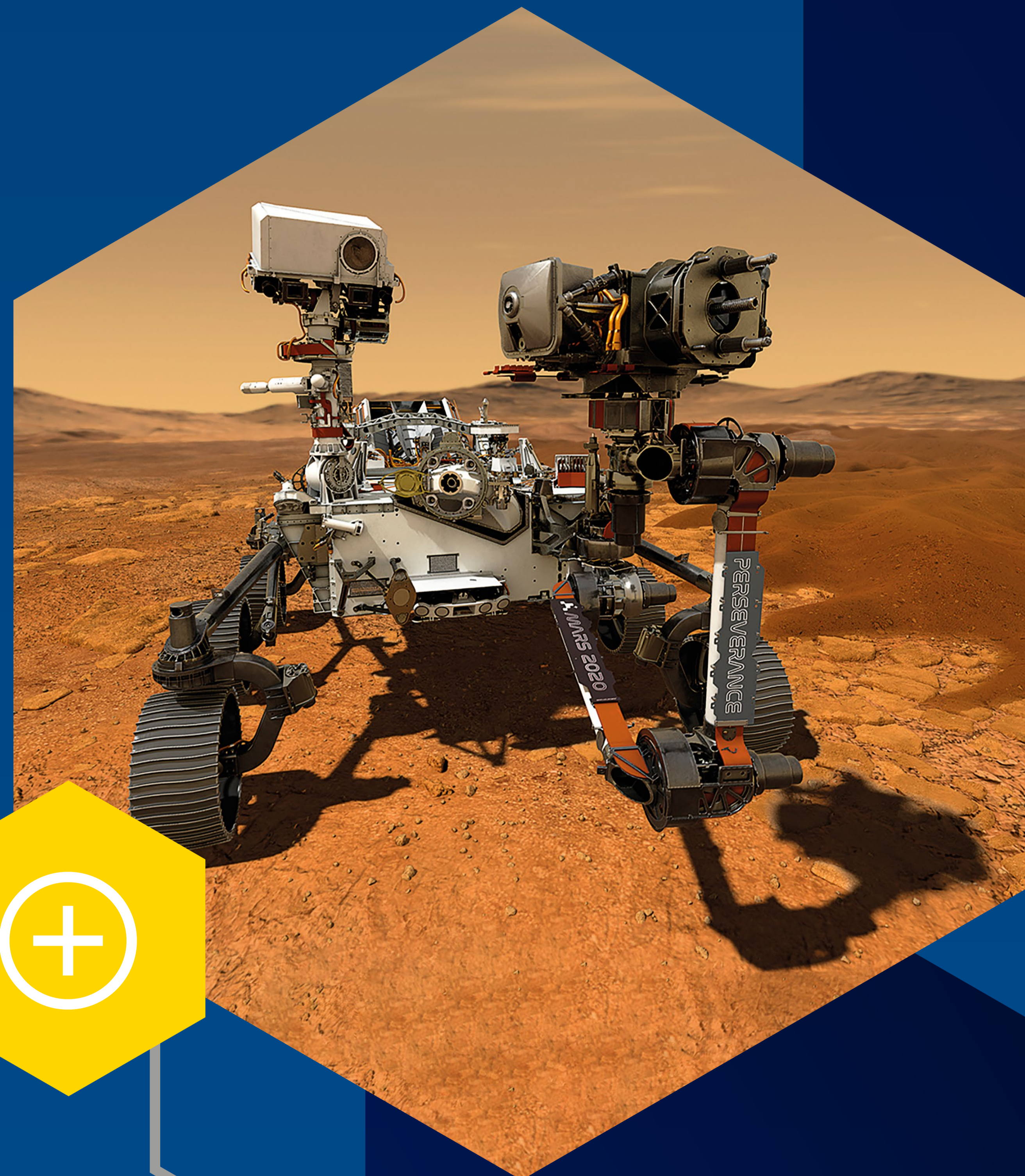
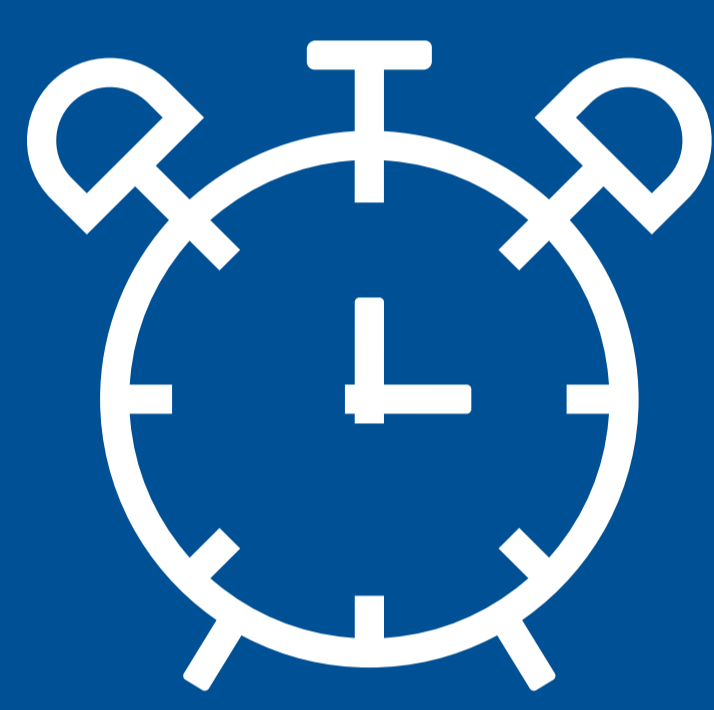


LITTLE-KNOWN USES OF RADIATION



6.1

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LITTLE-KNOWN USES OF RADIATION

SURPRISING USES



Ionising radiation is used in everyday life and in a wide variety of disciplines, some of which we would never have imagined. It is such a versatile tool! Radiation can reveal the invisible, sanitise food, date works of art, propel military vessels or send probes to the farthest reaches of the solar system.

These applications must be **controlled**, in particular to **protect** the professionals who use them.

DETECT / MEASURE

Radiation is absorbed to a greater or lesser extent by the materials it passes through. This property is used to reveal the inside of objects, in radiography, or to check the levels of a liquid or the thickness of a material.



SANITISE / STERILISE

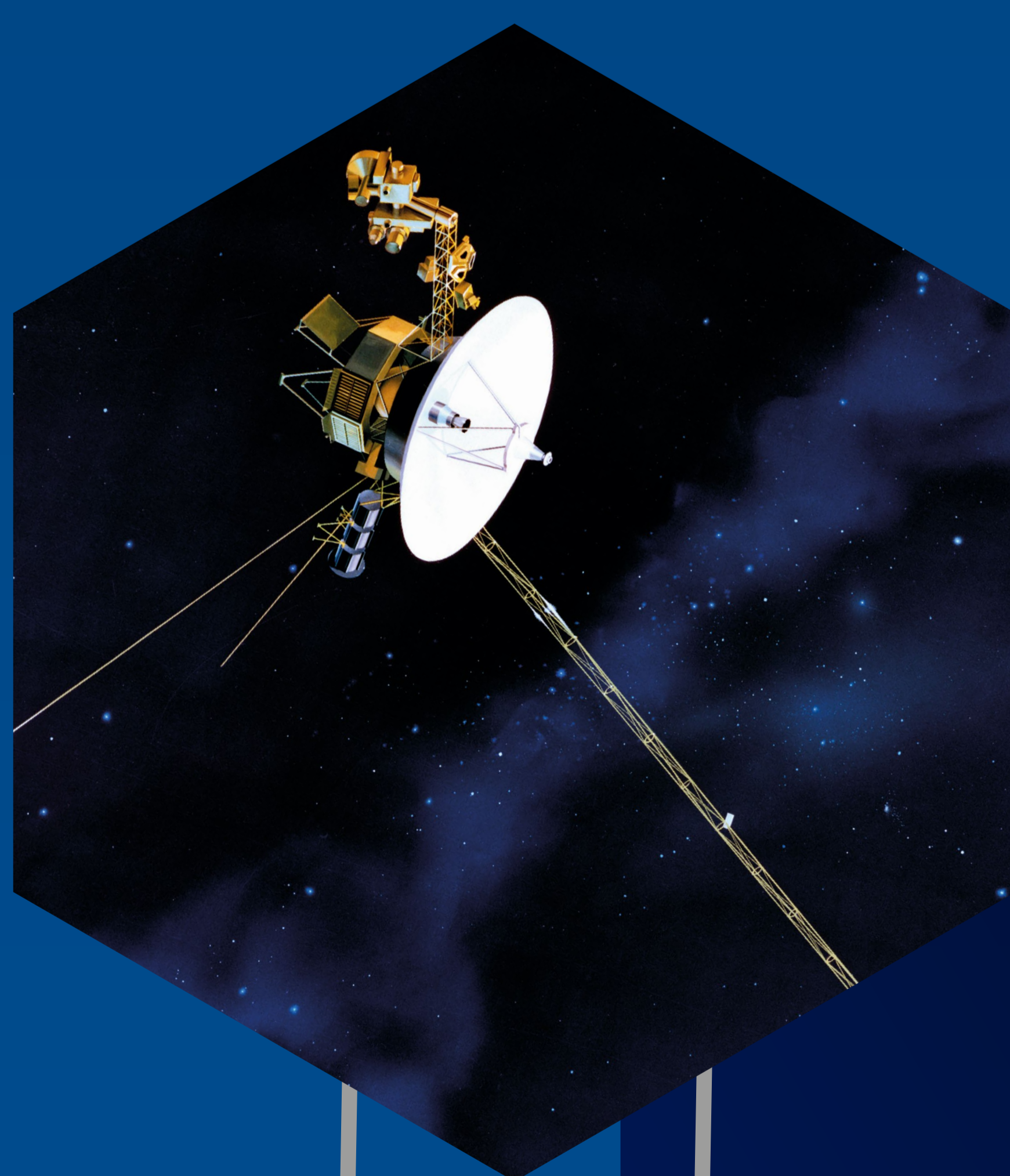
Radiation has the ability to destroy micro-organisms. It improves product preservation, for example, by preventing bulbs and tubers from germinating or by eliminating parasitic insects.

Radioactivity is also used to destroy micro-organisms and sanitise ancient objects in ethnology or archaeology, to improve their conservation, or for medical equipment.

DATE / PRESERVE

The radioactivity of a material decreases over time. It can therefore be used to date objects and fossils. Carbon-14 can be used to determine the age of objects up to 50,000 years old.

Other radioelements can be used to date events in the history of the Earth, its climate and the living beings that have inhabited it.



TRANSFORM / PROPEL

Radioactivity can be used to trigger chemical reactions, enabling the development of lighter, stronger materials for prostheses, electrical cables, aeronautical parts and Teflon cookware.

Space exploration probes, robots and satellites are equipped with very long-life batteries containing a radioactive source. Because of the need for autonomy, some submarines, aircraft carriers and ice-breakers are equipped with a nuclear engine.

6.2

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LITTLE-KNOWN USES OF RADIATION

DETECT, MEASURE



Ionising radiation is stopped to a greater or lesser extent depending on the **density of the materials** it passes through. It is therefore an excellent means of **probing, measuring and controlling**.

GAMMA RADIOGRAPHY

Gamma radiography uses a portable device containing a radioactive source to assess defects in a material or weld. This technique mainly uses iridium-192 and cobalt-60 sources. These high-activity sources present a high risk of exposure for workers, who must take appropriate protective measures.



The Venus de Milo was exposed to radiation using a gamma-ray machine, which revealed the fragility of its anatomy.



A technician prepares a gamma radiography machine to inspect a heavy piece of boilerwork. He has been specifically trained and will move away when the radiograph is triggered.



OTHER TYPES OF CONTROLS

RADIOACTIVE GAUGES

Beams of radiation from radioactive sources (krypton-85, caesium-137, americium-241, cobalt-60, promethium-147) are used to check the thickness of sheet metal for cars on rolling lines, the weight of sheets of paper in the paper industry, oil levels in refining towers or the filling of lighters or beer kegs.

ENGINE PROTOTYPING

A crucial mechanical part is made slightly radioactive by irradiation. Wear on the part during operation leads to a deposit of radioactive material in the lubricating oil. The oil is analysed to determine the metal loss and therefore the wear rate of the part.

X-RAY FLUORESCENCE DETECTOR

Detectors equipped with a radioactive source are used to check for the presence of lead in house paint (property diagnostics) or to determine the composition of minerals and metals.

AIR QUALITY

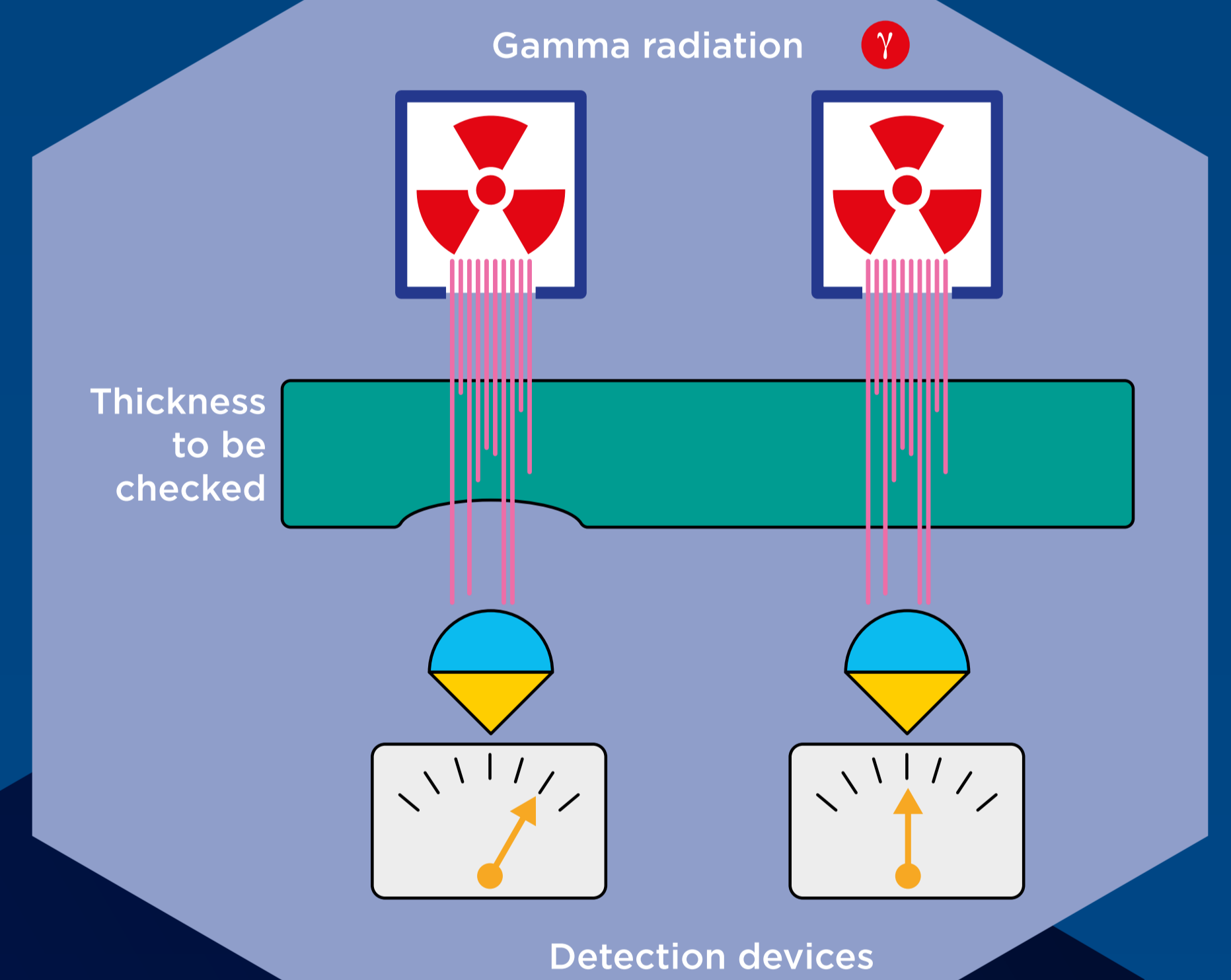
The dust content of the air can be measured using radiation on a sampling filter.



How do radioactive gauges work?

On one side, a source emits rays. On the other, a detection device measures the amount of radiation that has passed through the object.

The absorption of the rays depends on the thickness through which they pass and the structure of the material.





LITTLE-KNOWN USES OF RADIATION

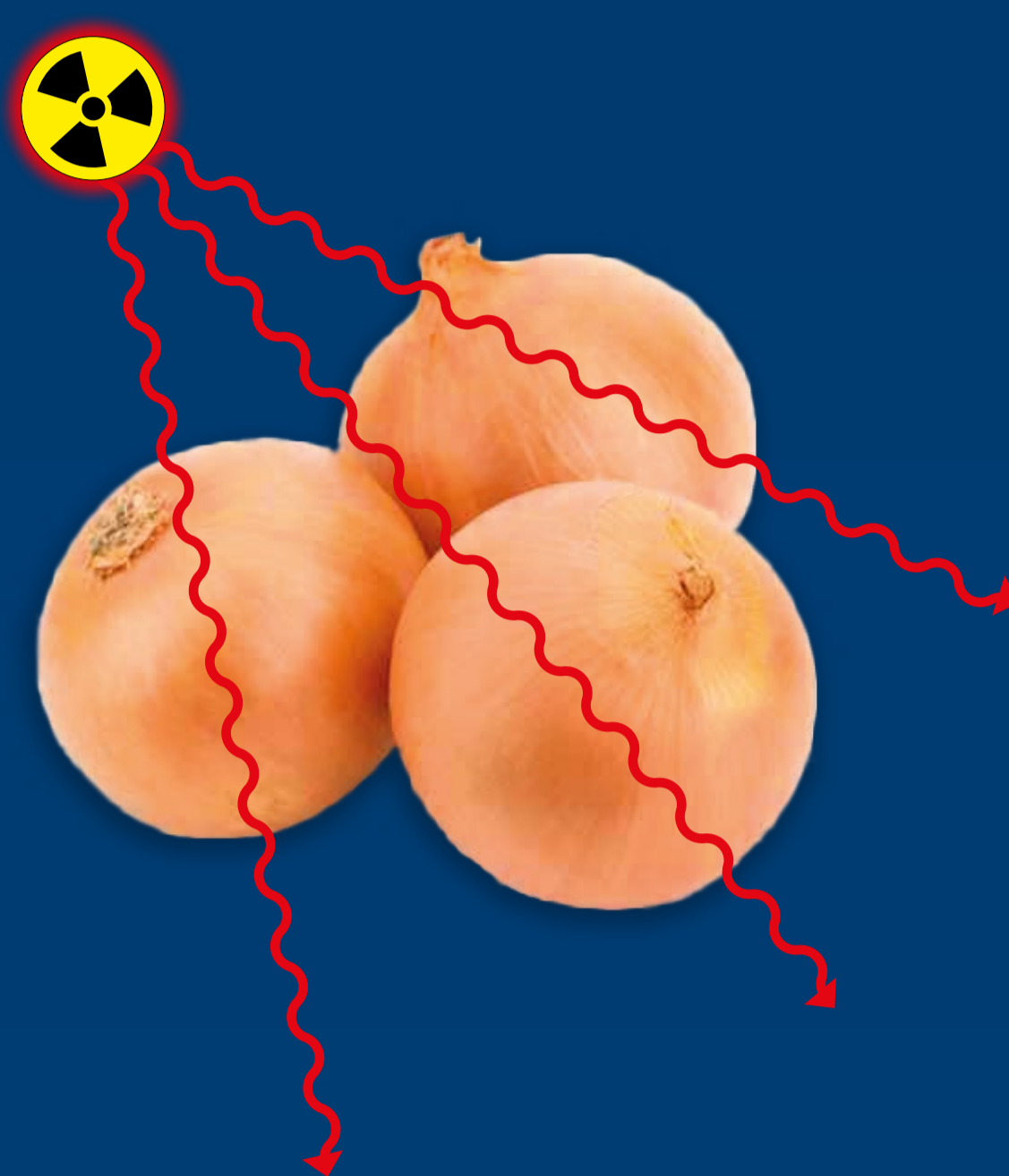
SANITISE, STERILISE



Ionising radiation is used in the food and healthcare industries to destroy micro-organisms.

IMPROVE CONSERVATION

Onions and shallots can be irradiated to inhibit sprouting, so that they keep longer. Vegetables, nuts and legumes can be irradiated for disinsectisation. Fresh fruit is not irradiated in France!



WHY AREN'T IRRADIATED ONIONS RADIOACTIVE?

Irradiation occurs when the radioactive source is located externally and the radiation passes through the products. Irradiation stops when you move away from the source. It is not a contaminant as such. The radiation only passes through, even if it modifies certain cells.

Irradiation is dangerous for humans because it modifies their cells, not because of the radioactivity itself, which only passes through.

In order to contaminate someone or something, the radioactivity must be carried by gases or solids (dust) that are deposited or inhaled.



Several irradiation techniques

- **The electron beam:** derived from a particle accelerator, it is highly efficient but treats products one by one.
- **Gamma rays:** derived from a radioactive source of cobalt-60, gamma rays are capable of treating a large quantity of product reliably, thanks to their penetrating power. There are six irradiators in France, treating around 3000 tonnes of products every year.

MAKING TRANSFUSIONS SAFER

As with food, blood products are irradiated to deactivate certain cells that could lead to a fatal disease in transfused patients.

This irradiation is generally carried out using a machine that emits X-rays.



STERILISE

Foodstuffs, pharmaceutical raw materials and medical devices are also treated to destroy micro-organisms.

Radiation, in particular gamma rays from cobalt-60, breaks chemical bonds when it interacts with living organisms, enabling bacteria, moulds and parasites to be eliminated when cold and with great reliability.

Their penetrating power guarantees effective and complete treatment of the product.

SPECIFIC LABELLING

In France, as in all of Europe, all irradiated foodstuffs must be labelled "treated with ionising radiation" or "treated by ionisation".

In practice, this labelling is almost never visible to the consumer, as irradiated ingredients are most often incorporated into prepared dishes where they are mixed with non-irradiated ingredients.

IRRADIÉ



IRRADIATED



DEBATE SHOULD WE IRRADIATE FOOD?

- Supporters of irradiation believe that this method is less harmful than other methods of food preservation, as it limits the use of chemicals and reduces the risk of contamination by pathogenic organisms. However, the quantity of foodstuffs treated by irradiation is decreasing every year.
- Controversy persists over the possibility of creating toxic substances. The European Food Safety Authority (EFSA) has not accepted as conclusive the results of studies demonstrating the mutagenic or carcinogenic nature of food irradiation, but is concerned by the neurological damage observed in cats fed heavily irradiated food.

6.4

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LITTLE-KNOWN USES OF RADIATION

DATE, PRESERVE



The ionising radioactivity naturally present in an object can be used as a tracer to **date** or **analyse** it.



DATE

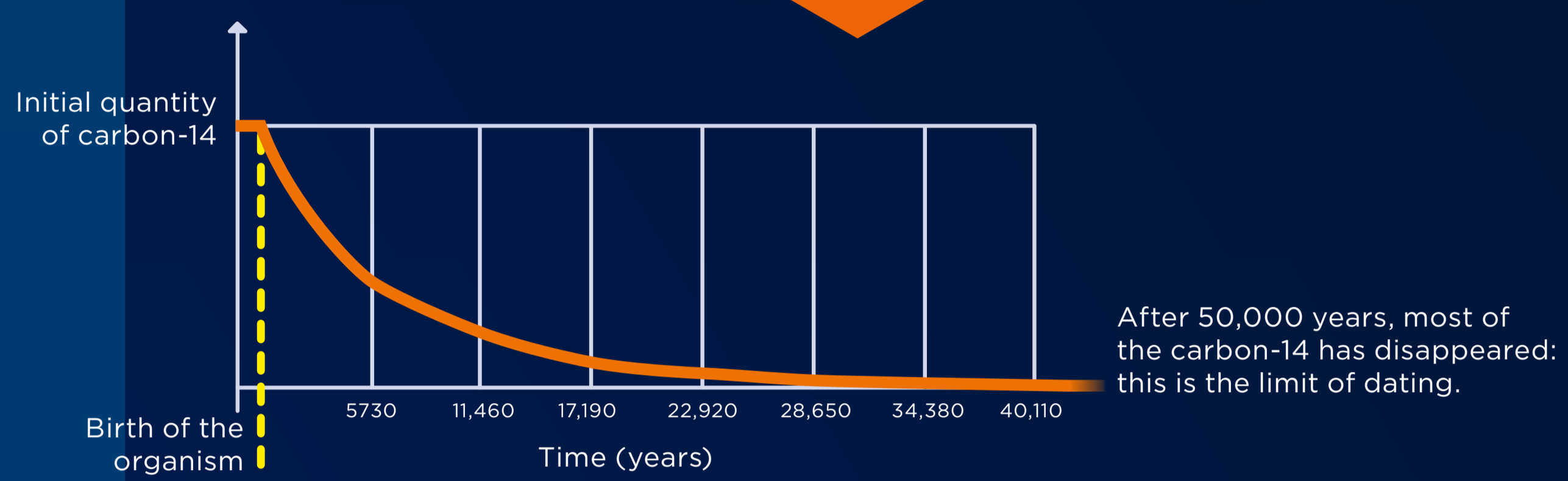
Radioactivity decreases over time and can therefore be used to date objects. Measuring carbon-14, for example, makes it possible to give a precise age to mummies and skeletons found by archaeologists.

By analysing other elements, such as lead, potassium, argon and uranium, it is possible to date the very age of the Earth.

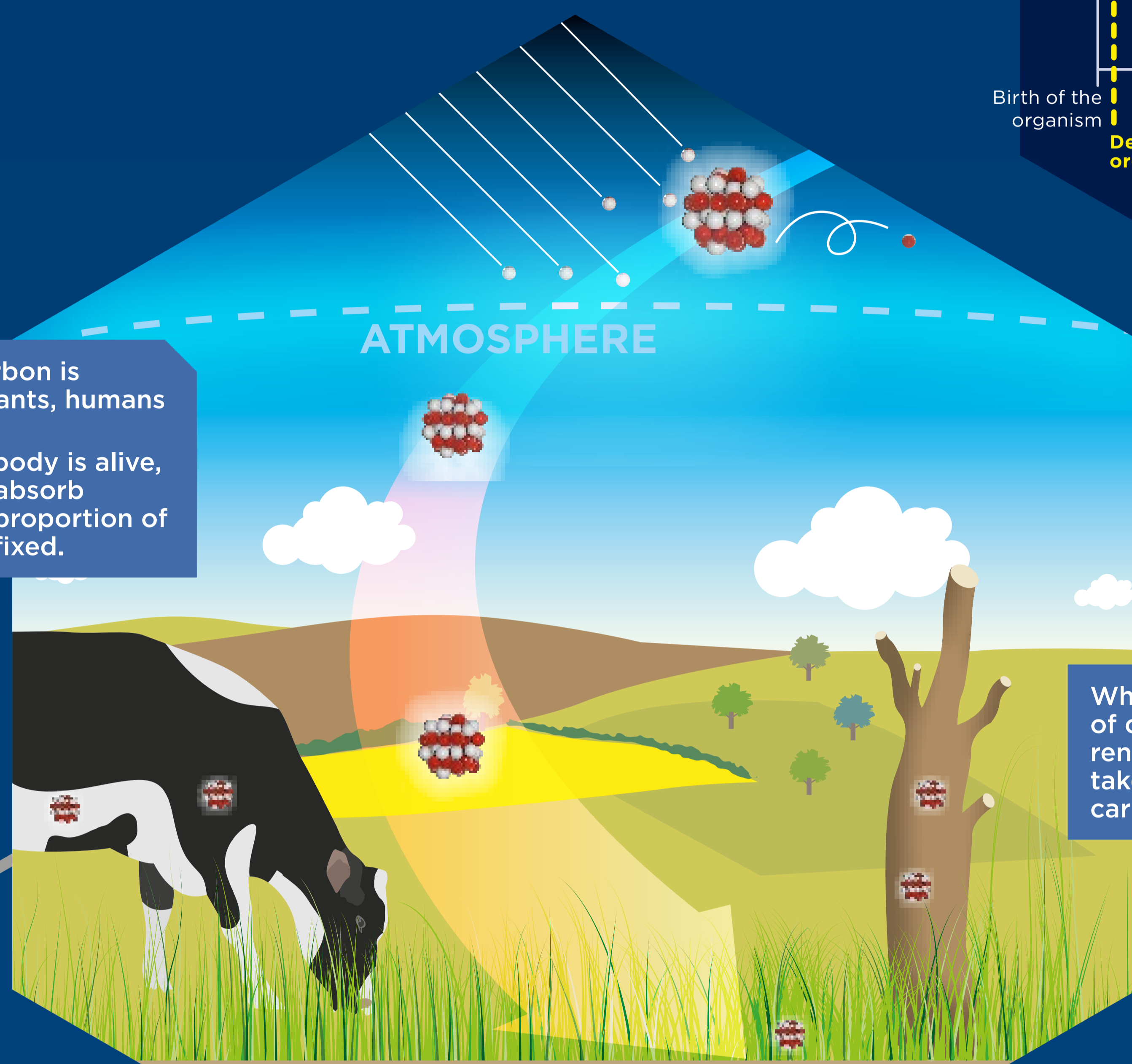


Carbon-14

It is naturally present in the air. It is produced from collisions between stable carbon in the air and cosmic rays. Its half-life is 5730 years.

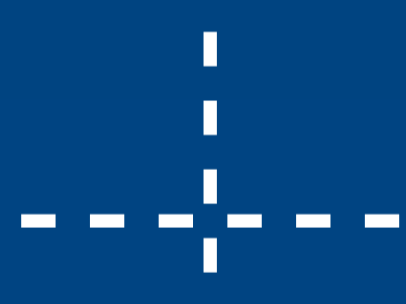


Radioactive carbon is absorbed by plants, humans and animals. As long as the body is alive, it continues to absorb carbon-14, the proportion of which remains fixed.



When an organism dies, its store of carbon-14 is no longer renewed: as radioactive decay takes place, less and less carbon-14 remains.

By determining how much carbon-14 remains in a sample compared with the normal level for living organisms, we can determine the date of death of the plant, person or animal. This method was used to identify the era in which mammoths lived.



PRESERVE

Radiation is ideal for disinfecting furniture, statues and mummies. Disinsectisation involves sterilising or destroying insects that attack old wood. Disinfection aims to destroy fungi, moulds and other parasites. This requires higher doses.





LITTLE-KNOWN USES OF RADIATION

TRANSFORM, PROPEL



Ionising radiation can be used to **transform** materials, but also to **propel** ships and space probes.

TRANSFORM

By irradiating materials, their properties can be modified to make them lighter or stronger, for example. This does not mean that they become radioactive.



VULCANISING TYRES

The elasticity and strength of tyres can be improved by irradiation.

WOOD PROTECTION

Wood protection resins can be reinforced by irradiation. The parquet floor in the Grande Galerie de l'Évolution at the Natural History Museum in Paris has been treated in this way to protect it from the many visitors who pass through it.

BABY NAPPIES

The effect of radiation can change the molecular structure of certain materials, allowing them to absorb considerable quantities of liquid, for example. This property has been used to make highly absorbent nappies.



HARDENING OF PLASTICS

Plastic playing card cases, packaging and electrical cable sheaths are irradiated to increase their resistance to chemicals and heat.

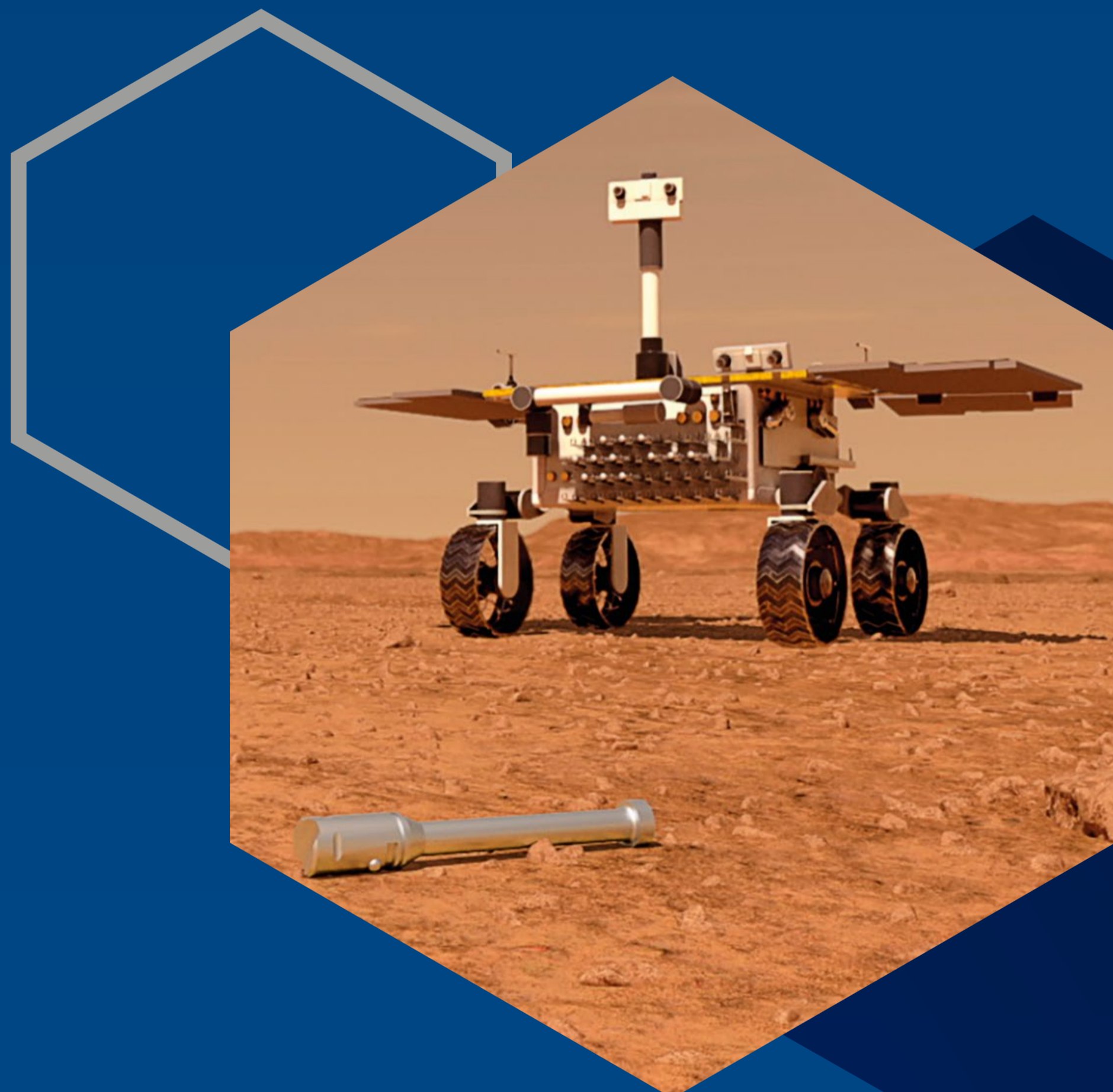
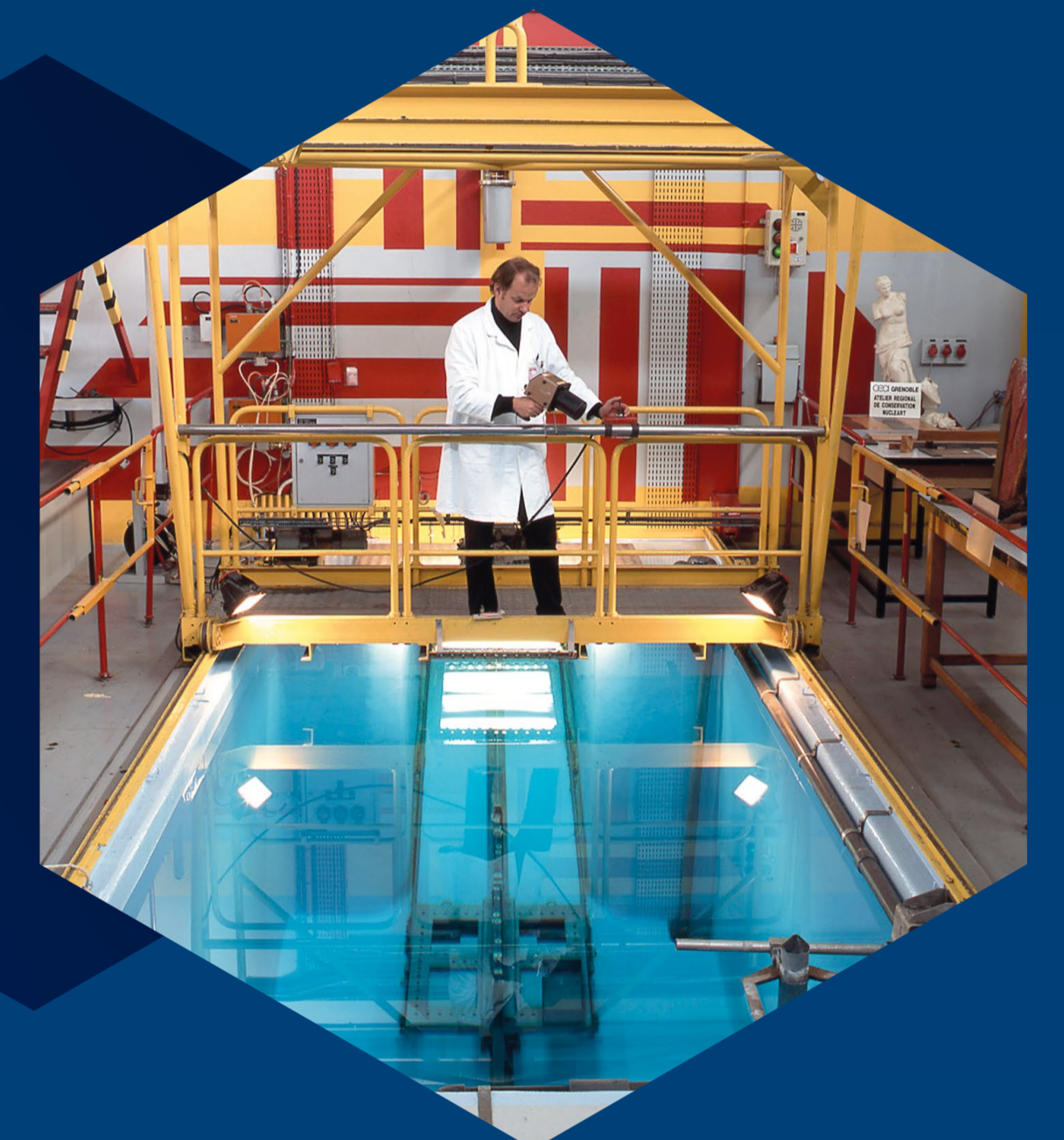
NANOSTRUCTURING

Using an irradiator, we can sculpt matter on a very small scale, that of the nanometre (10^{-9} m). Nanostructures have many applications, including miniature medical implants, microscopic electronic circuits and new ultra-fast-charging batteries.



TEFLON COATINGS

Teflon pan linings are made from micro-grains obtained by irradiation.



PROPEL

Radioactivity can be a source of energy for ships or space exploration machines.

THE ATOMIC BATTERY

Exploration space probes and Mars rovers need a stable, long-lasting energy source that requires no maintenance.

They are equipped with an atomic cell: a generator that produces electricity from heat, and this heat is produced by the radioactive decay of materials rich in plutonium-238.

NUCLEAR REACTOR

Some submarines, ice-breakers and aircraft carriers are powered by nuclear reactors that operate in the same way as power stations.

The advantages of nuclear propulsion over conventional propulsion are greater range, a smaller footprint (no fuel tank) and considerable power.

However, there are safety issues involved.





LITTLE-KNOWN USES OF RADIATION

AUTHORISED YESTERDAY... BANNED TODAY



In the past, radioactivity was used in a number of objects that are now **banned**. It's best to get rid of them, and Andra collects them.



LET'S NOT REPEAT HISTORY

RADIOACTIVITY FOR REJUVENATION

Marketed in the 1920s and 1930s, carafes containing capsules of radium salts were supposed to provide "invigorating water". A great American golf player died prematurely.

RADIOACTIVITY FOR BEAUTY

In the early 1930s, a radium and thorium beauty cream was launched on the market. Named Tho-Radia, it promised to make women more beautiful by erasing their wrinkles.

In 1937, radium and thorium were classified as poisonous substances, putting an end to the brand's "miraculous" product.

RADIOACTIVITY FOR BETTER NIGHT VISION

In the 1920s, radium was used in luminescent paints on watches, alarm clocks and aircraft instruments, for use at night.

The women who painted these objects in the factories developed cancer and necrosis of the jaw because they would use their lips to smooth their paintbrush bristles.

RADIOACTIVITY AS A CURE

Radium objects for medical use (ORUM) were widespread at the beginning of the 20th century. The surgeons' and radiologists' offices were equipped with radium needles, probes and compresses.

These objects are among the most active and therefore the most dangerous. If you have any, you should dispose of them with Andra.



RADIATION PROTECTION IS ALWAYS EVOLVING...

Until the 1980s, radioactive lightning rods were installed on roofs. They have been banned since 1987, but some remain in place.

Until the early 2000s, smoke detectors incorporating a radioactive source were widely used. Since then, new technologies have appeared that are just as reliable but without the risks.

Under normal circumstances, neither presents a danger to human health. However, they can present risks if they are damaged or dismantled.

For further information

on the collection process, go to the Andra website, "Espace producteur" (Waste producer section)



AND TODAY?

The addition of radioactive substances is prohibited in consumer and construction products. Waivers are possible but remain exceptional. The use of radioactivity is only justified if there is no equivalent technique.

INAPARAD

The official website for the national inventory of radioactive lightning rods.



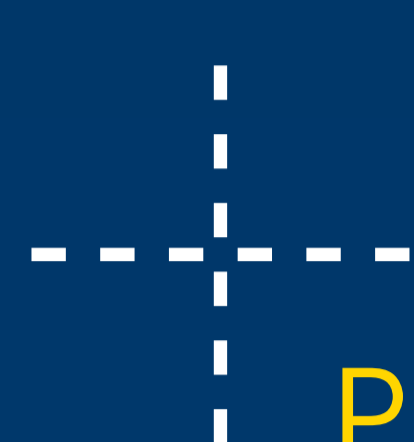


LITTLE-KNOWN USES OF RADIATION

CARE FOR ANIMALS



Pets and farm animals also benefit from the medical uses of ionising radiation.



PET CARE

19,000 veterinarians in 6,000 practices in France are equipped with X-ray equipment.



Like humans, animals may suffer from an accident or fall. In this case, X-rays are just as useful for locating and treating any fractures.

Just like us, our pets are at risk of developing cancer. They can be diagnosed and treated using the same radiotherapy techniques as humans.



CARE FOR LARGE ANIMALS

Treatment of large animals requires specially adapted equipment and premises, or portable X-ray generators (**mobile radiography**).

Equine mobile radiodiagnosis requires the presence of several people, mainly to hold the animal or the equipment in place. These practices must be regulated and monitored to protect everyone involved from the dangers of ionising radiation.

