MUSÉE D'HISTOIRE DES SCIENCES
GENÈVE

Booklets of the Musée d'histoire des sciences n° 7

The Pictet Cabinet

Une institution Ville de Genève

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VILLE DE GENÈVE

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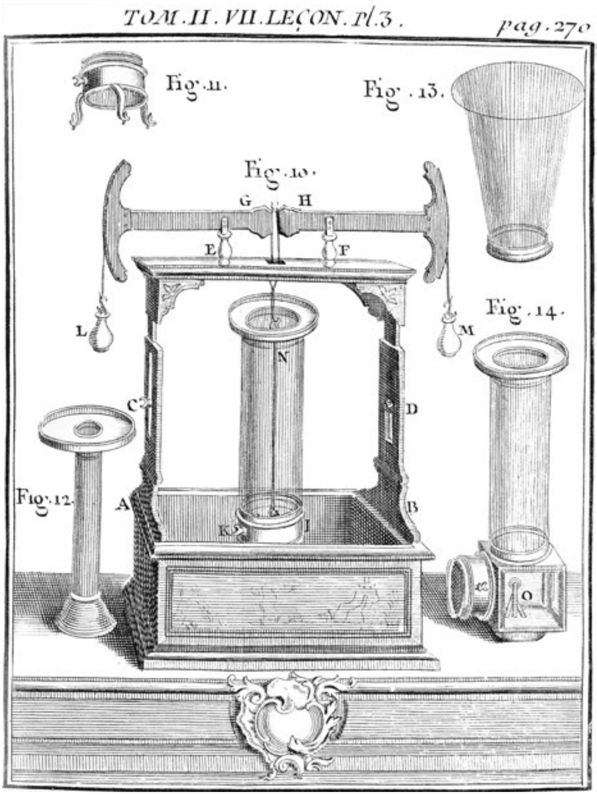
Cover : Portrait of Marc-Auguste Pictet
L'Evêque l'aîné, vers 1796
Collection Société des Arts de Genève

The art of teaching science through experiment

This booklet presents a number of emblematic instruments that belonged to the Genevan physicist Marc-Auguste Pictet (1752-1825). They were mainly used to teach experimental physics at the Académie de Genève and in his public lectures.
Produced by the most renowned European workshops of the time, these instruments (originally more than 500) bear witness to the essential place that Pictet gave to demonstrations and experiments in his physics courses.



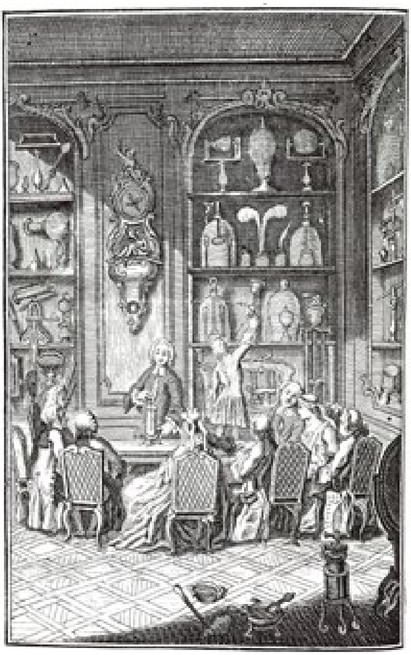
Equipment for measuring pressure in water
Leçons de physique expérimentale, Jean-Antoine Nollet, Paris 1749-1755
Library of the Musée d'histoire des sciences

From debate to demonstration

The early days of experimental physics

Up to the Renaissance, science was developed through reasoning, discussion and debating contests on the basis of ancient philosophy and Christian theology. However, at the end of the 16th century, Galileo (1564-1642) and other scholars dared to test received ideas through experiment. In their determination to understand how the world around them functioned, they made the first measuring instruments : barometers, thermometers, hygrometers.

Telescopes and microscopes allowed Galileo and others to begin exploration of the sky and nature. They worked together in learned societies supported financially by the aristocracy and royalty. They built new instruments to observe phenomena hitherto hidden, such as electricity and vacuum. Numerous new instruments designed to demonstrate natural or physical laws appeared in the 18th century. This was the golden age of scholarly salons. Experimental physics taught by skilled experimentalists became a discipline in its own right in English and Dutch universities.

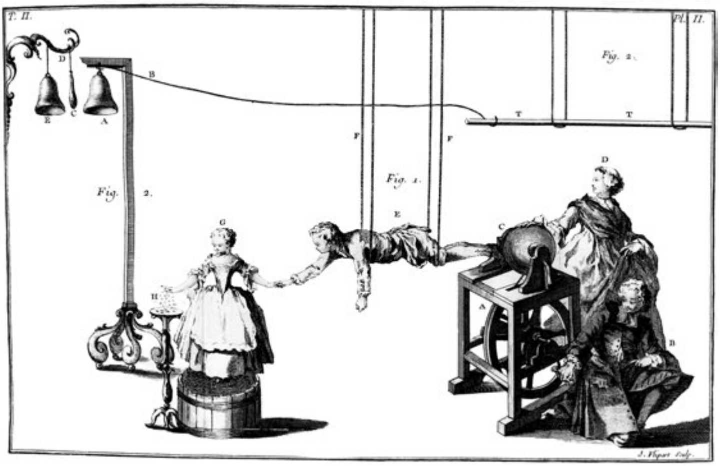


An 18th century physics salon
Leçons de physique expérimentale, Jean-Antoine Nollet, Paris 1749-1755
Library of the Musée d'histoire des sciences

Aesthetics in the service of science

One of the great personalities of 18th century experimental physics is undoubtedly Abbé Jean-Antoine Nollet (1700-1770). He was a physicist and accomplished experimentalist who gained a reputation for his spectacular public demonstrations on static electricity and his skills as a builder of scientific instruments. In *Leçons de physique expérimentale* (1738), he described details of experiments using 345 carefully selected instruments.

Nollet himself trained the craftsmen in his Paris workshops to build innovative apparatus for physics experiments. Instruments made in his workshops are easy to identify. Lacquered, polished and decorated with care, they resemble objects for a drawing room rather than scientific instruments. For Nollet, aesthetics made no difference to scientific performance but helped to capture the interest and admiration of the public. In 1770, the year of his death, he published a final work, *l'Art des expériences,* which deals with the materials, techniques and decoration of scientific instruments.

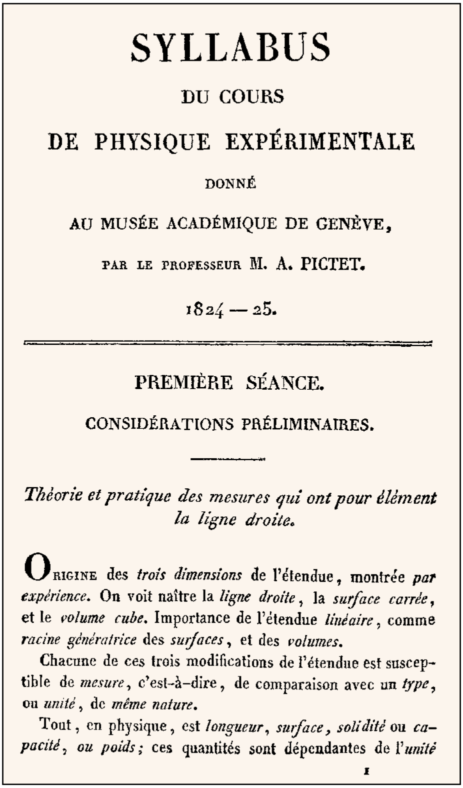


Abbé Nollet's spectacular demonstrations of static electricity
Essai sur l'électricité des corps, Nollet, Paris, 1753
Library of the Musée d'histoire des sciences

Marc-Auguste Pictet's notes

The experimental physics syllabus

In 1824, the Geneva physicist and astronomer Marc-Auguste Pictet published *Syllabus du cours de physique expérimentale* which he had prepared for his last year of teaching in 1824-1825. The 224 pages present each lecture followed by a list of the equipment used for demonstrations most of which were from Pictet's own cabinet of physics. This was the first publication of its kind in Geneva.



SYLLABUS

DU COURS

DE PHYSIQUE EXPÉRIMENTALE

DONNÉ

AU MUSÉE ACADÉMIQUE DE GENÈVE,

PAR LE PROFESSEUR M. A. PICTET.

1824 — 25.

PREMIÈRE SÉANCE.

CONSIDÉRATIONS PRÉLIMINAIRES.

Théorie et pratique des mesures qui ont pour élément la ligne droite.

ORIGINE des *trois dimensions* de l'étendue, montrée *par expérience*. On voit naître la *ligne droite*, la *surface carrée*, et le *volume cube*. Importance de l'étendue *linéaire*, comme *racine génératrice* des *surfaces*, et des *volumes*.

Chacune de ces trois modifications de l'étendue est susceptible de *mesure*, c'est-à-dire, de comparaison avec un *type*, ou *unité*, de *même nature*.

Tout, en physique, est *longueur*, *surface*, *solidité* ou *capacité*, ou *poids*; ces quantités sont dépendantes de l'*unité*

I

The *Syllabus* includes 38 lectures dealing with the main physics subjects of the time: measuring systems, geometry, astronomy, laws of motion, measurement of time, thermometry, hydrostatics, electricity, magnetism, optics, etc.

Of the 500 instruments from the Cabinet Pictet mentioned in the *Syllabus,* some 130 are now housed in the MHS. Some of these are described in the following pages.

First page of the Syllabus
Syllabus du cours de physique expérimentale, Pictet, Genève, 1824
Library of the Musée d'histoire des sciences

The power of steam

The invention of the aeolipile is attributed to the Greek engineer Heron (or Hero) of Alexandria (first century after Christ). Initially, the apparatus consisted of a hollow copper bowl fixed onto an axel and equipped with bent tubes. The steam produced by heating water in the ball escapes through the tubes making the sphere spin on its axis.

It was not until the 17th century, when the possibility of steam as an energy source was beginning to be recognised, that the aeolipile was equipped with wheels. The jet of steam was then used to propel the trolley in the opposite direction. This machine was the origin of steam engines which appeared at the end of the 17th century.

The aeolipile trolley
MHS 1198
Wood, copper, brass, Paul, Genève, 18th century

Nollet’s fire pump

A mine pump

In his experimental physics courses of 1738, Nollet described a fire pump without a piston which functioned in a similar way to certain machines used in England to evacuate water from mines. He was probably referring to the “engine to raise water by fire” invented by the Englishman Thomas Savery (1650-1715) at the end of the 17th century. Water was sucked up by a vacuum created by condensation then expelled through steam pressure.

Several machines were installed in English mines but their performance was disappointing. They were unreliable, required large quantities of water and fuel, and could only raise water from a depth of some 15 metres. Nollet mentions that a machine of this type had been installed in London to distribute Thames river water to some parts of the city. But the attempt had to be abandoned because a large fire cost too much in fuel and smoke engulfed the surrounding areas.

Fire pump
MHS 77
Wood, copper, brass, glass, Nollet (?), Paris, 18th century

The weight of a water column

This apparatus for studying water pressure, a wooden frame lacquered red and black decorated with gilded flowers and leaves, is an excellent example of an instrument from Nollet's workshops. It was used to demonstrate the principal postulated by Blaise Pascal (1623-1662) whereby the pressure exerted by a liquid on the bottom of a vessel depends on the height of the liquid and not on the shape of the containers, on condition that their base is identical.

A glass container is screwed onto a metal tube, the upper part being closed by a plug. The plug is supported by a rod attached to the ends of two levers from which weights can be suspended to counterbalance the effects of the weight of water at the base of the container. If the wide container is replaced by a glass cylinder (with the same diameter at the base) filled with water to the same level, it can be seen that the weight required to maintain the plug remains identical.

Apparatus for the study of water pressure
MHS 568
Wood, brass, glass, Nollet (?), Paris, 18th century

Hydrostatic balance

Verification of Archimedes' principle

Built by the famous Dumotiez workshops in Paris, this hydrostatic balance demonstrated Archimedes principle which stated that an object immersed in a fluid is buoyed up by a force equal to the weight of the fluid displaced by the object.

An empty cylinder is placed under one tray, a full cylinder of equal volume under the other. The scale is balanced by placing weights on the tray above the empty cylinder. The cross-bar is lowered using the rack and pinion in order to plunge the weighted cylinder into the container of water below it. It can be observed that balance is restored. The weighted cylinder appears to have lost some of its weight during its immersion. In reality, pressure is being exerted on it equal to the weight of the water transferred into the hitherto empty cylinder.

Balance hydrostatique
MHS 194
Steel, brass, glass, Dumotiez frères, Paris,
18th century

Watt's steam engine

The engine of the industrial revolution

In 1782, the Scotsman James Watt (1736-1819) developed the first double-action steam engine. The steam propelled the piston both up and down in the cylinder producing much greater power than had been possible before. He also improved the performance of his machine by equipping it with a separate condenser, so that it was no longer necessary to cool the cylinder. Finally, he designed a mechanical system (piston rod, balance, connecting rod, crank, drive wheel) which converted the piston movement from linear to circular.

The final improvements meant that the steam engine definitively replaced traditional mill wheels as the source of energy for industry. It was henceforth possible to site factories away from rivers.

Watt's steam engine
MHS 78
Steel, wood, brass, Newman, London, 19th century

Vacuum pump and its accessories

The vacuum takes centre stage

Since the invention of the first vacuum pumps in the 17th century, experiments using vacuums had always been very popular with the public and students. Amongst the most spectacular were the Magdebourg hemispheres which show the action of atmospheric pressure in relation to a vacuum, or the swelling of a pig bladder under a vacuum bell when the air becomes rarefied.

Other experiments are more unusual, such as those which use a double wind mill designed to study air resistance on the angle of the blades. The wind machine is placed in a vacuum under a cloche which is pierced on the side by a small hole. Taking care to cover the hole with a finger, a few pumping actions create a partial vacuum. When the finger is removed air enters quickly through the hole causing the blades of the wind machine to turn.

Double wind mill
MHS 66
Steel, brass, Hurter, London, 18th century

Other demonstration instruments in the Museum

The instant artist

This is a small apparatus demonstrating magnetism, featuring and artist copying one of four paintings which is placed in the same box. The small portraits which appear on the artist's canvas are drawn on a cardboard disc, underneath which is a magnetic needle. The disc orients itself according to the position of the metal bar glued underneath the large painting.

Magnetic recreation of a painting
MHS 682
Wood, cardboard, brass, Genève (?), 18th century

The exploding house

This apparatus was intended to demonstrate the chemical effects of an electric spark. The small house in painted metal contains a Volta pistol and a small tin flask containing an explosive mixture of hydrogen and oxygen closed with a cork. The mixture explodes in contact with a spark generated by an electrostatic machine. The force of the explosion blows off the roof of the house and the walls collapse.

The metal house for explosive demonstrations of electricity
MHS 1405
Sheet metal, 18th century

Anamorphoses

The origins of these extraordinary optical objects, anamorphoses, are in the Renaissance. They are deliberately distorted drawings which must be viewed in a specific mirror (cylindrical or pyramidal) to reveal their true proportions.

An anamorphose and its cylindrical mirror
MHS 193
Wood, cardboard, glass, 18th century

Electricity enhancer

Invented in England at the end of the 18th century, this instrument increased very low electrical charges and allowed them to be observed with the help of two balls of elder wood.

The electricity enhancer
MHS 714
Steel, brass, glass, Paul, Genève, 18th century

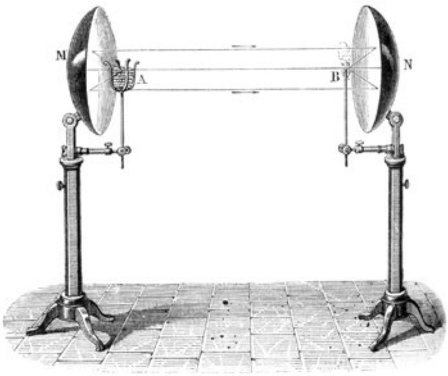
Megaphone

In contrast to the traditional conical speaking trumpet, it was claimed that this object shaped into two bulbs maintained a constant sound intensity over all distances.

Megaphone
MHS 1124
Brass, 18th century

Further reading

Pictet Marc-Auguste. *Syllabus du cours de physique expérimentale*. Genève, 1824.
Pyenson Lewis & Gauvin Jean-François. *L'art d'enseigner la physique.* Septentrion, Montréal, 2002.
Stahl-Gretsch Laurence-Isaline, Ficher Stéphane & Zein Maha. *Pictet et le théâtre des expériences.* Genève, 2019.



Pair of parabolic mirrors in brass
Traité de physique, Ganot, Paris, 1884
Library of the Musée d'histoire des sciences

At the beginning of the 19th century, Marc-Auguste Pictet used a pair of parabolic mirrors placed 4-5 metres apart in order to experimentally verify that heat is reflected in the same way as light.

Glowing coals are placed in a small metal basket at point A attached to the first mirror. A flammable substance, such as wooden kindling is placed at point B in front of the second mirror. The heat given off by the coals is reflected initially on the first mirror (M) before spreading to the second mirror (N). There, it is reflected for the second time before being concentrated at B where the kindling is set alight.

Parabolic mirrors on tripod
MHS 1744
Wood, brass, 19th century

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1. Under the skies of Mont Blanc
2. Once upon a time, there was electricity
3. Sun time
4. Seeing the infinitely small
5. Models of the universe
6. Observing the sky
7. The Pictet Cabinet
8. Jean-Daniel Colladon, Genevan scholar and industrialist
9. From foot to metre, from marc to kilo
10. The birth of modern meteorology
11. Vacuum tubes and light bulbs at the Musée d'histoire des sciences
12. The Villa Bartholoni

Downloads available at: http://institutions.ville-geneve.ch/fr/mhn/votre-visite/site-du-musee-dhistoire-des-sciences/parcours-permanent/

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