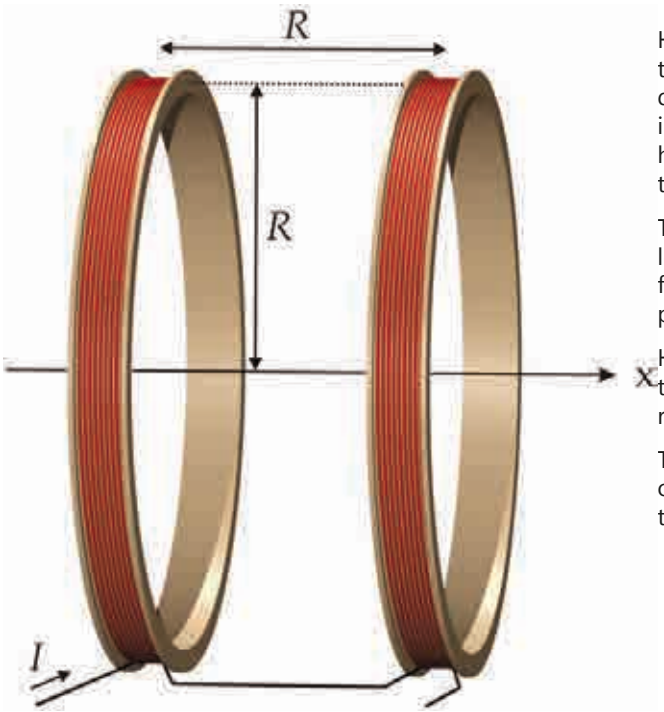
» Biot-Savart law
» Solenoid coil
» Magnetic field
» Induction
» Magnetic flux density

→ Magnetic field – Solenoid coil

A solenoid coil is a device consisting of an electric wire regularly wound spirally to form a long coil. With its current flow, it produces a magnetic field in its vicinity and particularly within the spiral where this field is virtually uniform.

The advantage of the solenoid coil is its uniformity. However, there are also drawbacks : it takes up more space than Helmholtz coils and cannot generate a high magnetic field without costly equipment and a cooling system.

→ Biot and Savart – Helmholtz coils



Helmholtz coils are a device consisting of two circular coils of the same radius, parallel, and placed opposite one another at a distance equal to their radius. Circulation of an electric current in these coils creates a magnetic field in their vicinity, which has the feature of being particularly uniform in the centre of the device in a smaller volume than the actual coils.

This coil type is frequently used in physics to create relatively low quasi-uniform magnetic fields with little equipment. It can, for example, be used to eliminate the earth's magnetic field to prevent it disrupting an experiment.

Helmholtz coils can be modelled by two combinations of n turns through which the same current I flows, with the same radii R, and separated by a distance R.

The magnetic field can be calculated, via the Biot-Savart law, on the coil axis via the field created by a coil for all points of this axis, at a distance x from its centre :

$$B_{spire}(x) = \frac{\mu_0 n I R^2}{2(R^2 + x^2)^{3/2}}$$

EXP 400 040 **Biot-Savart law**

Transformer study

This kit, designed for transformer experimental study, comprises a magnetic circuit and a series of various coils and accessories : two 250-turn coils, two 500-turn coils, one 1000-turn coil, one 135-turn coil, one 5-turn coil, one pair of poles, one hardened steel part and one soft iron part, as well as a hollow turn.

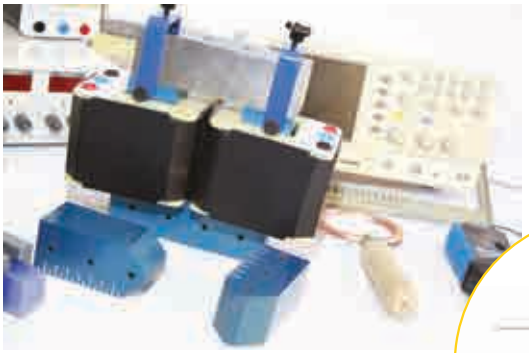
All coils are equipped with Ø 4 mm safety sockets and are covered with an insulating plastic cover preventing access to the windings.

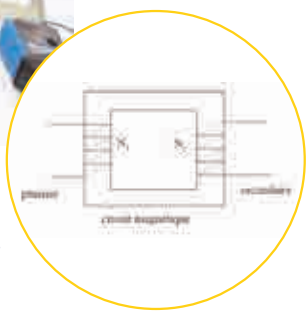
Necessary equipment

Reference	Designation	Quantity	Page
PED 021 370	Transformer study kit	1	132
PAM 067 690	Eddy current kit	1	133
PMM 062 685	5 MHz function generator	1	156
PEM 080 020	Black leads – 50 cm – Set of 10	1	139
PEM 080 021	Red leads – 50 cm – Set of 10	1	139
PMM 063 805	2 x 70 MHz digital oscilloscope	1	152
PMM 062 331	Clamp ammeter	1	162
PMM 064 000	320 W rheostat	1	138
PEM 063 700	BNC /Ø 4-mm sockets adapter	2	139

Subjects approached

» Transformer study
» Hysteresis losses
» Eddy current losses
» Joule effect losses
» Turns ratio





→ Checking the relationship between voltages at the terminals of each coil

A single-phase transformer consists of two main parts : a magnetic circuit ("iron") and two copper coils that are placed on each circuit leg. A first coil is supplied by sinusoidal voltage, and thus becomes the primary voltage. The transformer transfers the power transmitted by the primary to the secondary by magnetic induction, thus allowing the voltage at the secondary terminals to be measured. By modifying the number of primary and secondary turns, we can measure the different voltage ratios and check experimentally their equality with the ratios of the number of turns (i.e. the turns ratio).

→ Transformer loss study

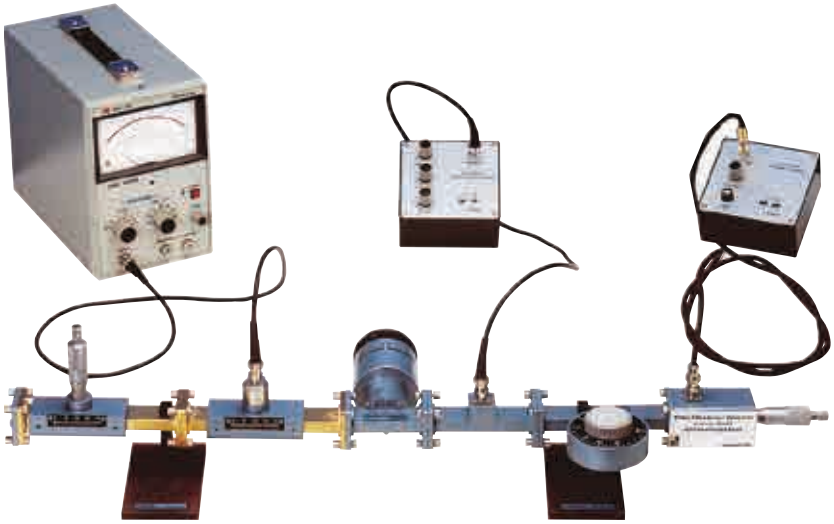
The single-phase transformer is not an ideal transformer. By connecting various loads (via a rheostat) at the secondary output, we can measure efficiency between power absorbed and power restored by the primary to the secondary. This measurement example highlights the presence of losses at transformer level. The open-circuit transformer study (i.e. no load behind the secondary) determines iron losses (due to hysteresis and eddy currents). A series of measurements can be performed by alternating the number of primary and secondary coil turns and by varying supply voltage. Based on voltage, current and phase-shift measurements (conducted by the oscilloscope and the clamp ammeter), we can calculate iron losses and show their linearity as a function of the average voltage's square root. Finally, a second study, in short-circuit this time, determines losses due to the copper winding resistances of each coil: these are the Joule effect losses.

→ Magnetism experiments

A series of accessories supplied with the single-phase transformer is used to reveal a number of physical phenomena related to magnetism. For example, by placing the hollow coil around one of the transformer legs, its overheating is observed when it is subjected to the magnetic field generated by a coil, thus proving the induction heating principle. In turn, the 5-turn coil generates high currents and proves the spot welding principle. Finally, the eddy current device shows the behaviour of material subjected to a magnetic field. Slowdown of the aluminium solid disk confirms presence of the eddy currents induced in metal materials subjected to a variable magnetic field, and forms an approach to the eddy current braking principle.

EXP 400 050 **Transformer study**

Guided electromagnetic waves training unit



EXPERIMENTS :

- *The GUN oscillator : study of one hyperfrequency source. Negative resistor operation, transmission range, characteristics...*
- *Detector & modulator : theory & operation of one PIN diode modulator and one X'tal detector.*
- *Propagation modes, wavelength & phase speed inside the wave guide : experimental study of the hyperfrequency waves propagation in free space & inside the wave guide.*
- *Resonance cavity passband : experimental checking of the relation between Q & the bandpass of a resonance cavity.*
- *Power measurement : study of the possible differences of the power measurement.*
- *Impedance measurements : determination of unknown impedances with the Smith abacus.*
- *Standing waves measurements : how to measure a stationary wave ratio with the SWRmeter or with a slot line?.*
- *Attenuation measurement : how to measure the components attenuation in a hyperfrequency system.*
- *Basic properties of a scattering coupling device : study of properties, coupling coefficient & directivity.*
- *Study of a wave guide hybrid T : basic principle, measurement method of the hybrid T characteristics.*

ÉLECTRICITÉ

CONSTITUTION :

- *Hyperfrenquency bench with Gunn oscillator, adapter with screw, slotted line*
- *Modulator fine diode*
- *Crystal support, variating damper, wave guide, adapted load, directive coupler, hybrid «T»*
- *Coaxial/Transmitte guide, horn antenna, reflector with support, guide support, supply, generator 1 kHz*

PED 022 170	**Guided electromagnetic waves training unit**

SWR meter

Standing Waves Ratio meter

- ***Input frequency :*** 1000 Hz, compatible with the microwaves system modulator, PED022170, & quadratic calibration
- ***Range :*** 70 dB by steps of 2 & 10 dB.
- ***Dimension :*** 135 x 200 x 240 mm. Weight : 2,5 kg.

PED 022 200	**SWR meter**

Power meter

- *Thermocouple based power measurement.*
- *Connectable to the microwave system, PED 022 170, by the coaxial adapter provided together with the system.*

PED 022 180	**Power meter**

Study of micro-waves

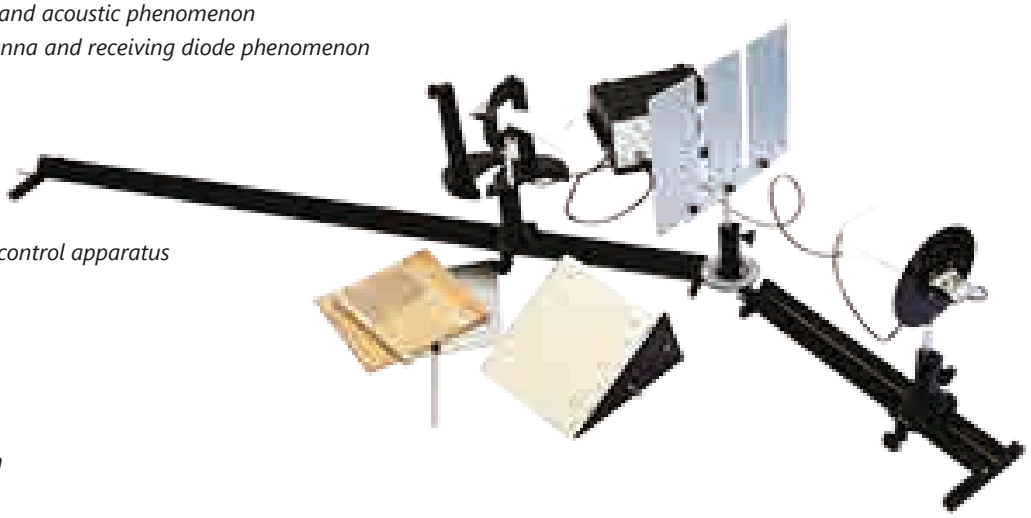
Set for study of the micro-waves in air propagation, allowing a wide range of experiments on the electromagnetic waves.
Direction-finding, diffraction, interference experiments, for micro-waves (λ=26mm).

EXPERIMENTS :

- *Wave's propagation and reflection*
- *Prism study, angle of deflection, refractive index*
- *Diffraction by a slot*
- *Interference and diffraction by a double slot or an grating*
- *Polarization : Malus law, polarization by a reflector*
- *Antenna pattern*
- *Comparison with optical and acoustic phenomenon*
- *Study of transmitter, antenna and receiving diode phenomenon*

CONSTITUTION :

- *Transmitter*
- *Receiver*
- *Antenna*
- *Power supply and signal control apparatus*
- *Bench*
- *Goniometric joint*
- *Adjustable single slot*
- *Adjustable multiple slot*
- *Grating*
- *Absorbent wooden screen*
- *Metallic reflective screen*
- *Paraffin prism, on rod*



PED 022 150	**Study of micro-waves**

ÉLECTRICITÉ

CHARACTERISTICS :

- **Transmitter**

Gunn diode located in a resonating cavity.
Pre-adjusted tuning in our workshop by accurate positioning of closing piston.
Polarized wave

- **Receveir**

Hyperfrequency reception diode, the diode also located inside resonating cavity. Generated voltage signal, proportional to the received hyperfrequency power. Rotating assembly for the polarization study (degree graduation).

- **Detection antenna**

Hyperfrequency reception diode
The stand is specially designed in order to be located outside of the field

- **Electonic box**

Direct reading of the measure with the digital display.

Retails :

Detection kit :

- *Transmitter*
- *Receiver*
- *Detection antenna*
- *Electronic box*

PED 022 160	**Detection kit**

Mechanical set :

PED 022 161	**Mechanical set**

Prisme paraffine :

PED 022 162	**Paraffin prism**

Chopper, 1-phase inverter, ELV, 150 W

CHARACTERISTICS

Equipment :

- *Power supply (acceptable): 10 VDC to 48 Vdc*
- *Max peak current: 10 A*
- *Customizable acceleration ramp*
- *Adjustable duty cycle, 0 to 100 %*

Control and Acquisition Software :

- *It allows the control of the power bridge via USB*
- *The student creates its diagram, positions the visualisation probes, adjust the operating parameters such as frequency, duty cycle, modulating frequency for the inverter ...*
- *It includes a library with necessary functions and measuring tools*

> TOPICS :

Choppers :

- *Serial,*
- *Tension reversible*
- *Current reversible*
- *4 quadrants*
- *over-fitted double serial.*
- *0 +E 0 / 0 –E 0*

1-phase inverter :

- *shift control full wave with fixed frequency*
- *shift control full wave with variable frequency,*
- *+E/-E PWM , +E/0/-E PWM ,*
- *constant U/F ratio.*

EP 210 B	**Chopper, 1-phase inverter, ELV, 150 W**

ÉLECTRICITÉ

ELV load bench, DC motor and generator

CHARACTERISTICS :

Mechanical characteristics :

- *Diameter : 40 mm*
- *Length : 65 mm*
- *Autolubricating bearings*
- *Max mechanical power : 29.3 W*
- *Speed : 4812 rpm at 25.5 mNm ; 2750 rpm at 102 mNm*

Electrical characteristics :

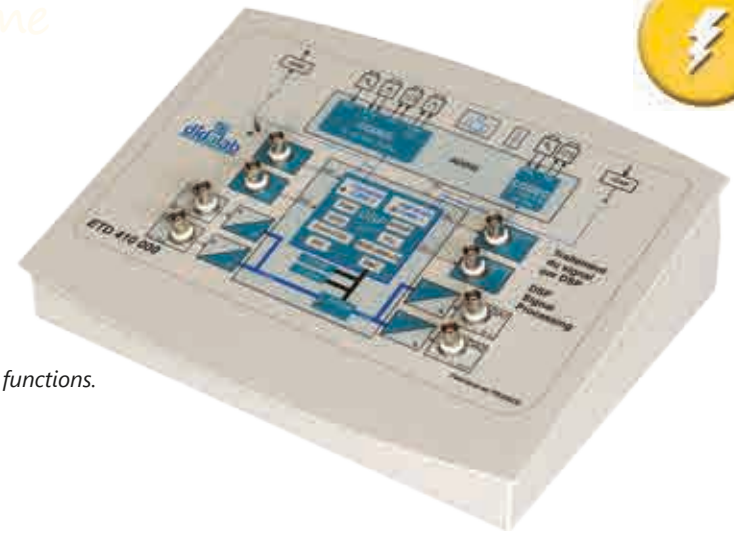
- *Operating voltage : 24 Vdc*
- *Power : 12.85 W with max efficiency (76.5%)*
- *60 W with 49% efficiency*
- *500 pts/turn coder withBNC outputs for the visualization of ChA and Chb channels*

The bench can be supplied with a speed measuring optional extra (EPD037620)
It measures, with a 2 lines ASCII display and a image analog output,
- Speed
- Position
- Current, Voltage, average power*

Energy balance, characterization of an electrical motor (electrical energy, mechanical energy, efficiency
Speed measurement can be used in order to make servo control practical works.

EPD 037 580	**ELV load bench, DC motor and generator**

Signal Processing in Real Time



STRENGTHS :

- *Very ergonomic, handling in a few minutes.*
- *A/D inputs, 16 bits 1 Mechs, +/- 10Vdc*
- *D/A outputs, 12 bits 100 kech/s, +/- 10Vdc*
- *Programmation with graphical functional blocks .*
- *Real Time virtual oscilloscope,32 channels*
- *More than 500 functions supplied*
- *Opportunity to enrich the catalog by creating your own functions.*

CHARACTERISTICS :

EQUIPMENT :

- *DSP processor, dual core,*
- *Computing power : 2 x 200 MIPS,*
- *A/D Inputs,16 bits 1 MS/s, On/Off, 3.3V,*
- *D/A Outputs, 12 bits 100 kS/s, On/Off, 3.3V*
- *Audio CODEC, 24 bits*
- *USB connection*

PROGRAM :

- *FibulaG : Graphical editor and compiler*
- *More than 500 macro funcitions supplied in the standard library,*
- *Opportunity to create your own library,*
- *Operates with Windows environment (XP or more recent (Pro versions))*

> TOPICS

- ***Signal theory.*** *(Sampling, quantification, FFT, IIR or FIR filters, random process, etc.)*
- ***Introduction to analogue transmissions.*** *(AM, FM, spectral analysis)*
- ***Introduction to digital transmissions*** *(Base band, ASK, PSK, QAM, modulations, multiplexing, etc.)*
- ***Information theory and Coding*** *(Channel coding, FEC, BER measurement, information flow, etc)*

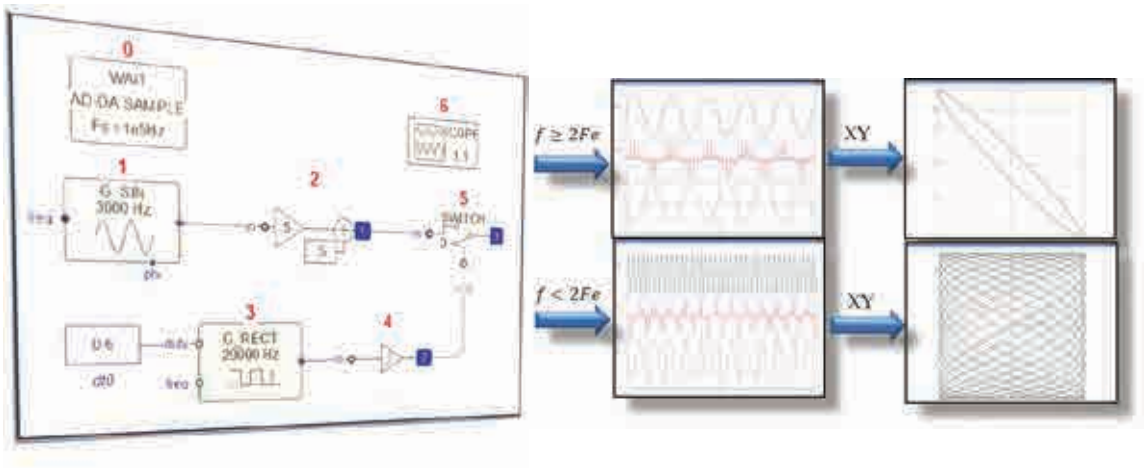
MAIN FUNCTIONS :

- *8-channels virtual oscilloscope, XY mode, constellation, FFT...*
- *LF function generator, sine square, triangle, IQ, Gaussian noise generator...*
- *Signal theory. (Sampling, quantification, FFT, IIR or FIR filters, random process, etc.,)*
- *Introduction to analogue transmissions (AM, FM)*
- *Introduction to digital transmissions (Base band, ASK, PSK, QAM, OFDM)*
- *Information theory and Coding (Channel coding, FEC, BER measurement, information flow, etc)*
- *Bode's diagram drawing for a filter or a frequency sweep servo system and signal analysis,*
- *Idem for Nyquist, Bode...*

ETD 410 000 **Signal Processing in Real Time**

ÉLECTRICITÉ

> Example : Shannon's Theorem



Digital Teslameter

The Teslameter permits the detection and the measurement of magnetic field from 0.1 mT to 200mT (or negative values, field usually created by 2 to 10A current).

- *Simultaneous measures of Bx, By, Bz*
- *Steel Ergonomic case, minimal congestion*
- *Triaxial and graduated sensor,*
- *Three protected sensors*
- *2 ranges of measure : -20mT to 20mT, -200mT to 200mT*
- *Digital output for acquisitions*

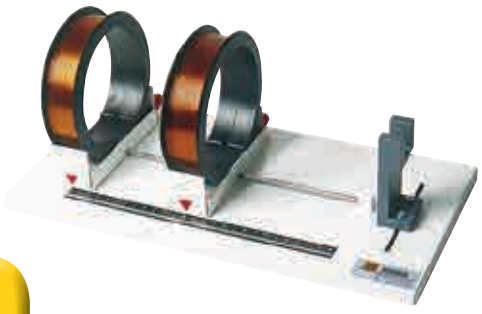
The Teslameter is composed of an acquisition box and a triaxial sensor allowing the measure along 3 axis : Bx, By, Bz, thanks to 3 Hall effect sensors.

SPECIFICATIONS :

- *Output signal : minimal sensitivity : 20mT range, 0.5% sensitivity ; 200mT range, 0.5% sensitivity.*
- *Bandwidth : from 0 to 100 Hz (at -3dB)*
- *Connexion : HDMI for the sensor, USB for the computer*
- *Software suitable for Windows with data exportation (Text, Excel, Regressi)*

PAM 067 365	**Digital Teslameter**

Helmotz Coils



Two adjustable-gap coils are mounted on a 400 x 200mm common base. One of the two coils is fixed, the other one can be moved. The gap can be measured on a 250 mm graduated rule.

COIL'S CHARACTERISTICS :

- *Enamelled wire 13/10- 100 turns on 4 layers*
- *Maximal current : 5A*
- *Output on safety connectors ⦰4mm with polaritys location*
- *Coil width : 34mm*
- *Average diameter of windings : 125mm*

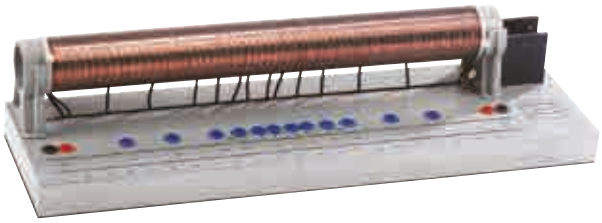
PAM 067 370	**Helmotz Coils**

⦰50mm Solenoid

Study of the electromagnetic induction and the magnetic field variation according to the current and the number of turns.

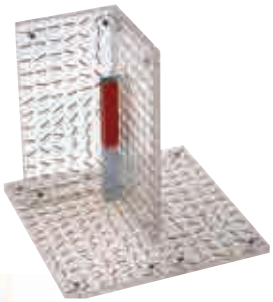
CHARACTERISTICS :

- *Double wrap on 400mm of insulated wire.*
- *⦰4mm sockets at 5, 10, 20, 30,50,70 and 100 wraps on both sides of the center*
- *Maximal generating conditions : 6V-7A*



PAM 067 375	**⦰50mm Solenoid**

Magnetic spectrum for overhead projection



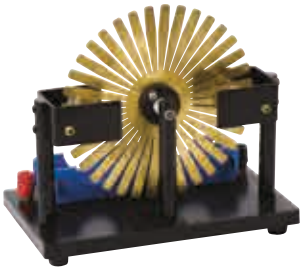
Simple apparatus enabling the underscoring of the lines of force of the magnetic field in 1, 2 or 3 dimensions :
The apparatus includes 4 plastic plates containing in total, 376 small magnetic bars, 8 mm long.
Each plate can be used either separately or coupled to the others.
Plate dimensions : 153 x 77 x 6 mm

PAM 067 480	**Magnetic spectrum for overhead projection**
PED 039 040	**Straigth magnet**

Rails for Laplace's law

Motion of a conductor crossed by a current inside magnetic field.
Current generation inside a conductor moving along anon-uniform magnetic fi eld.
It is constituted of of two conducting rails fi tted between two plates & one brass mobile conductor. It must be completed by one or two "U"-shaped magnets.
The apparatus can be displayed with a light source.
Requested current : 2 / 3 Amp.

PED 039 201	**Rails for Laplace's law**



Barlow's wheel

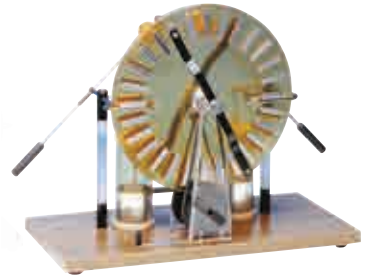
The electromagnetic force, generated by the action of a permanent magnet on the current crossing radially the wheel, starts up the wheel rotation. PVC stand.
The current crossing is ensured by one soft brushes system.
Ferrite strong magnet.
Red copper disk, Ø : 150 mm - Dimension : 200 x 125 x 180 mm - Weight : 1 kg

PED 025 525	**Barlow's wheel**

Wimshurt Machine

CHARACTERISTICS :

- *Disc size : ⌀340 mm*
- *Base size : 550x220mm*
- *Weight : 6,5kg*



PAM 065 015	**Wimshurt Machine**

Van de Graaf generator

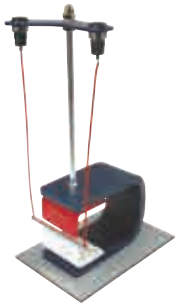
A Van de Graaf generator creates high dc voltage with very low current.
It allows a big number of experiments in electrostatics.
Constitution : Ø 25-cm hollow sphere.
It generates voltage up to 300 kV with electric sparks up to 12 cm
Supplied with spherical device with negative charges, used to discharge the main sphere.
Gross dim : 375 x 230 x 760 mm
Weight : 3,6 kg.

PAM 065 200	**Van de Graaf generator**

Electroscope

For the demonstration of electrostatic potentials.
Supplied with a charging ball and a set of condenser plates with insulated rod

PED 038 681	**Electroscope**



Effect of magnetic field on current

This apparatus shows the motion of a conductor inside a magnetic field
Dimensions : 160 x 100 x 270 mm ; weight : 2.5 kg

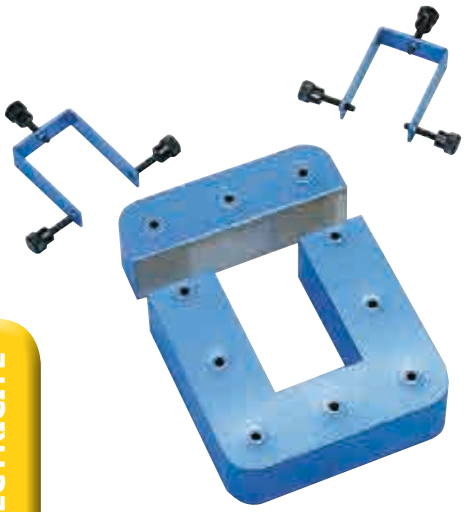
PED 025 500	**Effect of magnetic field on current**
PED 039 070	**Magnet with frame**

Study of the transformer

This set allows an experimental study of the transformers.

Reference	Designation	Quantity
PED 213 730	Magnetic circuit	1
PED 213 724	Pair of poles	1
PED 213 741	250-turns coil	2
PED 213 742	500-turns coil	2
PED 213 743	1000-turns coil	1
PED 213 745	135-turns coil	1
PED 213 726	Soft iron component	1
PED 213 727	Tempered steel component	1
PAM 067 590	5-turns coil	1
PAM 067 580	Fusion ring	1

PED 021 370 **Study of the transformer**



Single phase magnetic circuit

CONSTITUTION :

- *An "U"-shaped device*
- *A removable part for the system's closure*
- *High permeability Iron*
- *43 x 43 mm section*

200 W power capacity
Height : 190 mm - Width : 150 mm - Weight : about 7,5 kg

PED 213 730 **Single phase magnetic circuit**

ÉLECTRICITÉ

Coils

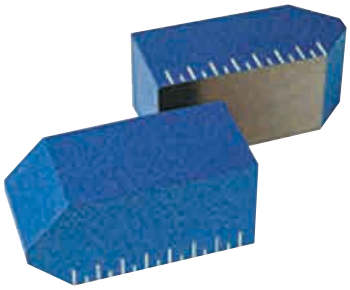
Coils equipped of safety sockets & fully protected with plastic insulating carter (electrical safety device).

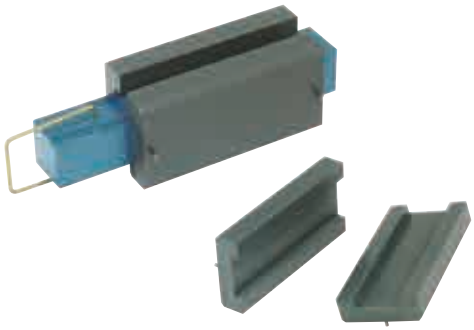
	Nb of turns	Wire's diam	Nb of sockets	Average R (Ohms)	Self	I max.
PED 213 741	250	16/10	3 0-125-250	0,6	5 mH	12 A
PED 213 742	500	10/10	3 0-250-500	2,8	18 mH	4,5 A
PED 213 743	1 000	8/10	3 0-500-1000	8,7	45 mH	2,5 A
PED 213 739	2 000	55/100	3 0-1000-2000	36	300 mH	1,5 A
PED 213 738	5 000	35/100	4 0-1000-3000 5000	200	1 H	0,6 A
PED 213 745	135	22/10	5 18-54-36-27			20 A

Pairs of poles

Laminated sheet metal poles, square section on one side, prismatic truncated shaped section on the other side, in order to concentrate the field.
The poles are fitted by stirrups on magnetic circuit
Side graduation for symmetrical assembly.
Weight : 2.5 kg

PED 213 724	**Pairs of poles**





Soft iron and Tempered iron components

Enabling the construction of a straight electromagnet.
Supplied with insulating wedges for coil adaptation.
The soft iron component has a "D" mark. The tempered iron component has a "T" mark.
Dimension : 150 x 24 x 24 mm - Weight : 850 g

PED 213 726	**Soft iron**
PED 213 727	**Tempered iron**
PED 213 728	**Set of blocks**

Straigt component

Laminated sheet metal. Core shaped, to be used with coils.
This core has, at one end, one slot for enabling the Frager turn adaptation.
Dimension : 150 x 45 x 45 mm - Weight : 2.2 kg

PED 213 722	**Straigt component**

Eddy Current kit

This removable transformer's accessory reveals the braking produced by induced Eddy Current. The set is composed of : An aluminium pendulum (200X700mm with slots), a ⌀106mm aluminium disk and a fixing device on the magnetic circuit

PAM 067 690	**Eddy Current kit**

5 turns coil

Study of spot welding
5 turns copper wire coil with pliers to be used with magnetic circuit & 1000 or 500 turns coil.
Enabling spot welding of two steel sheets up to 0.2mm thick.

PAM 067 590	**5 turns coil**

Melting ring (lead and tin)

Study of induction oven principle.
Red copper hollow turn with insulating handle to be used with magnetic circuit & coil, 1000 or 500 turns.

PAM 067 580	**Melting ring**

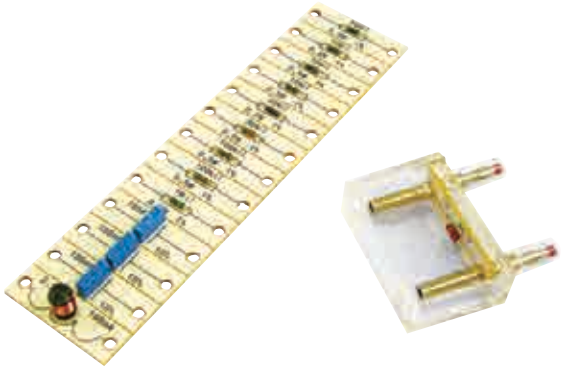
Kit for DC (Direct Current)

Constitution : 13 components *(100, 220, 470, 2 x 1000, 2 x 2000 ohms resistances, diode, Zener diode, VDR variable resistance, photo resistance, red LED, Incandescent light bulb).*

This assembly kit is supplied with 16 bipolar staples. Thus, you have 3 free staples to set your own components.

Deck to order separately (ref PEM015600).

PEM 015 701	**Kit for DC (Direct Current)**



Kit for AC (Alternative Current)

Constitution : 13 components *(4 x 10k, 20k, 30k, 2 x 100k, 1 Mohms resistances, 10 nF, 2 x 100 nF capacitors, 2,2 mH self)*

This assembly kit is supplied with 16 bipolar staples. Thus, you have 3 free staples to set your own components.

Deck to order separately (ref PEM015600).

PEM 015 721	**Kit for AC (Alternative Current)**

Universal deck

These decks answer the strictest security standards (IP2X).
They are designed to realize in a economic way all the experiments in electricity and fundamental electronics, (from secondary school to higher education).

Deck provided with 60 Ø 4-mm safety sockets.

These sockets are grouped in matrix of 5 by 3 equipotential blocks.

Path : 38 mm

Gross dim : 205 x 175 x 42 mm.

PEM 015 600	**Universal deck**

Bipolar staples

Transparent bipolar staples, with 2 male sockets for setting on the PEM 015 600 deck and 2 upward female sockets for stackable settings.

Path : 38 mm

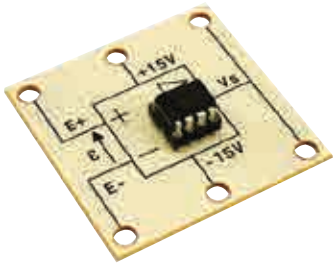
Supplied as self-assembly kits.

PEM 015 621	**Set of 4 staples**
PEM 015 630	**Set of 12 component-holders**

Quadripolar staple

Transparent quadripolar staple.
Supplied as self-assembly kits.

PEM 015 641	**Quadripolar staple**



Operational amplifier

TL081 amplifier.
Can be used in many experiments explaining operational amplifiersbehavior.
Socket for the ± 15 V symmetrical power supply, 2 output sockets, 1 socket for each input.

PEM 015 760	**Operational amplifier**

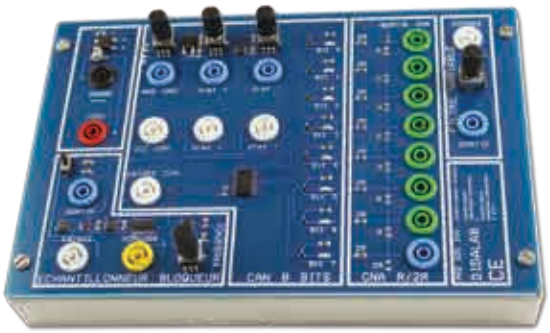
DAC/ADC Circuit

This model explains the Digital Analogue Conversion with R/2R networks, and Analogue Digital Conversion with Sample & Hold component.
With this module you can :

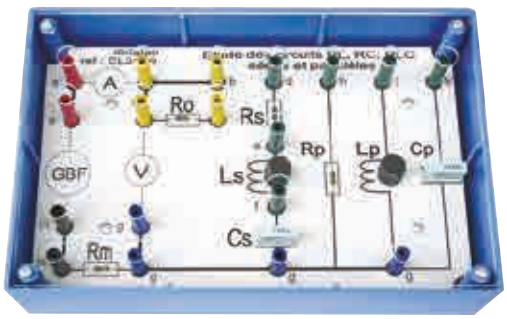
- **Implement a experimental protocol with a Sample & Hold component**
- **Understand of Caliber, Sampling, Resolution**
- **Study the parameters of signal digitalization.**

CHARACTERISTICS :

- *8 bits ADC*
- *Sample & Hold*
- *8 bits DAC*
- *R/2R setting*
- *12 V caliber*



PED 025 250	**DAC/ADC Circuit**



RLC circuit

Compact model for the study of serial and parallel RLC circuits with minimum connections.

A transparent screen protects the circuit.

PED 025 300	**RLC circuit**

Adjustable self, iron core

Adjustable self, graduated (Henry and cm), with Ø4-mm security sockets.
Inductance : slowly adjustable 0.1 to 1.4 H
Resistance : 10 Ohm – Max permanent current : 2 A
Max overvoltage : x22
Dim : 280 x 150 x 90 mm – Weight 6.5 kg.

PMM 064 300	**Adjustable self, iron core**

Power supply 6/12V - 5A

Electronically stabilzed power supply.
Outputs: 6 or 12 V AC or DC
Max current: 5 A

- *Protections : bimetalic strip protection on the AC output and current limitation électronique on the DD output ; fuse for the input*
- *DC outputs : 6 V (± 3 %) and 12 V (± 3 %).*
- *Ondultation : < à 100 mV pp on 6 V and 200 mV pp on 12 V.*
- *Weight : 3 kg*
- *Mains 230 V/50 Hz.*

PMM 062 150	**Power supply 6/12V - 5A**

Power supply 6/12V - 1A

2 DC outputs :

- Fixed output with fi xed output : -15/0/+15 V with middle point.
- Variable output 12/0/+12 V.
- Imax. : 1 A to be shared between the 2 outputs.
- Electronic stabilization and protection.
- Mains 230 V/50 Hz.
- Voltage drop while in load : 50 mV on the «variable voltage» output, ripple : 5 mV.
- Input : «Controlled voltage» (green 4-mm safety socket) allows the use of this power supply as a current amplifier.

PMM 062 190	**Power supply 6/12V - 1A**

Multiple voltages regulated power supply

- PRECISE : *Switching power supply offering a ripple < 3mV rms.*
- UNIVERSAL : *12 settings in 2V steps with + 1V adjustement range.*
- PRACTICAL : *ON/OFF switch, charger position and status indicators.*
- PROTECTED : *Against short circuits and reverse polarity.*

5 to 29V
2,5A to 24V
3,5A to 12V
4A to 5V
and charger 12 ou 24V

60 WATTS

PMM 062 470	**Multiple voltages regulated power supply**

Multiple-output power supply

- COMPLETE : *DC and AC voltages avaible simultaneously*
- PRACTICLE : *No common reference*
- PROTECTED : *The DC output is protected by fold-back current limiting. The AC outputs are protected by auto-reset thermal circuit-breakers.*

6 or 12V / 10A
or 24V / 5A

120 WATTS

RVD 000 042	**Multiple-output power supply**

Multiple-output power supply

- COMPLETE : *DC and AC voltages avaible simultaneously*
- PRACTICLE : *No common reference*
  AC and DC power-on indicators.
- PROTECTED : *The DC output is protected by current regulation. The AC outputs are protected by auto-reset thermal circuit-breakers.*

6 or 12V / 5A
EN = ET ~

120 WATTS

PMM 062 185	**Multiple-output power supply**

Universal Power supply

- UNIVERSAL : Choice of six voltages.
- PRACTICAL : ON/OFF switch.
  Power-on indicator.
- PROTECTED : Short circuit protection.
- RESISTANT TO SHOCK : Polycarbonate caseAL841B's REPLACEMENT

3V / 4,5V / 6V / 7,5V / 9V / 12V
1A

Power : 12 Watts

PMM 062 210	**Universal Power supply**

Multiple balanced output power supply - 30 Watts

- PRATICAL : ON/OFF switch.
  Power-on indicator.
- PRECISE : Output ripple < 3mV rms.
  Output voltage adjustable from ±10 to ±15V.
- PROTECTED : against Short circuit.

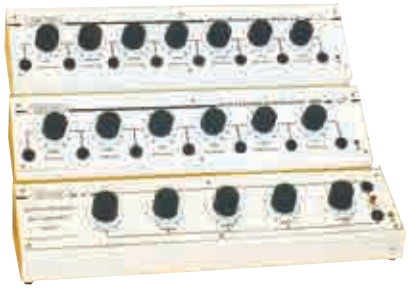
± 15V (Aj. ±10 à ±15V) 1 A
or 24V 1A
or 12V 2.5A

Balanced output voltage adjustable

PMM 062 180	**Multiple balanced output power supply - 30 Watts**

Decade Box

Output of each decade on safety socket.
Robust switches with metal frame and gold-plated contacts.
(contact resistance< 6 mOhms).
Max power rating : 0,5W.
Weight : between 1 and 1,35 kg.



			Multiplier in Ohms							
Reference	**Weight**	**Decades**	**1**	**10**	**100**	**1 K**	**10 K**	**100 k**	**1 M**	**Total Resistance**
PMM 064 610	1	4	X	X	X	X				11,110 KOhms
PMM 064 620	1,4	5	X	X	X	X	X			111,110 KOhms
PMM 064 630	1,44	6	X	X	X	X	X	X		1 111,110 KOhms
PMM 064 640	1,52	7	X	X	X	X	X	X	X	11,111 110 MOhms
Max current			700 mA	200 mA	70 mA	20 mA	7 mA	2 mA	0,7 mA	

Reference	Description	Min. value	Max value.	Accuracy
PMM 064 650	**5 decade capacitance box**	**100 pF**	**11,111 µF**	**+/- 1%**
PMM 064 660	**7 decade inductance box**	**1 µH**	**11,11111 H**	**+/- 5%**

ÉLECTRICITÉ

Rheostats

Please, ask for other values.

			Current (A at 23°C)		
Reference	**Power**	**Resistance (Ohms)**	**Permanent**	**During 15 min**	**During 4 min**
PMM 064 900	160 W	1	13	15	18
PMM 064 790		33	2,2	3,1	4,2
PMM 064 800		100	1,25	1,8	2,4
PMM 064 810		330	0,70	1	1,3
PMM 064 820		1000	0,4	0,57	0,75
PMM 064 830		3300	0,22	0,31	0,42
PMM 064 000	320 W	10	5,7	8	11,4
PMM 064 010		33	3,1	4,4	6,2
PMM 064 040		1000	0,57	0,8	1,14
PMM 064 730	640 W	165	2	2,8	3,7
PMM 064 680	960 W	110	3	3,6	4,2

Autotransformers

- Mains power supply :2P+T
- Output : 3 Ø 4-mm security sockets (earth socket)

CHARACTERISTICS :

- CEI1010-1 and CEM norms
- Handles for easy carrying
- *Rubberfoot skid*
- *Easy storage (stackable)*

Reference	Primary voltage	Secondary voltage	Secondary Intensity	Power	Dimensions	Weight
PMM 062 011	220 V	0 - 250 V	5 A	1,25	227 x 186 x 216	8
PMM 062 021	220 V	0 - 250 V	9 A	2,16	227 x 186 x 216	10,5

Security leads

All the following leads answer to EN61010 norm.

Vendu par lot de 10.

- Section 1 mm² - Imax = 20 A - Vmax = 1000 V (stackable)

Longueur	Black	Red	Blue
10 cm	PEM 080 000	PEM 080 001	PEM 080 002
25 cm	PEM 080 010	PEM 080 011	PEM 080 012
50 cm	PEM 080 020	PEM 080 021	PEM 080 022
100 cm	PEM 080 030	PEM 080 031	PEM 080 032

- Section 2,5 mm² - Imax = 36 A - Vmax = 1000 V (stackable)

Longueur	Black	Red	Blue
25 cm	PEM 080 050	PEM 080 051	PEM 080 052
50 cm	PEM 080 060	PEM 080 061	PEM 080 062
100 cm	PEM 080 070	PEM 080 071	PEM 080 072

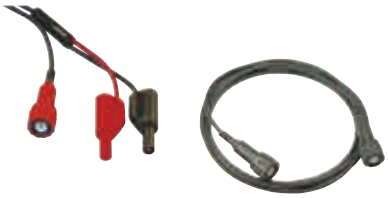
BNC "T" adapter, insulated

Derivation T, insulated : 1 male BNC / 2 female
Max voltage : 500 V - Set of 2.

PEM 063 960	**BNC "T" adapter, insulated**
PEM 063 961	**2 male/1 female «T» adapator**

BNC leads

CEI 1010 insulated.



PEM 010 021	**Black BNC lead, male/male ; 1 m ; 50 Ohm**
PEM 010 180	**Black BNC/2xØ 4 mm lead,; 1 m ; 50 Ohm**

Insulated crocodile clips

PEM 063 760	**Red, set of 10**
PEM 063 770	**Black, set of 10**

BNC/Ø 4-mm sockets adapter

BNC/2 Ø 4-mm sockets adapter, insulated.

PEM 063 700	**BNC/Ø 4-mm sockets adapter**

ÉLECTRICITÉ

Digital Teslameter

The Teslameter permits the detection and the measurement of magnetic field from 0.1 mT to 200mT (or negative values, field usually created by 2 to 10A current).

- *Simultaneous measures of Bx, By, Bz*
- *Steel Ergonomic case, minimal congestion*
- *Triaxial and graduated sensor,*
- *Three protected sensors*
- *2 ranges of measure: -20mT to 20mT, -200mT to 200mT*
- *Digital output for acquisitions*

The Teslameter is composed of an acquisition box and a triaxial sensor allowing the measure along 3 axis : Bx, By, Bz, thanks to 3 Hall effect sensors.

SPECIFICATIONS :

- *Output signal : minimal sensitivity : 20mT range : 0.5% sensitivity, 200mT range, 0.5% sensitivity.*
- *Bandwidth : from 0 to 100 Hz (at -3dB)*
- *Connexion : HDMI for the sensor, USB for the computer*
- *Software suitable for Windows with data exportation (Text, Excel, Regressi)*

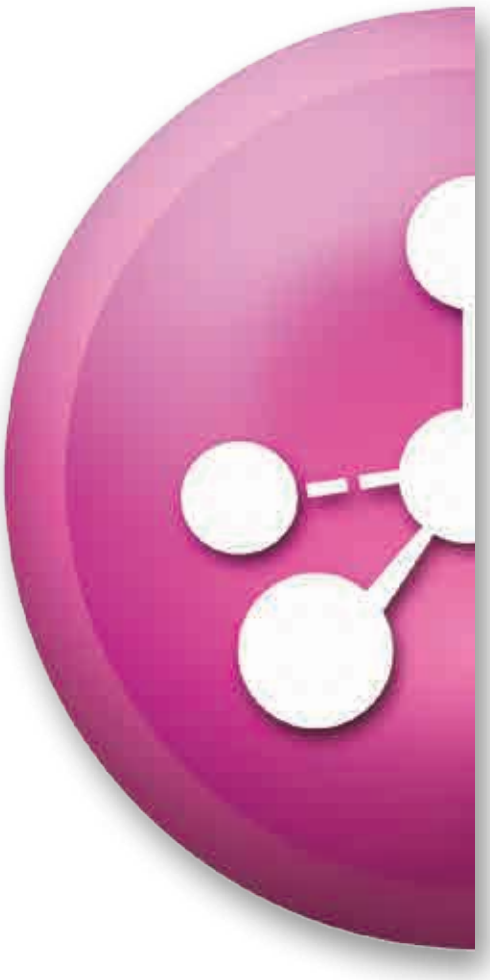
PAM 067 365	**Digital Teslameter**

DIDALAB IS NOW ISO9001 CERTIFIED.

Didalab has always been very concerned with its customer satisfaction and the quality of its products.

Thus, we ‘ve been ISO certified in July 2012.

Matter Physics



Experiments

Millikan's oil drop experiment

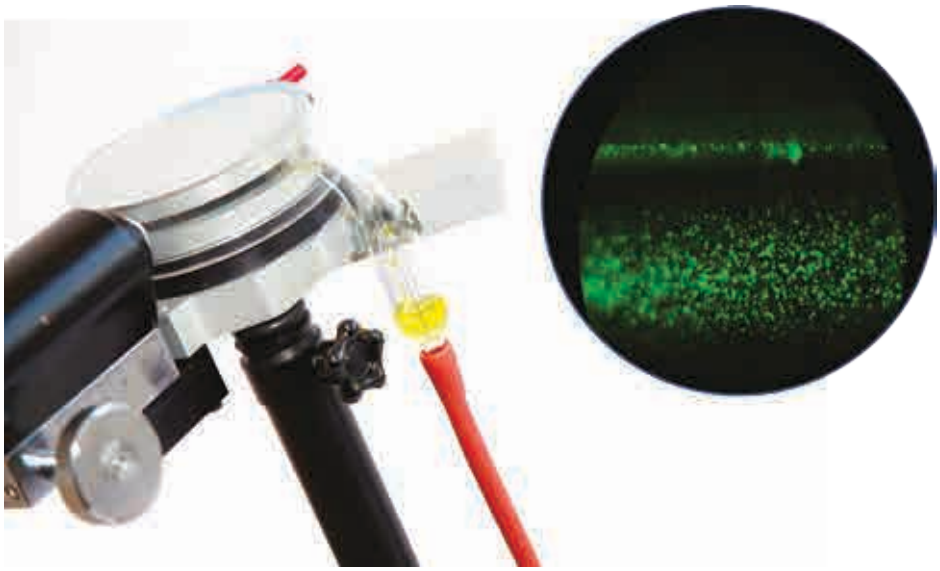
This experiment aims at repeating, in a simplified manner, the historical experiment by which Millikan in 1909 determined the exact value of the electron charge "e". It consists of studying the motion of a charged oil drop, subjected to the electric field of a parallel-plate capacitor, a white light source and a sighting device. This comprehensive pack is made up of several parts: a white light source and a sighting device, a mechanical/optical part, as well as a laser and a webcam allowing real-time observation of the phenomenon directly on your computer.

Necessary equipment

Reference	Designation	Quantity	Page
PSD 022 040	Millikan device	1	148
PSD 022 060	Millikan generator	1	148
POD 010 030	Didactic Webcam	1	172
POD 013 132	Green laser diode	1	78

Subjects approached

» Measuring electron electric charge
» Demonstrating electron quantum nature
» Implementing a sighting device
» Didactic observation on webcam



→ Determining electron electric charge

With an atomiser, spray oil drops in a capacitor made of two light alloy plates. As they pass through two small holes drilled in the plastic holder of the capacitor, some drops will be charged by electrostatic friction.

Once they have penetrated between the two flat capacitor plates, these oil drops are observed through a sighting device. The latter is equipped with a long focus lens to single out the oil drops falling along the capacitor axis and standing out as shiny dots against a dark background. Its eyepiece is engraved to a tenth of a millimetre.

A webcam supplied with a dedicated software, directly placed behind the sighting device, allows real-time display of the phenomenon on the computer.

The pack is secured to a base by a telescopic rod designed to set the sighting device at a height suitable for the user. First, we spray oil drops without charging the capacitor plates. Then, once the vortex motion has ceased, we apply a voltage to the capacitor terminals and identify the drop or drops that are blocked by this field (these are the ionised drops).

The voltage ensuring complete immobilisation of the drop is read. Voltage is cut, and at the same time the chronometer (integrated in the Millikan generator) is triggered. The time required by the drop to cross a certain number of micrometer graduations is measured.

Oil drop electric charge is determined by calculating its fall velocity. We observe that, according to oil drop size and velocity, this is always a multiple of the electric charge e, the elementary electron charge.

EXP 500 010 Millikan's oil drop experiment

Zeeman effect

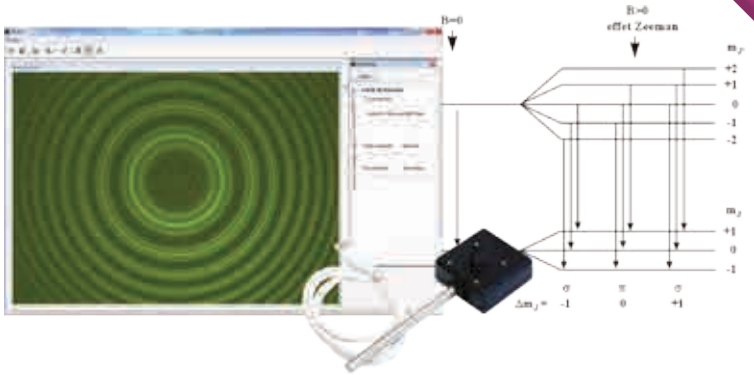
At the root of the Zeemen effect is the subdivision of the energy levels of atoms and molecules plunged into a magnetic field. According to conditions, the spectral lines are divided into an odd number (the effect is said to be "normal") or an even number (the effect is said to be "abnormal") of components. This phenomenon is visible to the naked eye or from a computer screen via the didactic webcam provided in this pack.

Necessary equipment

Reference	Designation	Quantity	Page
POD 013 550	Zeeman effect pack	1	149
POF 010 112	1 metre optical bench	1	76
POF 010 124	Standard optical rider	6	76
POD 061 250	Dual condenser	1	85
POD 060 410	Iris diaphragm	1	85
POF 020 210	Fabry Pérot etalon	1	97
POM 052 025	Green plastic filter	1	172
POD 060 230	Slide holder	1	84
POD 010 030	Didactic webcam	1	172
POF 010 815	PENTAX fixed focal-length lens	1	169
POF 010 820	Ring for PENTAX lens	1	169

Subjects approached

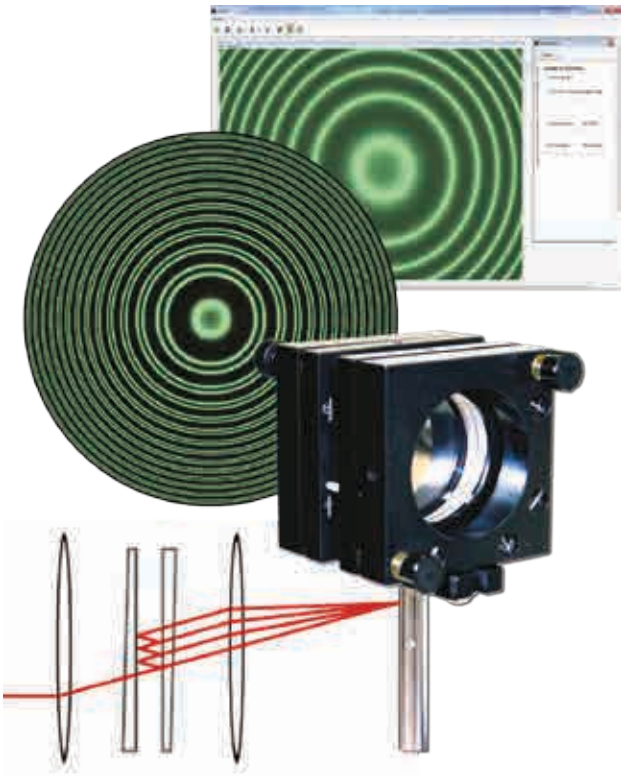
» Bohr atomic model
» Normal and Abnormal effect
» Fabry Pérot
» Spinning electron



→ Normal effect

To observe the Normal effect, we use the mercury lamp with a green filter to select the spectrum and observe only the 546 nm line of mercury leaving the Zeeman box containing the coils and the spectral source. We thus observe our source outside the magnetic field axis, perpendicular to it. We place first a diaphragm, then a condenser. We then place, behind them, the Fabry-Péror etalon, previously adjusted, and finally our green filter just before placing our CCD sensor. For this exercise, we will not use the sensor lens but a camera lens, to ensure better image quality. We then plug in the power supply and increase slowly the current until we observe the rings that are divided into three. To observe the abnormal effect, we position ourselves in the magnetic field axis without using the diaphragm.

→ Fabry Perot study - Fineness



To be able to separate the different rings more efficiently, we need to have them as thin as possible. This is equivalent to refining the peaks in the previous curve, i.e. reduce Δλ with respect to δλ. Thus, a good quality interferometer will exhibit a far lower Δλ than δλ.

For simplicity's sake, we will use the following value, known as fineness :

$$F = \frac{\delta\lambda}{\Delta\lambda}$$

The greater the fineness, the finer the rings. To increase fineness, the surfaces making up the cavity can be made highly reflective. Indeed, we can show that fineness increases at the same time as the surface reflection coefficient.

Consequently, Fabry-Perot interferometers can have finenesses of a few dozens or a few hundreds. In research, this can even attain a few hundred thousands.

This high degree of fineness is a major asset of this type of interferometers with respect to Michelson's interferometer, which has a fineness of 2.

Fineness can be linked to photon lifetime in the cavity and to the free spectral range in FSR frequency :

$$F = 2\pi N$$

Thus, the number of oscillations N carried out by light in the cavity increases at the same time as fineness :

$$F = 2\pi\tau FSL$$

EXP 500 030 Zeeman effect

Demonstrating Planck's constant

Highlighting the photoelectric effect, emission of electrons by a metal material when the latter is exposed to electromagnetic radiation of a sufficiently high frequency, is a means of approaching and better understanding the particulate aspect of light. The experiment proposed, using our photoelectric cell, a HP mercury spectral lamp and a micro-ammeter, aims at showing the photoelectric effect, verifying Einstein's equation and experimentally measuring Planck's constant. To do this, the photoelectric cell, with a spectral range from approx. 340 to 700 nm, is installed in a metal box ensuring its light insulation and safety. A drum secured on the front of this box allows a variety of filters and diaphragms to be placed in front of the cell to perform a set of measurements. Last but not least, one device only is used to supply both the cell anode and cathode with two voltage ranges (-2/2 V and -2/30 V) and as micro- ammeters to measure photo-current (with a number of measurement ranges: 10-8 to 10-13 A).

Necessary equipment

Reference	Designation	Quantity	Page
POD 068 951	Planck's constant	1	150
POD 010 057	LP Mercury lamp	1	166
POD 010 056	Stand for spectral lamp	1	166
POD 002 192	Half-moon stand	1	101

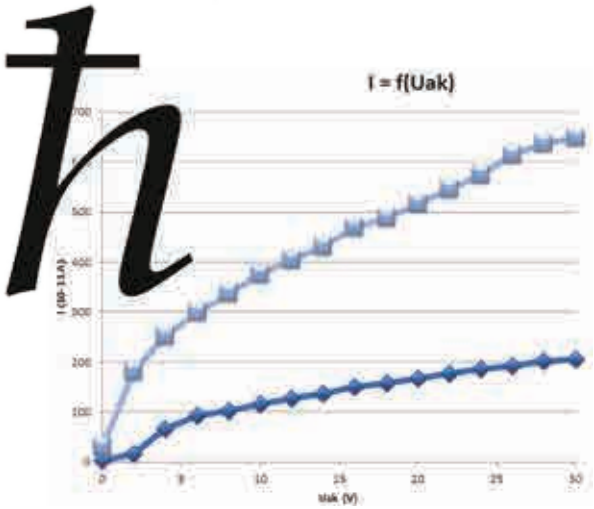
Subjects approached

» Determining h
» Implementing a protocol
» Measuring the current-voltage characteristic of the photoelectric cell

→ Measuring the current-voltage characteristic of the photoelectric cell

Photo-current value increases at the same time as the value of the difference in electric potential applied between the cathode and the UAK anode. This photo-current reaches saturation when UAK attains a certain value. This level of saturation depends on light intensity, but not on incident frequency. When UAK becomes negative, photo-current drops. Based on this experiment, we can measure a number of photoelectric cell current-voltage characteristics according to light intensity (with diaphragms) and to incident frequency using the mercury lamp (using the filter set). This is a means of checking experimentally matching with the theoretical characteristic.

→ Experimental determination of the value of Planck's constant h



According to Einstein's theory, light is composed of a flux of particles, known as photons. The energy of each photon is then equal to E = h.ν, where h is Planck's constant. Measurement of Planck's constant based on the photoelectric effect relies on determination of the difference in breaking voltage (for which photocurrent is zero) for various homogeneous incident frequencies. To do this, we propose using the "zero current" or "compensation" method. In the 10-13 A measurement range, we modify the potential value until a zero photocurrent is obtained. The spectral lamp is then covered, and current is measured. This current value is very close to dark current and photoelectric cell noise. The lamp is uncovered, and potential adjusted to attain the current value previously measured. We thus obtain breaking potential according to incident frequency. Based on the potential – frequency straight line slope; the value of h can be calculated experimentally.

EXP 500 040 **Planck's constant**

Milikan's experience

To introduce Milikan's experience, which has permitted to find the electron's electric charge.

PRINCIPLE :

Oil droplets are electrically charged and insert in a uniform electric field. The field value is adjustable in order to immobilize a droplet.

When the electric field goes to zero, the oil droplet falls et quickly aim to a limit speed. You calculate the droplet's weight thanks to its speed, and thus to find its charge.

The repetition of the experiment leads to find that the electric charges are a multiple of "e" ($1.6x10^{19}$ C).

CONSTITUTION :

- *Plan capacitor*
- *1 scope*
- *1 sprayer*
- *1 lighting system*

PSD 022 040 **Milikan's experience**

Millikan generator

This generator includes a all necessary functions for carrying out all measurements :

- *Voltage generator (0 to 600 V) for the condenser (voltage digital display).*
- *Built-in digital timer (falling time measurement).*
- *Lighting power (6 V-2,5 Amp. DIN plug).*

PSD 022 060 **Millikan generator**

Zeeman Effect

ZEEMAN POWER SUPPLY :

- *Dimensions : 368 x 151 x 310 mm*
- *Power supply of the two coils : digital display 4 digits and two safety sockets*
- *Current adjustable from 0 to 20A with a progressive rise of the current and a better phenomenon control.*
- *Supply of the Hg source with 2 safety sockets and a switch on the front face.*
- *Global Start and Stop switch on the back face. Supply 220V*

ZEEMAN COILS :

- *Size : 200 x 140 x 122 mm*
- *2 coils with safety sockets*
- *Airgap (Hyperco core) with variable spacing (helicoid) with Derlin handle to avoid any metallic contact. 4mm hole along the whole core for the deviating effect's observation.*
- *Centered-support for a precise positioning of the Hg source.*
- *Front face made of translucent Plexiglas for a better protection and an optimal view of the source and the coils. ⦰30mm hole for passing light.*
- *4 vibration absorbing 185mm-height feet*

MERCURY SOURCE :

- *⦰6.5 mm Hg lamp*
- *Metallic protection of the bulb with three ⦰8.5mm holes*
- *The hole used for the phenomenon observation has a ⦰9mm lens (f=10mm)*
- *Connected to the power supply with 2 safety leads*

POD 013 550 **Zeeman Effect**

Planck's constant

In Physics, the Planck's constant ħ is a constant used to describe the quanta size.

TECHNICAL CHARACTERISTICS :

Current measures :

- *Measure range : 10^{-8} -10^{-13} A*
- *6 measurement ranges*
- *Digital display on 4 digits*
- *Zero drift*

Cell supply :

- *Voltage : -2V/+2V ; -2V/+30V*
- *2 ranges*
- *Digital display on 4 digits*
- *Resolution 0.01 V*
- *Stability <0.1 %*

Photocell :

- *Spectral response : from 340 to 700 nm*
- *Nickel anode*
- *Sensibility : ≥ 1 µA/lm*
- *Dark current : I ≤ 2.10^{-12} A (-2V ≤ UAK ≤ 0V)*

Filters :

- *5 filters on a cylinder : 365,0 nm ; 404,7 nm ; 435,8 nm ; 546,0 nm ; 577,0 nm.*

Diaphragm :

- *2 / 4 / 8 mm.*

CONSTITUTION :

- *A box with the photocell, 3 diaphragms and 5 filters on a cylinder.*
- *A ⌀ 10 mm rod.*
- *1 power supply*

POD 068 951 **Planck's constant**

Measuring instruments

MEASURE

Digital Oscilloscope 2 x 50 MHz - 5352DC

- *Autoset, datalogger mode*
- *FFT functions.*
- *19 automatic measurements including dc amplitude, rms value, time, frequency,*
- *ΔV, Δt, duty cycle, arithmetic operaors, etc... and Go-No-Go mode.*
- *4 k points memory per channel.*
- *Supplied with : power cord, user's manual (CD-ROM), software.*

PMM 063 801 **2 x 50 MHz Oscilloscope**

Digital Oscilloscope 2 x 70 MHz - 5372DC

- *Autoset, datalogger mode*
- *FFT functions.*
- *27 automatic measurements including dc amplitude, rms value, time, frequency,*
- *ΔV, Δt, duty cycle, arithmetic operaors, etc... and Go-No-Go mode.*
- *4 k points memory per channel.*
- *Supplied with : power cord, user's manual (CD-ROM), software.*

PMM 063 805 **2 x 70 MHz Oscilloscope**

Digital Oscilloscope 2 x 100 MHz - 53102DC

- *Autoset, datalogger mode*
- *FFT functions.*
- *27 automatic measurements including dc amplitude, rms value, time, frequency,*
- *ΔV, Δt, duty cycle, arithmetic operaors, etc... and Go-No-Go mode.*
- *4 k points memory per channel.*
- *Supplied with : power cord, user's manual (CD-ROM), software.*

PMM 063 802 **2 x 100 MHz Oscilloscope**

	PMM 063 801	PMM 063 805	PMM 063 802
Number of channels	2	2	2
Vertical mode			
Bandwidth	50MHz	70MHz	100MHz
Resolution	8 bits	8 bits	8 bits
Sensitiviy	2mV/div to 10V/div	2mV/div to 10V/div	2mV/div to 10V/div
Rise time	<8,75ns	<5,8ns	<3,5ns
Coupling	AC, DC, GND	AC, DC, GND	AC, DC, GND
Input impedance	1M ohms//16pF	1M ohms//16pF	1M ohms//16pF
Horizontal mode			
Time base	1ns to 10s / div	1ns to 10s / div	1ns to 10s / div
Display	windows, roll, XY	windows, roll, XY	windows, roll, XY
Acquisition			
Sampling rate	250MS/s	250MS/s	250MS/s
Memory per channel	4 kbits	4 kbits	4 kbits
ETS Sampling rate	25GS/s	25GS/s	25GS/s
Mode	singleshot, peak, average	singleshot, peak, average	singleshot, peak, average
Average	2, 4, 8, 16, 32, 64, 128, 256	2, 4, 8, 16, 32, 64, 128, 256	2, 4, 8, 16, 32, 64, 128, 256

Digital Oscilloscope 2 x 70 MHz - 5472DC

- *Autoset, datalogger mode*
- *FFT and FFT rms functions*
- *27 automatic measurements including dc amplitude, rms value, time, frequency,*
- *ΔV, Δt, duty cycle, arithmetic operaors, etc... and Go-No-Go mode*
- *Up to 2 Mpoints memory per channel.*
- *Supplied with : power cord, user's manual (CD-ROM), software.*

PMM 063 700 **2 x 70 MHz Oscilloscope**

Digital Oscilloscope 2 x 100 MHz - 54102DC

- *Autoset, datalogger mode*
- *FFT and FFT rms functions*
- *27 automatic measurements including dc amplitude, rms value, time, frequency,*
- *ΔV, Δt, duty cycle, arithmetic operaors, etc... and Go-No-Go mode*
- *Up to 2 Mpoints memory per channel.*
- *Supplied with : power cord, user's manual (CD-ROM), software.*

PMM 063 710 **2 x 100 MHz Oscilloscope**

Digital Oscilloscope 2 x 150 MHz - 54152DC

- *Autoset, datalogger mode*
- *FFT and FFT rms functions*
- *27 automatic measurements including dc amplitude, rms value, time, frequency,*
- *ΔV, Δt, duty cycle, arithmetic operaors, etc... and Go-No-Go mode*
- *Up to 2 Mpoints memory per channel.*
- *Supplied with : power cord, user's manual (CD-ROM), software.*

PMM 063 715 **2 x 150 MHz Oscilloscope**

	PMM 063 700	PMM 063 710	PMM 063 715
Number of channels	2	2	2
Vertical mode			
Bandwidth	70MHz	100MHz	150MHz
Resolution	8 bits	8 bits	8 bits
Sensitiviy	2mV/div to 5V/div	2mV/div to 5V/div	2mV/divto 5V/div
Rise time	<5ns	<3,5ns	<2,3ns
Coupling	AC, DC, GND	AC, DC, GND	AC, DC, GND
Input impedance	1M ohms (+2%) //16pF	1M ohms (+2%) //16pF	1M ohms (+2%) //16pF
Bandwidth limit	yes, 20MHz (-3dB)	yes, 20MHz (-3dB)	yes, 20MHz (-3dB)
Horizontal mode			
Time base	1ns à 50s / div	1ns à 50s / div	1ns à 50s / div
Display	windows, zoom, roll, XY	windows, zoom, roll, XY	windows, zoom, roll, XY
Acquisition			
Sampling rate	1GS/s	1GS/s	1GS/s
Memory per channel	2Mbits max	2Mbits max	2Mbits max
ETS Sampling rate	25Gech/s	25Gech/s	25Gech/s
Mode	single, peak (10ns min), average	single, peak (10ns min), average	single, peak (10ns min), average

Adjustable power supply, simple

- PRACTICAL : Digital display of voltage and current
- PRECISE : Coarse and fine voltage adjustment.
- Adjustable current from 0 to 10A or 0 to 1A
- USEFUL : Automatic constant voltage or current operation
- PROTECTED : Short circuit protection.

VOLTAGE :

- *Adjustable from 0 to 30V (0 to + or -5mV) with fine adjustment*

CURRENT:

- *Adjustable from 0 to 10A or from 0 to 1A, depending on the selected range*

0 - 30V / 0 - 10A
300 WATTS

PMM 062 603	**Adjustable power supply, simple, 10A**
PMM 062 830	**Adjustable power supply, simple, 5A**

Adjustable power supply, simple

- PRACTICAL : Digital display of voltage and current
- EASY : Automatic mode select button : separate, tracking and series
- PRECISE : Fine voltage adjustment
- QUIET : Silent temperature-controlled fan cooling

2 x 0 - 30V / 0 - 3A
or 1 x + 0 - 30V / 0 - 3A
or 1 x + 0 - 60V / 0 - 3A
or 1 x + 0 - 30V / 0 - 6A

180 WATTS

PMM 062 602	**Adjustable power supply, double**

Adjustable power supply, triple

- EASY : Direct digital display of voltage and current, even in the series or parallel mode
- SURE : Automatic disconnection each time the master and slave channel configuration is changed
- COMPLETE : Third channel with fixed or variable position and voltage or current display
- EFFICIENT : Idc adjustment independent of load
- QUIET : Silent temperature-controlled fan cooling

2 x 0 - 30V / 0 - 3A
or 1 x + 0 - 30V / 0 - 3A
or 1 x + 0 - 60V / 0 - 3A
or 1 x + 0 - 30V / 0 - 6A +
1 x 2- 5,5V / 3A
or 1 x 5,5V - 15V / 1A

200 WATTS

PMM 062 605	**Adjustable power supply, triple**

DC Power supply, Programmable, 640W

- VISUAL : Large graphic display
- TOUCH : Sensitiv keyboard
- CONNECTED : USB, RS232, RS485 & 0-10V insulated
- PERFORMANCE : Output in the back-side, used for remote-sensing.
- FUNCTIONS : Square, positive and negative ramp, rise or fall time.

DC output : 0 - 32V ; 0 - 20A
Floating output : on 4mm safety terminals in the front-side
640 WATTS

PMM 062 830	**DC Power supply, programmable 640W**

Adjustable power supply, simple

- PRACTICAL : Digital display of voltage and current - Cord housing
- PRECISE : Coarse and fine voltage adjustment
- UTILE : Fonctionnement automatique à tension ou courant constant
- PROTECTED : Short circuit protection.
- QUIET : Silent temperature-controlled fan cooling

0 - 30V / 0 - 3A
90 WATTS

PMM 062 601	**Adjustable power supply, simple**

Adjustable and multiple power supply, AC/DC

- COMPLETE : DC and AC voltages available simultaneously
- POWERFUL : Current generator
- PRACTICAL : No common reference. - Cord housing
- PROTECTED : The DC output is protected by current regulation.
- The AC outputs are protected by auto reset thermal circuit-breakers.

0 - 5, 6, 12 or 30V / 0 - 25mA, 250mA
or 2,5A in DC
and 6 or 12 or 24V / 5A in AC

120 WATTS

PMM 062 220	**Adjustable and multiple power supply, AC/DC**

Adjustable power supply, triple + interfaces

- COMPLETE : Three outputs available simultaneously
- PRACTICAL : Digital voltage display
- USEFUL : Setting memory
- COMPATIBLE : RS232, USB* and LABVIEW interfaces
- PROTECTED : Short circuit protection
- *OPTIONAL EXTRA : USB RS232

0 to + 15V / 1A
or 0 to 30V / 1A
or 2 to 5,5V / 3A
or -15 to +15V / 0,2A

48 WATTS
RS232 + USB* + LABVIEW
LG991S sofware provided

PMM 062 460	**Adjustable power supply, triple +interfaces**

MEASURE

Function generator, 12MHz DDS + RS232, Labview, USB*

- PRECIS : Very high frequency accuracy (0.005%) with display over 4 or10 digits.
- Very high sine quality (distorsion <0,1%).
- PROTECTED: 50Ω and TTL output protected up to ±60V
- EASY: Storage for 14 setups and parameters
- INTERFACES : RS232 and LabView
  USB* with the optional extra USB RS232

FUNCTIONS

- *Triangle, Sine, Square, Ramp (rising and falling), Impuls, DC*
- *Output level : 20V peak to peak (open circuit), 10V peak to peak into 50Ω*
- *Offset voltage : ± 10V (open circuit), ± 5V into 50Ω independent of the attenuator.*
- *Duty cycle : adjustable from 10 to 90%*
- *Modulation : Internal sine-wave AM, FM, PSK, FSK to 800 Hz. External on BNC socket,Input impedance : 10KΩ.*
- *Frequency sweep : Internal : linear or logarithmic, sweep time adjustable from 10ms to 10s Sweep from 0,372 Hz to frequency Max.*
- *TTL output : Rise and fall times : < 10 ns, Synchronous square-wave signal 0 to 5 Volts. Fan-out : > 10.*
- *Frequency counter : 0,8Hz to 100MHz in 5 automatic ranges*

11 µHz to 12MHz
Direct Digital Synthesizer
AM, FM, FSK, PSK PROTECTED
RS232 + USB*+ Labview

PMM 062 690	**Function generator, 12MHz DDS**

Function generator, 5MHz (+Ampli)+RS232+Labview+USB*

- COMPLETE : Reciprocal frequency counter 50MHz.
- Internal linear or logarithmic sweep, and external VCF or FM modulation. AM modulation.
- CMos function.
- Independent offset of the attenuator.
- PRECISE : High waveform quality.
- Continuously variable duty cycle on all ranges
- PROTECTED : 50Ω and TTL outputs protected against up to ±60V reverse power surges.
- EASY : All parameters display

FUNCTIONS

- *Output level : 20V peak to peak (open circuit), 10V peak to peak into 50Ω.*
- *Independent offset of the attenuator*
- *Duty cycle : Variable : continuously from 20 to 80 % on all ranges and for all wave forms.*
- *Frequency sweep: Internal : Linear or logarithmic, sweep time adjustable from 10 ms to 5 s and depth adjustable for 1 to 100. %*
- *Frequency sweep: External : Input on BNC socket, input impedance : 47KΩ ± 10%, bandwidth : DC to 20KHz. 500:1 and 1:500 ratio*
- *Amplitude modulation : Internal : 440 Hz frequency. Depth : 4 steps at 25, 50, 75 or 100%*
- *TTL Output : Rise and fall times : < 20 ns.*
- *Frequency counter : 0 to 50 MHz in 8 automatic ranges. Reciprocal reading for very low frequencies.*

PMM 062 685	**Function generator, 5MHz, with amplifier**
PMM 062 680	**Function generator, 5MHz, without amplifier**

Power supply, 6/12V - 5A

Electronically stabilized power supply.
Outputs : 6 or 12 V AC or DC.
Max current : 5 A.

- Protections : bimetallic strip protection on the AC output and current limitation on the DC output, fuse for the input.
- DC Outputs : 6 V (± 3 %) and 12 V (± 3 %).
- Ondulation < 100 mV pp. on 6 V and 200 mV pp on 12 V
- Weight : 3 kg – Mains : 230 V/50 Hz.

PMM 062 150 **Power supply, 6/12V - 5A**

Power supply, 6/12V - 1A

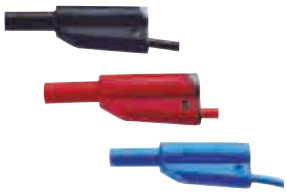
2 DC Outputs

- Fixed output with middle point : - 15/0/+15 V
- Adjustable output : -12/0/+12 V
- I max : 1A to be shared between the 2 outuputs
- Electronic stabilization and protection
- Mains : 230 V/50 Hz
- Voltage drop while in load : 50 mV on the adjustable voltage output, ripple : 5 mV
- Input : «Controlled voltage» (green Ø4-mm socket) allows the use of this power supply as a current amplifier.

PMM 062 190 **Power supply, 6/12V - 1A**

Safety leads

All the safety leads answer to EN 61010 norm.



- Section 1 mm² - Imax = 20 A - Vmax = 1000 V (stackable)

Length	Black	Red	Blue
10 cm	PEM 080 000	PEM 080 001	PEM 080 002
25 cm	PEM 080 010	PEM 080 011	PEM 080 012
50 cm	PEM 080 020	PEM 080 021	PEM 080 022
100 cm	PEM 080 030	PEM 080 031	PEM 080 032

Differential probe

- Differential voltage : + 700V
- Max voltage : + 600V eff.
- Dividing factor : x 20 or x 200
- Accuracy : + 3%
- Bandwidth : 30 MHz on x 20
  40 MHz on x 200
- Rise time : 12 ns on x 20
  9 ns on x 200
- Operation with 9.0-V battery, or with separately available power supply module (optional extra)
- Very secure : category III-2
- Can be used with every oscilloscopes
- Auto Power Off

PMM 063 950 **Differential probe**

MEASURE

didalab
WWW.DIDALAB.FR

Digital multimeters

- Large display
- 10-A range
- Double OFF position
- Protection with fuses
- 600V CAT III / answer to IEC 61010-2-033 norm

Available in 3 versions :

		PMM 062 900	PMM 062 901	PMM 062 902
Display		2000 points	4000 points	
Measurements		Average		RMS
I_{DC}	Gammes	200 µA/2000 µA/20 mA/200 mA/ 2 A/ 10 A	400 µA/4000 µA/40 mA/400 mA/ 4 A/ 10 A	
	Best accuracy	1%L + 3 pts	1%L + 3 pts	
	Best resolution	0,1 µA		
I_{AC}	Gammes	200 µA/2000 µA/20mA/ 200 mA/ 2 A/ 10 A	400 µA/4000 µA/40 mA/400 mA/ 4 A/ 10 A	
	Best accuracy	1%L + 5 pts	1%L + 5 pts	
	Best resolution	0,1 µA		
V_{DC}	Gammes	200 mV/2 V/20 V/ 200 V/600 V	400 mV/4 V/40 V/400 V/600 V	
	Best accuracy	0,5%L +3 pts	0,5%L +3 pts	
	Best resolution	0,1 mV		
V_{AC}	Gammes	200 mV/2 V/20 V/ 200 V/600 V	400 mV/4 V/40 V/400 V/600 V	
	Best accuracy	1%L + 5 pts	1%L + 5 pts	
	Best resolution	0,1 mV		
Resistance	Gammes	200 Ω/2k Ω/20k Ω/200k Ω/2M Ω/20M Ω	400 Ω/4k Ω/40k Ω/400k Ω/4M Ω/40M Ω	
	Best accuracy	0,5%L +2 pts	0,5%L +2 pts	
	Best resolution	0,1 Ω		
Continuity (with buzzer)		Yes		
Diode test		Yes		
Frequency		-	5 Hz/50 Hz/500 Hz/5 kHz/50 kHz/500 kHz/50 MHz	
Capacitance		-	50 nF/500 nF/5 µF/50 µF/100 µF	
Ranges selection		Automatique / Manuel		
Other characteristics		Data Hold, Auto Power Off, disengageable MAX	back-lit, Data Hold, Auto Power Off, disengageable, relative mode	
Security		600V CAT III selon IEC 61010-2-033		
Dimensions/Masse		181 x 92 x 57 mm / 335 g (without battery)		

MEASURE

R-L-C multimeter

- 2 000-points multimeter, manual mode
- Display : 3 1/2 digits LCD - Height : 17 mm
- Ranges : DCV, ACV, DCA, ACA, OHM – DIODE TESTS - CONTINUITY WITH BUZZER - TRANSISTOR - LOGIC - CAPACITANCE - INDUCTANCE - FREQUENCY – DUTY CYCLE
- Function : Auto Power Off
- Supplied with shock-proof cover
- Norms : CE and IEC1010 cat. II 600V

PMM 069 610 **R-L-C multimeter**

Analogue multimeters

- Rugged, simple tools which are extremely safe to use.
- Electrical safety : 600V CAT III as per IEC611010-1 ed2
- Fold-way stand for use in tilted position
- Single switch
- Safety sockets
- Double insulation

	PMM 069 527	PMM 069 528	PMM 069 529	PMM 069 530	PMM 069 531
Functions :	AC/DC ampmeter	Galvanometer with central zero	AC/DC voltmeter	Multimeter	Single and three-phase AC/DC wattmeter
Equipment :	Magneto-electric with rectifier	Magneto-electric	Magneto-electric with rectifier	Magneto-electric	Ferrodynamic
Ranges :					
Voltage :	1 100-mV range for shunts	1 100-mV for shunts	8 DC ranges : 100 mV to 1000 V 6 AC ranges : 3V to 1000 V	8 DC ranges 100 mV to 1000 V 6 AC ranges 3 V to 1000	6 1-phase ranges : 60 V to 480 V 4 3-phase ranges : 60 V √3 to 240 V √3
Current :	11 DC ranges : 100 µA to10 A 7 AC ranges : 10 mA to 10 A	2 DC ranges: 30 µA, 3 mA	-	4 DC ranges. 1 mA to 1A 1 50 µA range 5 AC ranges : 0,3mA to 3A 1 range 150 µA	1 range. 5 A
Resistance :	-	-	-	3 cal. 0,5 Ω - 1 kΩ - 1 MΩ	
Basic accuracy :	2% DC / 2,5% AC 3,5% for 10 A range	± 1,5%	± 1,5% in DC ± 2,5% in AC	± 1,5% et 2% in DC ± 2% et 2,5% in AC	± 2,5% in DC ± 2% in tri AC ± 1% in mono AC
Frequency operating range:	45 to 400 Hz		-	45 to 400 Hz	
Fuses :	1 A HPC and 10 A HPC	315 mA HPC	-	3,15 A HPC and 160 mA HPC	6,3 A HPC
Dimensions :	165 x 105 x 50 mm				
Weight :	450 g				

Decade boxes and shunts

References	Values
Resistance boxes	
PMM 064 551	0,1 à 1 Ω
PMM 064 552	1 à 10 Ω
PMM 064 553	10 à 100 Ω
PMM 064 554	100 à 1 000 Ω
PMM 064 555	1 à 10 kΩ
PMM 064 556	10 à 100 kΩ
PMM 064 557	100 à 1 000 kΩ
PMM 064 558	1 à 1 MΩ
Kit for Wheastone's bridge	
PMM 064 559	K ratio box
PMM 064 560	Zero galvanometer
PMM 064 561	Double switching box
PMM 064 562	Switching box

Multimeter clamp

- LCD display
- AC and DC current measurements
- 1mA resolution in AC and DC
- AC and DC voltage measurements up to 600V
- Resistance measurements and continuity test
- Auto Power Off
- Data Hold and Peak Hold (10ms) functions
- AC and DC Current analog output
- 600V - CAT II / 300V - CAT III

SPECIFICATIONS	
DC current	
Ranges	10A - 80A - 100A
Basic accuracy	+ (2,5 % + 10dgt)
AC current	
Ranges	10A - 80A - 100A
Accuracy	+ (2 % + 10dgt)
DC voltage	
Ranges	600V
Accuracy	+ (1,0 % + 2dgt)
AC voltage	
Ranges	600V
Accuracy	+ (1,5 % + 5dgt)
Resistance	
Ranges	10kΩ
Accuracy	+ (1 % + 3dgt)

PMM 062 330 **Multimeter clamp**

TECHNICAL CHARACTERISTICS	
Digital display	5 digits LCD - back-lit
Flash tube	Xenon lamp
Colour	6500°K
Flash time	60 to 1 000µs
Operating range	from 100 to 15 000 Flashs/min
Range selection	Automatic
Accuracy	+ 0,05% + digits
Resolution	0,1 FPM/RPM<1000FPM/ RPM>1,0FPM/RPM
Sample rate	1 second
External input	5V to 30V rms
Power supply	DC 220V/9V 3A adapter
Dimensions – Weight	210 x 120 x 120mm - 1kg

Stroboscope

- Stroboscope with microprocessor
- Very high accuracy
- High luminosity Xenon lamp

PMM 015 002 **Stroboscope**

Tachometer

Combination Contact/Photo Tachometer Wit hits optical and mechanical sensors, this tachometer can measure with extreme accuracy the rotating speed of motors and the scrolls of industrial process.

In optical mode, the «laser» can detect up to approximatively 2 meters.

This instrument has min an max memoriy records.

PMM 013 530 **Tachometer**

Stopwatch, 30 memory records

Stopwatch, 30 memory records - 10 functions - Counter 1/100 sec in 24h – Simple time and addition – Lap time – Split time – Lap counter – Repeatable countdown – Sound Start/Stop -Timer metronome - Alarm - Hour/Calendar – Programs selection scrolling - Water resistant - Dim : 75 x 62 x 25mm - 120g – ABS housing.

PMM 013 810 **Stopwatch, 30 memory records**

Light meter

Light meter

- Measurement : 20 lux to 20 000 lux
- Spectral response according to CIE Photopic
- Peak Hold and Hold functions
- LCD 2 000-pts display
- Supplied with user's manual

SPECIFICATIONS	
Measuring rang	20 lux to 20 000 lux
Resolution	0,01 lux
Accuracy	+(3% + 10d)
Spectral response	According to CEI Photopic
Measuring rate	2,5 mes/s
Display	LCD 2000 pts
Functions	Peak-hold, Hold
Operating temperature	0°C to 50°C
Storage temperature	-20°C to 60°C
Power supply	9V battery
Autonomy	>200h typ. (alkaline)
Dimensions - Weight	190 x 66 x 35mm - 220g

PMM 066 935 **Light meter**

Air flow meter

Air flow meter

- Measurement : 0 to 30 m/s
- Units : m/s, MPH, knot, ft/min
- Measure of the air temperature (-20°C to +60°C)
- Min/Max, average function
- Back-lit LCD
- Supplied with user's manual

SPECIFICATIONS	
Measuring range	0 to 30 m/s
Resolution	0,01 m/s
Accuracy	+3% of full scale
Measuring therhold	0,4 m/s
Units	m/s, MPH, knots, ft/min
Temperature measurement	-20°C to +60°C
Accuracy	0,5°C from 0° to 450°C
1° out of this range	2,5 mes/s
Measuring rate	2,5 mes/s
Display	4 digits LCD, back-lit
Functions	Min/Max/Average
Operating temperature	0°C to 50°C
Storage temperature	-20°C to 60°C
Power suppy	9V bat.
Autonomy	>200h typ. (alkaline)
Dimensions - Weight	228 x 66 x 35mm - 330g

PMM 066 937 **Air flow meter**

Sound meter

Sound meter

- 3 ranges : 30 to 130dB)
- dBA and dBC frequency weighting
- Min/max function
- AC/DC Signal Output
- answer to IEC651 type II
- Supplied with user's manual, microphone, filter for microphon, calibration screwdriver, protective cover

SPECIFICATIONS	
Measuring range	30 to 130 dB (3 ranges)
Resolution	0,1 dB
Accuracy	+1,5dB (94dB - 1kHz)
Frequency response	31,5Hz to 8kHz
Weighting	A and C / quick, slow
Dynamic for each range	
50dB	LCD 2000 points
Display	LCD 2000 points
Functions	Min/Max
Analog output	AC : 1Vrms. Full scale / 600 ohms
DC	10mV/dB / 50 ohms
Operating temperature	0°C to 50°C
Storage temperature	-20°C to 60°C
Power suppy	9V batt.
Autonomy	>200h typ. (alkaline)
Dimensions - Weight	275 x 64 x 30mm - 710g

PMM 066 936 **Sound meter**

Carbon Monoxyde (CO) meter

- Wide CO measuring range from 0 to1000ppm
- Max / hold function
- Black-lit LCD display
- Supplied with user's manual

SPECIFICATIONS	
Measuring range	0 to 1000ppm (2000ppm limited at 5min max)
Resolution	1ppm
Accuracy	+(5% + 5ppm)
Response time	<70 sec pour 90%
Sensor	electrochemical, adjusted to 205ppm
Long time drift	<5%/an, depending of use
Measuring rate	2,5 mes/s
Display	LCD 2000 pts, back-lit
Functions	Max, Hold
Operating temperature	0°C to 50°C Storage
temperature	-20°C to 60°C
Power supply	9V battery
Autonomy	>200h typ. (alkaline batt)
Dimensions – Weight	189 x 67 x 35mm - 200g

PMM 066 938 **Carbon Monoxyde (CO) meter**

Current clamp

- Hal effect sensor
- Measuring range : 100 mA to 650 A
- Gain : Output signal 1 mV/100 mA or 1 mV/1 A
- Opening : 30 mm
- BNC connector
- Power supply : 9-V battery

PMM 062 332 **Current clamp**

Digital thermometer

- Measuring range : -50°C to 300°C
- Accuracy : + 1°C
- ON/OFF switch
- LCD display
- Display : MAX and MIN temperature

PTM 041 365 **Digital thermometer**

Red liquid thermometer

ThermThermometer, made of glass for general use in laboratories. Standard dimensions according to ISO recommendations. Ø 6 x L 305 mm. Resistant graduation – Unless otherwise specified, these thermometers can be totally immersed.

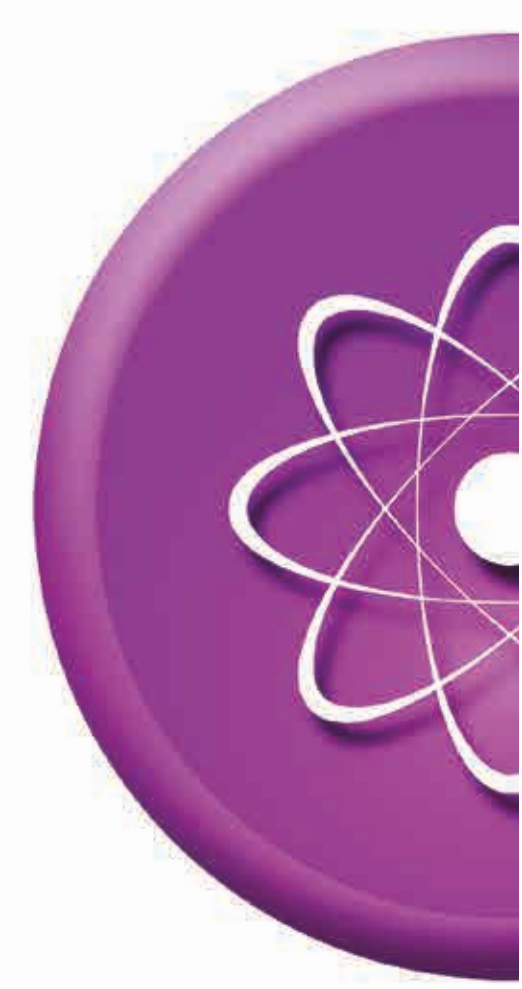
CHARACTERISTICS:

- Red liquid : toluene or pentane
- Immersion : complete
- Graduation on ennamelled stalk
- supplied with hanging loop
- Supplied in plastic housing

Available in 3 versions :

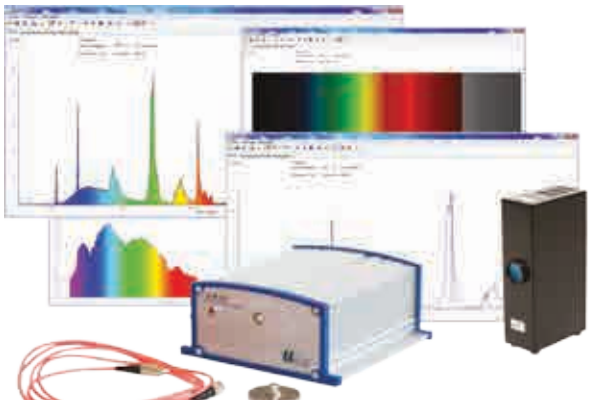
CMD 154 000	**-10 to +60°C thermometer**
CMD 154 100	**-10 à +110°C thermometer**
CMD 154 200	**-10 à +150°C thermometer**

HIGH SCHOOL SELECTION

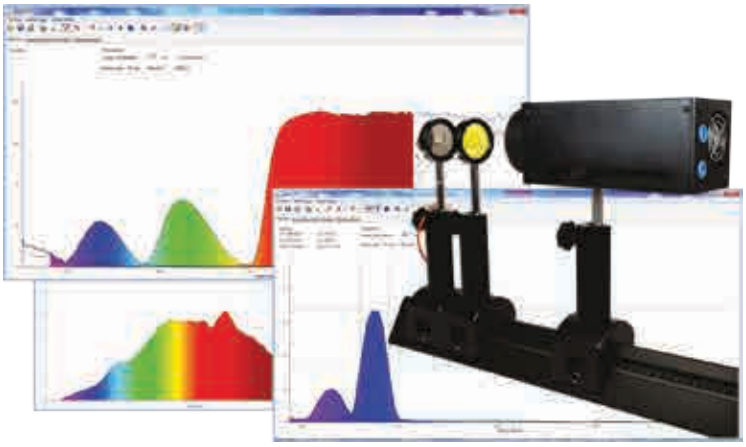


→ Spectrum studies

Optical fibres allow great freedom of movement. Used for demonstrations during classes, they will let you move from source to source easily. The simple, intuitive software, with its multi-station system, allows measurement and superimposition of curves. It is ideal for showing the gases making up different bulbs, such as mercury in energy saving light bulbs. Combined with a video projector, the SPID spectrometer will prove indispensable in your classes. Three display modes, simple, coloured and spectroscope mode, are available.



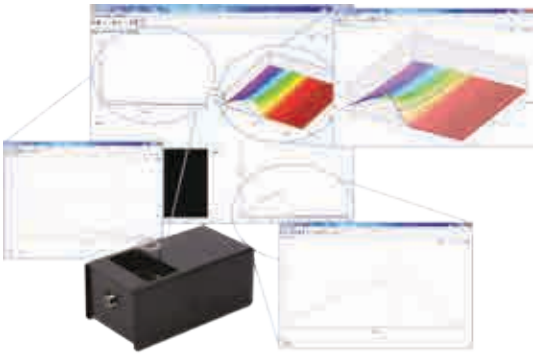
→ Coloured filter spectrum study



To study colour filters, all you need is a continuous spectrum source, normally a halogen, two optical stands and a fibre-holder token delivered with the spectrophotometer. The software allows you to create a reference and to implement solid or liquid filters by simply positioning them in front of the motionless fibre. The transmission or absorption curve is immediately displayed on the screen. You can show colour synthesis in a new way and study the principle of interference filters.

→ 3D chemical kinetics study

Previously, your students were not necessarily able to build up a scientific approach using kinetics. You had to teach them a Lambda max. Henceforward, you can ask them to choose themselves a lambda according to the data of the product to be studied, before going back to the exact lambda max that they are now able to measure. All this is thanks to the fact that the spectrophotometer observes all wavelengths in real-time and displays them in 3D. You can now browse through your acquisition at any time and at all wavelengths.



High school Spectrophotometer

The optical fiber guides the light, which is analysed by the spectrometer. You can observe the spectrum of any light source : ray spectrum, continuous spectrum (sun, glowing lamp, candle), fluorescent spectrum...

With the absorption module, you can make spectrophotometric chemical dosings, check the Beer-Lambert's law, find the concentration of a chemical solution and characterize all absorption spectrum : Chlorophyll, colouring agents, Copper suphate, Iodine...

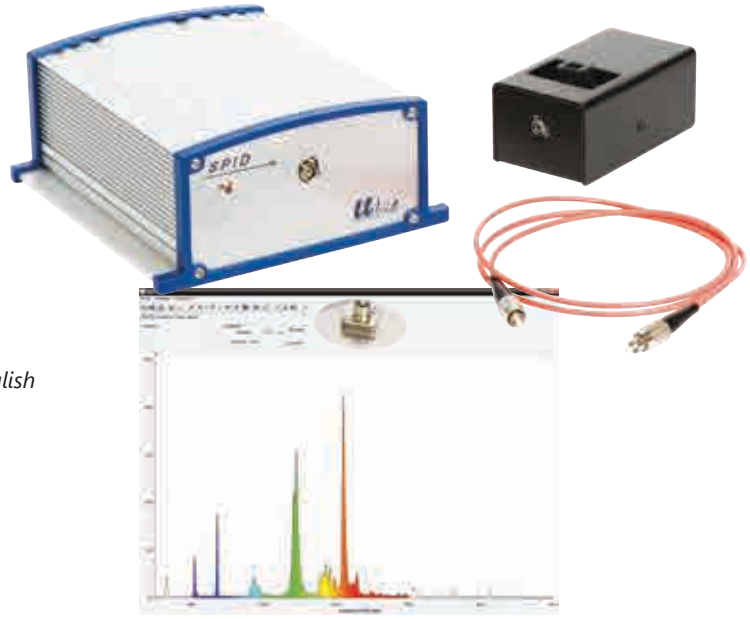
You can also observe the variation of absorbance along a time (kinetics) with one or several wavelengths.

French conception and manufacturing. Intuitive software.

Complete documentation with examples of experiments.

> Curriculum

- *Observation of the bandwidth of colour filters*
- *Study of light sources*
- *Kinetic study of a chemical liquid*
- *Implementation of BEER-LAMBERT's law.*



CONSTITUTION :

- *Spectrometer with optical fiber*
- *2-m optical fiber, 50 µm*
- *Absorption module*
- *Set of 100 tanks*
- *USB cable*
- *Software operating with Windows, in French or in English*
- *1 fiber connector holder, Ø 40 mm*

POF 010 360	**High school Spectrophotometer**

Superior Spectrophotometer

This spectrophotometer gets all the features of the reference POF 010 360 above, but also gets Colorimetry, Linear sensitivity and Luxmeter optional extras.

LINEARITY SENSITIVITY + COLORIMETRY :

For the calibration of your CCD sensor, drawing of the Planck's curves and implementation of Wien's law.

LUXMETER :

To measure the light intensity of your light source. Fitted in a ⌀40-mm lens holder for easier handling.

POF 010 361	**Superior Spectrophotometer**

Spectral Lamps high and low pressure

- *Adapted ventilation*
- *2P+E power outlet with fuse*
- *No risk of burning*
- *Economical*
- *Usable on the lamp base or on optical bench*

POD 010 050	**Low pressure mercury lamp**
POD 010 051	**Spare low pressure Spectral lamp**
POD 010 057	**High pressure mercury lamp**
POD 068 505	**Spare high pressure Spectral lamp**
POD 010 058	**Low pressure Sodium lamp (18W)**
POD 068 495	**Spare Sodium Spectral lamp 18W**

ECO27 Power supply for spectral lamp

A power supply specialy adapted to ECO27 Spectral lamps.

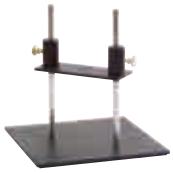
- *Optimal safety*
- *Economical*
- *Adapted ventilation*

POF 010 060	**ECO27 Power supply for spectral lamp**

ECO27 Spectral lamps

These Spectral lamps have an excellent value for money.
They allow the acquisition of rare gases at lower cost !

POF 010 061	**Sodium Spectral lamp ECO27**
POF 010 062	**Mercury Spectral lamp ECO27**
POF 010 063	**Cadmium Spectral lamp ECO27**
POF 010 064	**Hg/Cd Spectral lamp ECO27**
POF 010 065	**Zinc Spectral lamp ECO27**
POF 010 066	**Mercury/Zinc Spectral lamp ECO27**
POF 010 067	**Helium Spectral lamp ECO27**
POF 010 068	**Neon Spectral lamp ECO27**



Stand for spectral light

POD 010 056	**Stand for spectral light**

Accessories for spectral lamp

Fixing the lamp with a very simple screw thread system

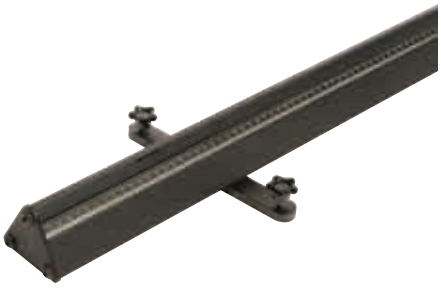
POD 010 052	**Iris diaphragm**
POD 010 053	**Condenser**
POD 010 055	**Froster glass**

Prismatic optical bench, with accessories

CONSTITUTION

- *1 prismatic bench, 2m*
- *3 optical rider, standard*
- *1 optical rider, wide base*
- *1 LED lamp*
- *2 lens-holders, for Ø 40-42 mm lenses*
- *1 translucent screen*
- *1 set of 8 components (lenses and mirrors)*

POF 010 100	**Prismatic optical bench with accessories**



DidaFirst prismatic bench

New economical range of high quality optical benches, for your optical experiments

POF 010 110	**2-m prismatic bench**
POF 010 112	**1-m prismatic bench**
POF 010 114	**Stand for optical bench**
POF 010 115	**Goniometer coupling**

Optical rider

All metallic optical rider. Width : 50 mm
For diam 8-mm to diam 14-mm rods
Height of the column : 100 mm

POF 010 124	**Optical rider**

Wide optical rider

All metallic optical rider. Width : 100 mm
For diam 8-mm to diam 14-mm rods
For a better stability for heavier components

POF 010 125	**Wide optical rider**

Optical rider with horizontal motion

All metallic optical rider
For diam 8-mm to diam 14-mm rods
Motion range : ±12.5 mm

POF 010 126	**Optical rider with horizontal motion**

Optical rider with vertical motion

All metallic optical rider.
For diam 10-mm rods.
Motion range : 20 mm

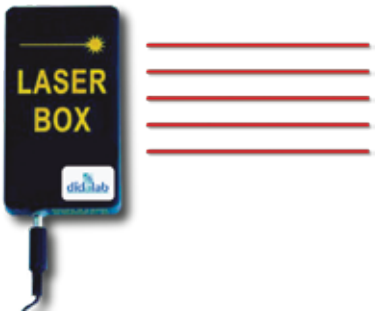
POF 010 122	**Optical rider with vertical motion**

HIGH SCHOOL

12-V LED lamp

- *Dual condenser - Pulling convergence adjustment.*
- *Fitted out with two slots, Ø 50 mm, for frosted glass & metal "d"-shaped objects (provided).*
- *distance rod axis / object indicated*
- *diam 10-mm rod*
- *Supplied with mains transformer*

POD 069 125	**12-V LED lamp**
POD 069 127	**Spare LED**



5-beam laser

5-beam laser, 650 nm, with liner generator.
With its magnetic base, this product can be used for the study of diffracting objects on a magnetic white board.
Supplied with its power supply (mains transformer)

POD 013 215	**5-beam laser**

Magnetic components

To add to the 5-beam laser, here is a set of plexiglas optical components with magnetic base.

- *4 biconvex lens*
- *1 bicocave lens*
- *2 planoconvex lens*
- *1 planoconcave lens*
- *1 concave mirror*
- *1 convex mirror*
- *1 plan mirror*
- *1 prism*
- *1 parrallel faces plate*
- *1 tube representing an opticalfiber*

POD 013 216	**Magnetic components**

Lasers

Homogenous and circular beam
Directivity of the beam adjusted in our workshop
On the end, you can fit out a microscope's lens.
Supplied with diam 10-mm rod and mains power supply.

Different wavelengths available :

POD 013 133	**Red laser – 650 nm**
POD 013 136	**Blue laser – 405 nm**
POD 013 132	**Green laser – 532 nm**

Glasses for Laser protection

Norm EN208.

POD 020 500	**for 600 / 760-nm lasers**
POD 020 510	**for 200 / 540-nm lasers**

Reflex Digital Camera model

The pedagogical model of the digital camera can be put on a Ø-10 mm rod or on a camera's stand.

It allows to model the functioning of a Reflex digital camera

Supplied with a specific software. It is powered by the USB port.

You can take pictures up to 3 Millions pixels, adust the white balance, contrasts, digital zooms up to x5 ... etc.

You can also visualize the Bayer filter when showing only green, or blue, or red pixels, or a combination of those.

By setting the lens, the students can understand the field depth and the digital aperture principle.

You can also change the position of the sensor. It shows the analogy with the first existing camera. A system of « return picture » with mirror allows the eye aiming and the understanding of Reflex aiming

This model is supplied with a complete manual.

> Curriculum

- *Focus, aperture, time exposure*
- *Field depth, magnification*
- *Sensor : sensibility and accuracy*

CONSTITUTION :

- *Two Pentax lens, (one of which with a fixed 50-mm focus, the other with a 28 to70-mm focus*
- *One Ø 10-mm rod (M5).*
- *One USB cable.*

POF 010 810 **Reflex Digital Camera model**

Caliens camera, for high school

With the high school Caliens camera, you can sample and analyze light images, with a complete software, user friendly.

Your diffraction and interferences measures are easy, precise, and intuitive, due to cursors and quick visualization.
You can adjust the integration time for a better precision and convenience.

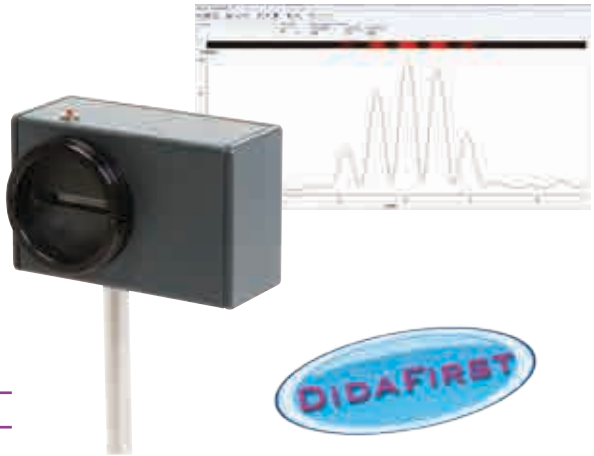
With the simulation function, you can model very easily the effect of the wavelength on an interference image.

CONSTITUTION :

- *CCD camera*
- *Software, (operating with Windows)*
- *USB cable*
- *Diam 10-mm stainless steel rod*

TECHNICAL CHARACTERISTICS :

- *2 048-pixels CCD sensor*
- *Adjustable integration time*



POF 010 300 **Caliens camera, for high school**

Set of 4 filters

In order to experiment with the Caliens camera, with no environment difficulty.
2 polarizers and 2 filters with neutral density (0.9)

POD 010 025 **Set of 4 filters**

Study of a CCD sensor

Now, with this additional cable, you can explain the principle of CCD photosensitive sensors and show the relation between the light received by the sensor and the electrical measure.

This cable retrieves the "raw" signals of the sensor, clock, trigger and the signal on an oscilloscope or a C.A.O interface.

POF 010 610 **Study of a CCD sensor**

HIGH SCHOOL

Lens holder Ø 40/42mm

- *Fully metallic*
- *Fast implementation of the component*
- *Perfect centering through four retaining lugs*
- *Component maintained by springs at the protected ends*
- *Two sides :*
  - A Ø 40 mm
  - Another Ø 42 mm for lenses placed in protective rings
- *Mounted on Ø10-mm rod*

POD 010 090	**Lens holder Ø 40/42mm**

Simple Lens holder Ø 40mm

Easy and quick fixing system with three nylon screws.
Allows the attachment of all components of Ø 40 mm.
Mounted on Ø10-mm rod.

POD 010 110	**Simple Lens holder Ø 40mm**

Screens

15 x 25 cm screens mounted on a rod of 10 mm de Ø.

POD 010 002	**Metal screen with millimeter graduation**
POD 010 006	**Translucent screen**
POD 010 007	**Translucent screen with millimeter graduation**

Simple Telescope

- *Achromatic lens with 173 mm focal length, antiflash processing*
- *Pulling adjustment*
- *View range : from 400 mm to infinite*
- *Supplied with 10x eyepiece with crosshair and 10x micrometer eyepiece.*
- *Mounted on Ø10-mm rod*

POD 069 400	**Simple Telescope**
POD 069 411	**Lens +100 mm**
POD 069 412	**Lens +200 mm**

Simple collimator

- *Achromatic lens, 120 mm, glareproofed*
- *Adjustment by pulling*
- *Crosshair*
- *Mounted on Ø10-mm rod*

POD 069 380	**Simple collimator**
POD 069 385	**Collimator with lighting**

HIGH SCHOOL

Diffraction holes on barrel

8 holes diffraction mounted on a cylinder frame of 70-mm Ø.
Ball bearing indexing system allowing accurate placement of each of the eight holes with respect to the axis of the mount.

Holes diameters :

- 0,1 mm
- 0,15 mm
- 0,2 mm
- 0,3 mm
- 0,5 mm
- 0,7 mm
- 1 mm
- 1,5 mm

POD 013 015	**Diffraction holes on barrel**

Condenser

Ø 50-mm condenser. Focal length : +44 mm on Ø 10-mm rod

POD 010 053	**Condenser**

Adjustable slot

Adjustable spacing of 0-8 mm.
Effective length of 42 mm.
Intended for experiments that do not require the knowledge of the opening.
This slot can be mounted horizontally or vertically.

POM 051 540	**Adjustable slot**

Iris diaphragm

Iris entirely made of metal.
Continuous and regular opening.
Adjustable from 1.5 to 30 mm ; 12 fins.

POD 069 410	**Iris diaphragm**

Simple plate holder

This stand enables to set any type of strip or slide with a thickness up to 5 mm.
It is equipped with screw in nylon to avoid scratches.
Mounted on Ø10-mm rod.

POD 060 230	**Simple plate and grating holder**

Pair of polarizing filters

The polarizing filter can be positioned degree by degree. The active zone of the 35 mm diameter polarizing filter is protected on both sides by glass plate. In cross polarization & analysis position, extinction is better than 99.9% on visible spectrum overall.

Provided by pair (2 polarizing filters fitted out on rod)

POD 060 910	**Pair of polarizing filters**

½ & ¼ waves retardation plates

Retardation plates have different propagation velocities of the light wave depending on the positionning, they are specially cut in order to have the waves on the slow axis delayed, of either one half wavelength or on quarter wavelength.

560 nm plates, Ø 35 mm, are made of polymeric material, 85% efficient. 430-700 nm blades have an effective diameter of 18 mm.

POD 060 955	**¼ plate - 430 à 700 nm**
POD 060 965	**½ plate - 430 à 700 nm**

Laurent's polarimeter

The Laurent polarimeter is a darkness analyser, enabling an accurate measurement of the polarization direction and angle of a polarized light through an optical medium, and to find the liquid 's content... Actually, some isotropic transparent bodies, crossed by one rectilinear polarized monochromatic light beam, rotate the polarization plane around the beam propagation direction.

This polarimeter is supplied with a Sodium spectral lamp.
The strong metallic stand has a slightly oblique sheath for tubes (max length 220 mm).
Supplied with 2 polarimetric tubes : 100 mm and 200 mm

CHARACTERISTICS

- *Measuring range : 2 graduated rings (0-180°)*
- *Glass tubes : 100 mm and 200 mm, diam 15 mm*
- *Path : 1°*
- *Precision : 0,05° (with vernier)*
- *Dimensions : 200 X 360 X 450 mm- Weight : 10 kg*
- *Light source : Sodium spectral lamp (589nm)*
- *Power supply : 230V - 50/60Hz*

POD 068 570	**Laurent's polarimeter**

Polarimetric tubes

- *Metallic ring*
- *For all kinds of liquids.*
- *The 2 different lengths show that the rotating angle is in direct proportion of the length of solution column (test tube)*

POD 068 560	**Set of 2 shutters**
POD 068 531	**10-cm Polarimetric tube**
POD 068 541	**20-cm Polarimetric tube**

Pedagogical webcam

This 3-Millions pixels CCD camera is used to take the place of the human eye during practical works session and show to the whole classroom with a video-projector or an interactive whiteboard.

With its pedagogical software, in French or in English, you will be able to measure light intensity profiles, objects (with calibration)...

Set on a Ø 10-mm rod, it can be used in a lot of positions with or without is adjustable lens.

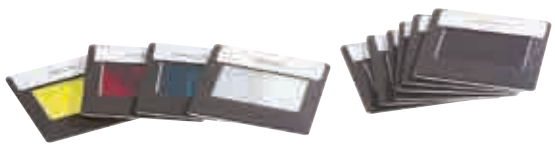
Implement your experiments very easily, save the results, capture the pictures one by one, up to 43 pictures/second (1024*768) in burst mode.

POD 010 030	**Pedagogical webcam**

Plastic filters

Slides, dim 50x50 mm.

POM 052 022	**Red filter**
POM 052 023	**Blue filter**
POM 052 024	**Yellow filter**
POM 052 025	**Green filter**



Diffraction and interference objects

Ø 40-mm glass plates.

Young's slits

- *3 double slits*
- *Width of slits : 70 µm*
- *Distance between slits : 200, 400, 500 µm*

POD 066 710	**Young's slits**

Slits

- *7 slits and wires on a glass plate*
- *Widths : 30, 40, 60, 80, 100, 150, 200 µm*
- *Accuracy : 1 µm*
- *Space between slits : 5 mm*

POD 066 700	**Slits**

Circular frosted glass plate

Frosted glass plate, 2 mm thick.
Frosted glasses diffuse light in all directions.
Therefore, they are used for creating homogeneous background (before an object, for instance).

POD 066 385	**Ø 50-mm Circular frosted glass plate**

«d»-shaped object

This token integrates both the object and the frosted glass, thus it is ideal for geometrical optics experiments using the projection of an object with an homogeneous light.
- 2-mm thick - "d"-shape object, silk-screened.

POD 066 410	**diam 50-mm object**

Set of 8 components

40-mm Ø lenses, focal lengths : -500,-200, +100, +200, +500 mm and Ø 40-mm mirrors, flat, convex -200 and concave +200 mm

POD 010 511	**Set of 8 components**

Protection rings

Set of 10 plastic rings, Ø 42mm for Ø 40-mm lens protection

POD 010 500	**Protection rings**

Gratings

These gratings have a great uniformity of lines on the whole working area.
The working area (dim 36 x 24 mm) is protected by a glass plate.

Compatible with our slide-holders

POD 062 810	**100-lines/mm grating**
POD 062 820	**300-lines/mm grating**
POD 062 830	**600-lines/mm grating**
POD 062 200	**1200-lines/mm grating**

Forced oscillations and resonance

DESCRIPTION :

- *1 weight holder plate fitted to a rod with a spring*
- *Set of weights*
- *Measurement of elongations with a software*
- *1 test tube can be filled with water or oil for the study of fluid damping*
- *Discs of different diameters for the variation of friction coefficient*
- *1 motor for a near sinusoidal excitation*

SUJETS ABORDES

- ***STATIC STUDY :***
  - *Stiffness*
  - *Elongation*
  - *Balance position*
  - *Hook's Law*

- ***FREE OSCILLATIONS DYNAMIC STUDY :***
  - *Specific period*
  - *Damping*
  - *Influence of friction.*

- ***FORCED OSCILLATIONS DYNAMIC STUDY :***
  - *Resonance of physical system*
  - *Influence of damping*

PHD 015 130 **Forced oscillations and resonance**

Melde's vibrator

Apparatus conceived to generate mechanical waves from a low frequency signal.

- *Waves travel on a cord, a spring, a plate or a loop*
- *Frequency : 0 to 1 lHz – amplitude: 0 to 7 mm*
- *Input protected by a fuse*
- *Ø 10-mm rod*

PHM 022 810 **Melde's vibrator**

Stroboscope

- *Digital display : 3½ digits, LCD*
- *Flash tube : Xenon lamp*
- *Flash time : 60 to 1000 µs*
- *Operating range : 10 to 15000 flashs/min*
- *Accuracy : 0.05% + 1 digit*
- *Resolution : 0.1 FM/RPM < 1000 FPM/RPM >1.0 FPM/RPM*
- *Sample rate : 1 second*

PMM 015 002 **Stroboscope**

HIGH SCHOOL

didalab
WWW.DIDALAB.FR

Basic ultrasound bench

This apparatus is directly intended to be used by Students for the training to on propagation of sounds & ultrasounds.
The apparatus enables notably the measurement of wavelengths, the signal amplitude received according to the transmitter distance, as the reflection & interference phenomena in the presence of objects.
Used in "burst" mode, it enables the measurement of the propagation speed, as an introduction to the measurement principle of a Sonar.

CONSTITUTION

TRANSMITTER :

- *Continuous or burst mode transmission*
- *Operating frequency : 40 kHz*
- *Transmitter control voltage output*
- *Synchronization output ("burst" mode)*

RECEIVER :

- *Magnetic base*
- *BNC connection*

2-m METALLIC RULE

PHM 075 240	**Basic ultrasound bench**
PHM 075 241	**Transmitter**
PHM 075 242	**Receiver**

Propagation in solid / liquid / gas

Set using ultrasonic measure for the determination of the sound's propagation speed in a solid. You can use it horizontally on a rod for measures in solid or air, vertically for the levitation or the Doppler Effect.

CHARACTERISTICS

- *Piezoelectric transducer ⦰40m with BNC output*
- *Transducer harmonic frequency : 37kHz +/-3Hz*
- *Emission of a wave packet every 30ms*
- *Pulsation duration : 0.07 ms*
- *Transmitted power : 10W*
- *Speed measure precision: < 3 %*
- *Size : height 250mm, diameter 120mm*

CONSTITUTION :

- *1 holder for vertical measurements*
- *2 Piezoelectric transducers*
- *Impedance matching gel*
- *5 polyacrylate solids ⦰37mm*
- *5 aluminium solids ⦰37mm*
- *2 inox rods ⦰10mm*

PED 023 410	**Propagation in solid/liquid/gas**

HIGH SCHOOL

didalab
WWW.DIDALAB.FR

Accurate dynamometers

- *Accurate reading*
- *Fastening hook and metallic traction hook*
- *Adjustable zero*
- *Measuring range in 50 graduations on 10 mm*
- *Reading index for a better accuracy*
- *2% accuracy*

Reference	Range	Accuracy	Colour
PHM 021 910	0,1 N	0,002 N	Silver
PHM 021 920	0,2 N	0,004 N	Beige
PHM 021 930	1 N	0,02 N	Yellow
PHM 021 940	2 N	0,04 N	Red
PHM 021 950	5 N	0,1 N	Blue
PHM 021 960	10 N	0,2 N	Green
PHM 021 970	20 N	0,4 N	Purple
PHM 021 980	50 N	1 N	Orange
PHM 021 990	100 N	2 N	Gold
PHM 021 890	Complete box of dynamometers		

Calorimeter

CONSTITUTION OF THE CALORIMETER

AN ALUMINIUM CONTAINER :

- *Total contents : 650 mL*
- *Double stainless steel metallic wall*

PLASTIC COVER WITH :

- *Opening for the stirring rod.*
- *A Ø 5-mm opening for the thermometer*

A SET OF RESISTANCES :

- *Fastening of the resistance with Ø 4-mm plugs on brass sockets*
- *4 sets of resistance : 1, 2-3-5 Ohms*

DIGITAL THERMOMETER:

- *Digital Thermometer : -50° à +200°C*
- *Accuracy : 0,1°C*

CHARACTERISTICS :

- *Contents : 600 ml approx.*
- *Radiation gains or losses : very low*
- *External dimensions : Ø 110 mm- Height : 130 mm*

PTD 039 510	**Calorimeter**

ALPHABETICAL INDEX

> A

> B

> C

> D

> E

> F

ALPHABETICAL INDEX

> Q

> R

> S

> T

> U

> V

> W

> Z

REFERENCE INDEX

> CGM

> CMD

> E

> EXP

> OXA

> PAM

> PBU

> PED

> PEM

> PHD

> PHM

> PMM

REFERENCE INDEX

> POD

REFERENCE INDEX

REFERENCE INDEX

> POF

> POM

> PSD

> PTD

> PTM