

MUSÉE
D'HISTOIRE
DES SCIENCES
GENÈVE

PARC DE LA PERLE DU LAC

Discovery **+15**
booklet
A tour
of the permanent
exhibition



WHAT IS A MUSEUM?

Like other museums, the Museum of History of Science (MHS) defines its mission around the objects that make up its collection. In 2022, the International Council of Museums adopted the following definition:

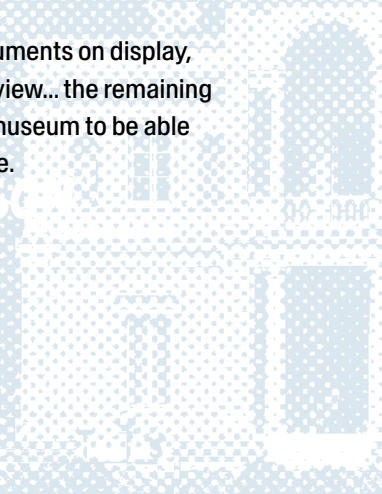
“A museum is a not-for-profit, **permanent** institution in the **service of society** that researches, collects, conserves, interprets and exhibits tangible and intangible **heritage**. Open to the **public**, accessible and inclusive, museums foster diversity and sustainability. They operate and communicate ethically, professionally and with the participation of **communities**, offering varied experiences for **education**, enjoyment, reflection and **knowledge sharing**.”

The Geneva Museum of History of Science:

- is the only one of its kind in Switzerland
- houses a collection of approximately **3,000** scientific instruments
- the objects on display have come from the studies of Genevan scientists or research institutes, and date from the 17th to the 20th century. They provide documentary evidence of scientific progress in the West during this period, the history of Geneva and Switzerland, and how scientific knowledge has developed over time.

If you want to extend your visit by counting all the instruments on display, you should be able to find some 500 objects on public view... the remaining 2,500 are kept in the museum archives. It is rare for a museum to be able to display its entire collection, often due to lack of space.

MUSEUM



WHAT HAVE YOU NOTICED ABOUT THE BUILDING THAT YOU'RE STANDING IN?

This villa was built in 1830, and is:

- constructed in the Italian neoclassical style, inspired by the Greek and Roman temples of Antiquity.
- set in the grounds of the Perle du Lac, on the shores of Lake Geneva, in green and tranquil surroundings. In fact, the banker who commissioned the building, Jean-François Bartholoni, originally had it built as a summer house.
- the only building and park designed by the famous Parisian architect, Felix-Emmanuel Callet (1791-1854), that is located outside France.
- one of the first detached houses in Geneva to possess a balcony and loggia, to allow residents and guests to enjoy the sun and views of the lake and Mont Blanc.
- one of the few 19th-century mansions open to the public.

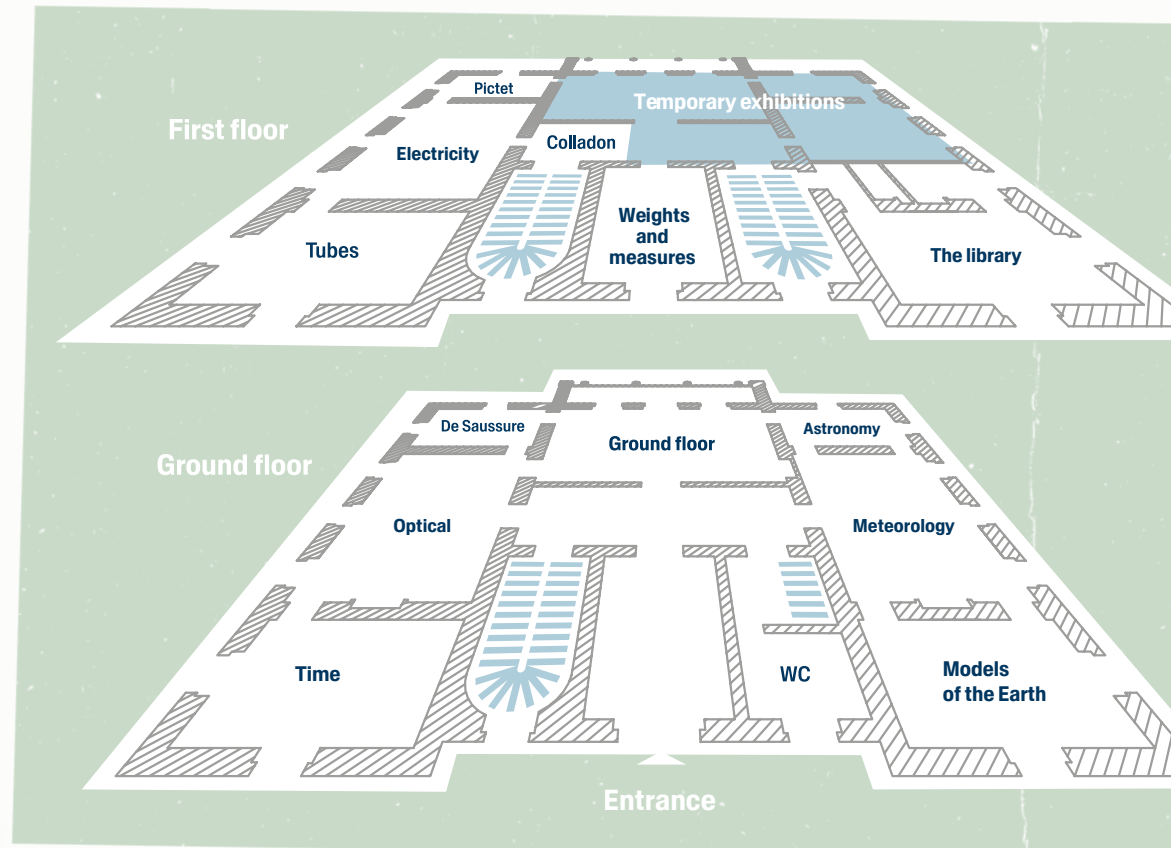


USING THE MAP AS A GUIDE

As you can see from the map, the displays in each room focus on a particular discipline: astronomy, meteorology, optics, electricity, etc.

You'll find most of the answers to the questions in this booklet by examining the objects on display, or by reading the accompanying display labels.

There is also a temporary exhibition covering three of the rooms on the first floor. Feel free to visit the special exhibit after you've answered all the questions in this booklet.



AN EXQUISITE TABLE-TOP SOLAR SYSTEM!

Find this astronomical instrument in the Grand Salon. Be aware that it does get moved around the museum from time to time, although it should still be easy enough to find.

Sir Richard Neville, an English nobleman who married the daughter of a Geneva politician, gifted this planetarium, or *orrery*, to the City of Geneva in 1775. It is one of the key pieces in the Museum's collection. The orrery was built in the 18th century by one of England's leading manufacturers of astronomical instruments. With the sun at its centre, it represents a heliocentric view of the world.

Tick the correct statement.

The planetarium was built in (approximately):

- 1770 by Georges Adams
- 1630 by Galilée
- 1810 by Charles-Francois Delamarche

Here are a few clues to help you fill in the labels for the image below.

- Today, Jupiter has 92 known satellites, but at the time this planetarium was created only four had been identified by the great Italian scientist, Galileo Galilei.
- Mercury is the closest planet to the Sun.
- Saturn, with its beautiful rings, is easy to identify.
- Mars has two satellites, discovered long after this orrery was constructed; however, scientists had already hypothesised their existence.
- Our home planet is clearly visible!



WOULD YOU LIKE TO SEE...

this mechanical
masterpiece in action?
Scan the QR code below.

RINGS GALORE

The armillary sphere is one of the oldest instruments designed to represent the universe. The first models date back to Ancient Greece, to approximately 250 BC. This instrument represents the heavens and the earth, where the observer is located.

From what point of view does the armillary sphere on display represent the universe?

- heliocentric
- centrifugal
- geocentric

Flattening an armillary sphere produces a two-dimensional instrument, invented by the Greeks and improved by scientists from the Arab world in the Middle Ages, which is displayed in the same case as the armillary sphere.

What is this instrument called?

- a compass
- an astrolabe
- a quadrant



TALKING ABOUT THE WEATHER

Although people have been discussing the weather since time immemorial, the scientific discipline of meteorology, based on measurements, only really came into being in the 18th century with the appearance of the first weather-related instruments, and further developed during the 19th century with sustained observation of the four main meteorological variables (see the table below).

Link the meteorological variables to the instruments used to measure them

Variable		Instrument
Pressure	<input type="radio"/>	<input type="radio"/> Thermometer
Temperature	<input type="radio"/>	<input type="radio"/> Hygrometer
Wind speed	<input type="radio"/>	<input type="radio"/> Barometer
Humidity	<input type="radio"/>	<input type="radio"/> Anemometer

The history of the thermometer

In 1738, Jacques-Barthélemy Micheli du Crest, a scientist from Geneva, invented an innovative thermometer that contained pure alcohol and a temperature scale that was divided into 100 equal degrees above zero (and 30 below zero), making the instrument universally applicable.

Micheli du Crest defined the value of 100 degrees as the boiling temperature of water.

What did 0 correspond to?

- the temperature (around 8°C) of the cellars of the Paris Observatory
- the temperature at the top of Geneva Cathedral
- the temperature at which ice melts

A few years later, Anders Celsius invented a mercury thermometer with a temperature scale where 0 degrees represented the boiling point of water and 100 the temperature at which water froze. Fifteen years later, a Swedish botanist improved on that instrument by inverting the scale, giving rise to the thermometer we know today!



AURORA BOREALIS MACHINE AMAZING COLOURS IN THE SKY

Complete this text using the display label as a guide.

This machine was invented in around

by the Genevan scientist

who put forward his own theory on the formation of aurorae.

He believed that the phenomenon arose due to interactions between electrical discharges in the near the north and south poles and the Earth's field.



WOULD YOU LIKE TO SEE...

this electromagnetic masterpiece in action?
Scan the QR code below.

THE SUPERSTAR OF THE ALPS!

Genevan botanist, physicist, geologist, and meteorologist Horace Bénédict de Saussure (1740-1799) used the Alps as a kind of natural laboratory.

During the second half of the 18th century, he criss-crossed this mountain range to carry out a wide range of experiments and take measurements.

His successful ascent of Mont Blanc in 1787 led to him being considered one of the pioneers of modern mountaineering. The set of instruments used by Saussure during his alpine expeditions forms part of the core collection of the Museum of History of Science.

Link each object belonging to Horace-Bénédict De Saussure to the purpose for which it was used.

Use the object labels in the display cases to help you.

- | | | | |
|---------------------------|-----------------------|-----------------------|---|
| Portable hair hygrometer | <input type="radio"/> | <input type="radio"/> | To measure atmospheric electricity captured by means of a metal rod |
| Cyanometer | <input type="radio"/> | <input type="radio"/> | To measure atmospheric pressure |
| Graphometer | <input type="radio"/> | <input type="radio"/> | To measure air humidity |
| Electrometer | <input type="radio"/> | <input type="radio"/> | To measure the intensity of the blue of the sky |
| Portable siphon barometer | <input type="radio"/> | <input type="radio"/> | To measure vertical and horizontal angles |



THE MICROSCOPE: MORE THAN MEETS THE EYE!

The microscope, namely a magnifier that enables you to see things that are invisible to the naked eye, has greatly improved over the centuries.

Number the microscopes below from 1 to 5 (from the oldest to the most recent) and circle the one that belonged to the Genevan scientist Abraham Trembley.

This 18th century scientist discovered a special ability possessed by freshwater hydra, namely:

- cell regeneration
- pollination
- molecular reproduction



OPTICAL ILLUSIONS

Several objects in the room display optical illusions. Four optical illusions that you can test are briefly described below.

Only three of them are based, notably, on the theory of retinal persistence. Circle them.

Cartoon

By spinning the device quickly and looking through one of the slits, the images on the inner surface appear to come to life. This mechanism is inspired by a 19th-century optical toy called the zoetrope.

The bee and the flower

When the disc is spun, the bee appears to be collecting nectar from the flower.

Animated Images

Look at the reflected images in the mirror through the slits. You'll get the impression that the images are moving. This optical toy is called the *péripnoscopes*.

Three-dimensional birds

When you place your eyes in front of the two eyepieces and turn the wooden knobs on the sides of the device, you will scroll through different photographs. Birds and bird eggs seem to appear in three dimensions.

The fourth is a process that allows us to see in 3D

What is the name of this method?

AT NOON SHARP!

The sundial cannon or “noonday gun” was invented at the end of the 18th century. It was designed to fire at high noon, when the Sun reached its zenith and its rays passed through the mounted magnifying glass, producing enough heat to light the fuse of the cannon and detonate the gunpowder inside.

The sundial cannon was used to set watches to solar time before mechanical movements became sufficiently accurate and reliable.

In 1967, the 13th General Conference on Weights and Measures defined the second as 9,192,631,770 cycles of radiation associated with the transition between the two hyperfine levels of the ground state of a particular atom, making the second accurate to the 10th digit after the decimal point.

What kind of atom is used to measure the length of a second in atomic time?

- a space atom
- a diamond atom
- a caesium atom

What is the name of the instrument on display in the room that measures atomic time?

- the atomimeter
- the Foucault pendulum
- the atomic clock

WOULD YOU LIKE TO SEE...

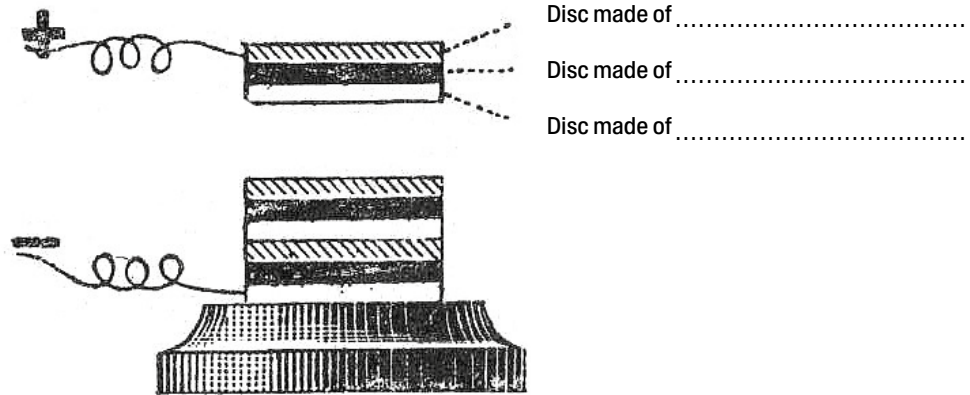
the sundial cannon firing?

Scan the QR code below.



THE FIRST ELECTRIC BATTERY: A GROUNDBREAKING INNOVATION

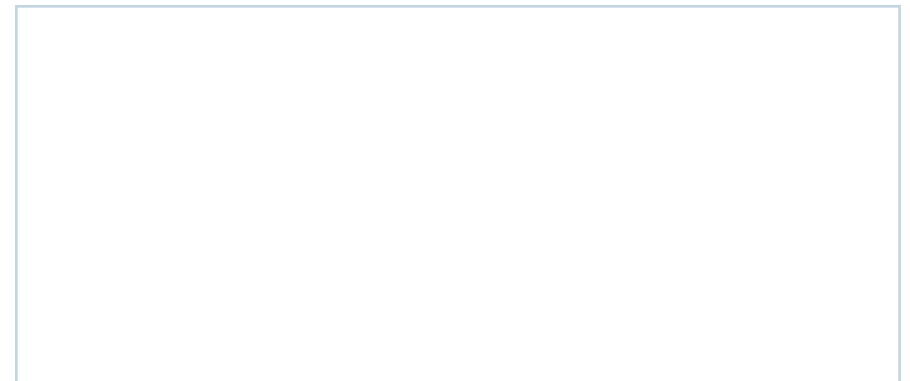
Find the first electric battery in the room and complete the labels for this engraving showing its structure.



Who invented this type of battery?

In which year?

List two other batteries in the same display case.
Draw a diagram of one of the batteries below and write a descriptive caption, based on the display label.



MOTORS... KEEP ON TURNING

In 1820, the Danish scientist Hans-Christian Oersted (1777-1836) noticed that an electric circuit with a current flowing through it disturbed the needle of a nearby compass. For the first time, a link between electricity and magnetism was established, and a new field of physics was born: electromagnetism.

French scientist André Marie Ampère (1775-1836) conducted experiments to prove that an electrical circuit could behave like a magnet. He developed a mathematical theory of the phenomenon, formalising the first laws of electromagnetism. His discoveries led to a range of technological innovations.

Among the objects depicted below, circle those that operate on the basis of electromagnetism

Indicate the name of each object.



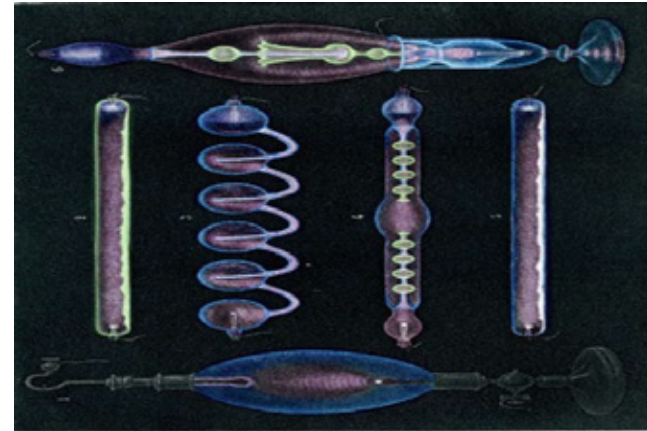
WOULD YOU LIKE TO SEE...

a motor that activates
a miniature workshop?
Scan the QR code below.



GLASS TUBES: NOT JUST FOR CHEMISTRY LABS

In the 18th century, scientists observed a coloured glow appearing in glass tubes that had been partially emptied of air when electric discharges were applied from a machine.



Electric discharges
in tubes containing
rarefied gases

Guillemin Amédée,
"Les phénomènes de la physique",
Paris, 1869
Library of the Museum
of the History of Science

In the display case containing glass tubes like the ones in the picture above, you'll notice that one of them is shaped like an animal. What animal is it?

- a tiger
- a bear
- a dog

In the 19th century, scientists noticed that when the vacuum in the tubes was increased and higher voltage was applied, the coloured glow inside the tube disappeared and the glass tube itself began to glow a fluorescent green.

In 1887, the English chemist and physicist William Crookes established that this green glow was caused by invisible rays that he called **cathode rays**. Later on, the physicist Joseph Thomson identified cathode rays as being made up of negatively charged, sub-atomic particles: **electrons**.

Cathode ray tubes were used in old television sets, which were much bulkier than the flat screen televisions in our homes today.

First floor, bedrooms

Tubes



Below is a photo of the Crookes tube on display in the room

Draw in the missing Maltese cross and add arrows to show the trajectory of the electrons.

WOULD YOU LIKE TO SEE ...
the Crookes tube light up? Scan the QR code below.



Look around the room for a long, slightly dented tube partially covered in aluminium foil. It enabled a physicist from Geneva to verify that the mass of electrons varies according to their speed, thus confirming one of the most well-known physics formulae conceived by one of the world's most famous scientists.

Answer the following three questions:

1. What was the name of the physicist from Geneva who invented this tube?

- Charles-Edouard Bruye
- Charles-Hippolyte Fruye
- Charles-Eugène Guye

2. What was the name of the famous scientist who came up with the formula that expresses mass-energy equivalence?

.....

3. What is the formula?

.....

.....

First floor, bedrooms

Weights and measures

TAKING MEASUREMENTS: WHAT A PAIN IN THE FOOT!

Units of length based on parts of the human body - including "forearms" (cubit), fingers, thumbs (inches) and feet - were common until the French Revolution. However, a "foot" might measure 32.38cm in France but only 30.48cm in England. In Switzerland, it varied from canton to canton: 29.33cm in Berne but only 26.39cm in the Pays de Vaud.

When they chopped off their king's head, French revolutionaries also abolished all units of length relating to the human body, especially if the body in question was a royal one. They established a new base unit of length, the metre, free from any human reference, that was equal to one ten-millionth of the distance from the North Pole to the Equator (the quadrant of the Earth's circumference), measured along the meridian passing through Paris.

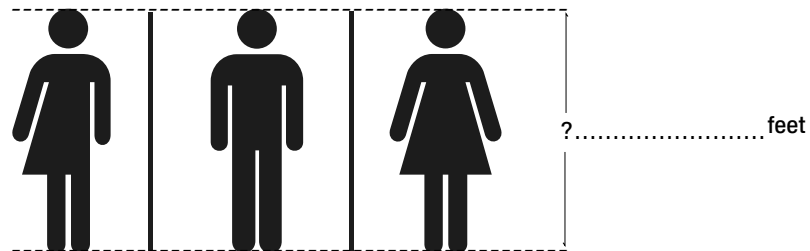
The definition of a metre has now been fully de-materialised. What is it?

- The length of an iron-nickel standard alloy rod kept at the Bureau International des Poids et Mesures in Sèvres, near Paris.
- The length of the path travelled by light in a vacuum over a period of $1/299,792,458$ of a second.
- The length equal to 1,650,763.73 wavelengths of the light emitted during the transition between the $2p_{10}$ and $5d_5$ levels of the krypton-86 atom.

Measure your height using the metric height gauge provided in the room

Given that one British Imperial foot equals 30.48 cm

how tall are you in feet?



UNDER PRESSURE...

The Magdeburg hemispheres are a classic physics experiment to demonstrate atmospheric pressure.

In this room, you'll find a pair of decorated copper hemispheres from the workshop of Abbé Nollet, a famous 18th-century French clergyman and physicist.

Can you locate these beautiful objects?



In the 17th century, the German scientist Otto von Guericke carried out a spectacular experiment: he fitted together two hollow copper hemispheres, 40cm in diameter, and extracted the air inside using a vacuum pump of his own invention. Two teams of eight horses, hitched to each hemisphere and pulling in opposite directions, were unable to separate the hemispheres.

How do you think the hemispheres can be separated?

- by smashing them with a hammer
- by forcing air inside them
- there is no way of separating them

Tick the single false statement in the following list:

With his experiment, the clever Otto von Guericke demonstrated that:

- air has a weight equal to atmospheric pressure
- the atmospheric pressure exerted on the joined hemispheres, inside which a partial vacuum had been created, held them together
- horses were weak, unlike elephants, which would have been able to separate the hemispheres
- it was possible to create even a partial vacuum

FULL STEAM AHEAD!

In 1782, the Scottish engineer James Watt developed a new type of steam engine that would pave the way for the industrial revolution in the 18th and 19th centuries. He invented a device that allowed steam to condense outside the main cylinder - on what he called a "condenser". This modification greatly improved the efficiency of steam engines, which came to replace water wheels in the manufacturing and mining industries.

The centrifugal or "fly-ball" governor, another one of Watt's innovations, was used to control the speed of an engine.

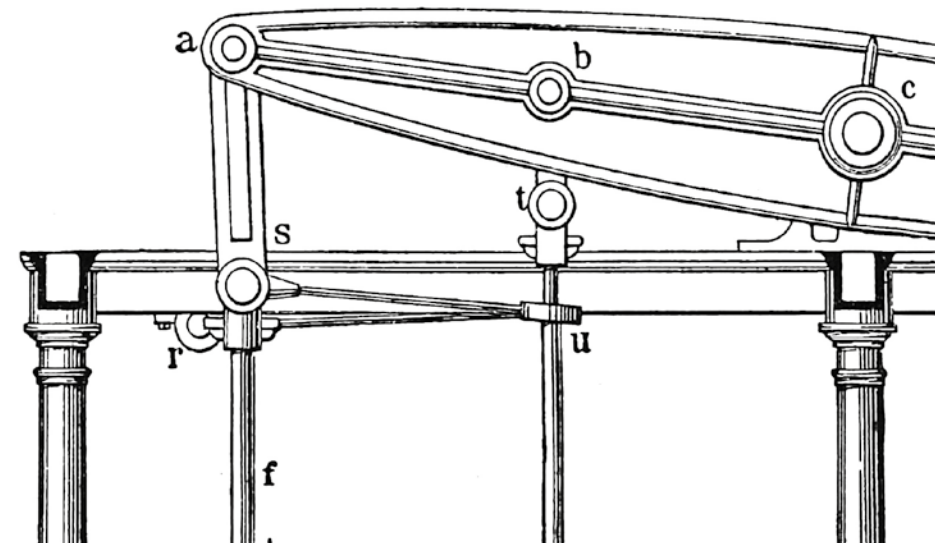
What is the function of the beam and the parallel motion linkage in Watt's engine?

- to increase air flow and ventilate the machine
- to pump cooling water
- to convert linear into circular motion



WOULD YOU LIKE TO SEE...

this machine,
which revolutionised industry, in action?
Scan the QR code below.



THE MURDER WEAPON

Before you leave... solve the riddle that still haunts the Museum of History of Science...

On February 2, 1967, tragedy struck the museum: the only night a security guard was found knocked out. On the evening of the attack, the guard had gone through every room on the ground floor, except one - the scene of the crime! He used to write down an item from each room he visited.

Here's the list found in his little notebook:

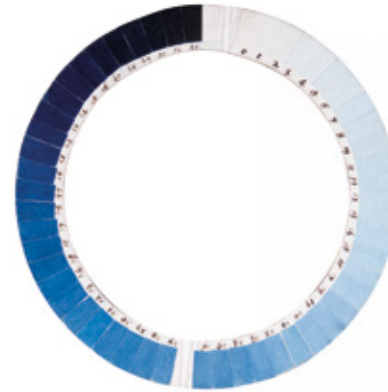
- Hair hygrometer
- Mallet astronomical telescope
- Adams orrery
- Micheli thermometer
- Midi cannon
- Trembley aquatic microscope

The location of the crime is: Room

Only one piece was not stored. It is in the list below but not in the images beside.

- Armillary sphere
- Circular cyanometer
- Dial barometer
- Micheli alcohol thermometer
- Meridian telescope
- Electron microscope
- Navicula de Venetiis

The murder weapon is:



THANK YOU FOR YOUR VISIT

Our museum may be small, but it has a rich collection of objects! If you didn't have time to see everything, don't worry, you can download and watch a playlist of videos on the scientific instruments featured in this booklet!

To access the playlist, scan the QR code below.



Notes



Notes

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closed Tuesdays, December 25

and January 1st

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streetcar 15 (Butini & France stops)

bus 11, 28 (Jardin botanique stop)

Mouettes boat M4

(Châteaubriand stop)

train Léman Express L1, L2, L3, L4

(Genève-Sécheron stop)

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