Menu² ELEMENTOS
150 aniversario de la tabla periódica 1869-2019

THE OTHER 'ELEMENTS' IN THE PERIODIC TABLE

Element *(noun)*

Lat. *elementum*

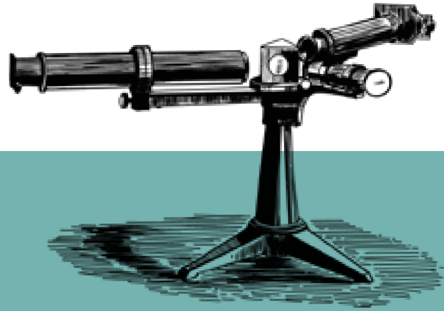
1. an essential or characteristic part of something abstract – "the death had all the elements of a great tabloid story"
2. Chem. each of more than one hundred substances that cannot be chemically interconverted or broken down into simpler substances and are primary constituents of matter. Each element is distinguished by its atomic number, i.e. the number of protons in the nuclei of its atoms
3. the rudiments of a subject – "legal training may include the elements of economics and political science"
4. any of the four substances (earth, water, air, and fire) regarded as the fundamental constituents of the world in ancient and medieval philosophy
5. a part in an electric kettle, heater, or cooker which contains a wire through which an electric current is passed to provide heat
6. a person's or animal's natural or preferred environment
7. a group of people of a particular kind within a larger group
8. Mat. an entity that is a single member of a set

The Oxford Dictionary, in relation to chemistry, defines elements as a 'primary constituents of matter'. But we can also understand "elements" to mean each one of those individuals 'of a particular kind within a larger group', those who deserve recognition for their collaborative work.

This exhibition is dedicated precisely to these other "elements", the scientists who discovered the different chemical elements in the Periodic Table, to share their peculiarities and thus humanise them. Because there is no better way to approach, discover and enjoy science than through the stories of its protagonists, their lives and "miracles", and also their quirks and oddities.

First published in 1869 by the Russian chemist Dimitri Mendeleev, the Periodic Table of the Chemical Elements is one of the greatest achievements of science and a fundamental tool for chemistry.

Not surprisingly, in such a simple, visual and intuitive structure, it condenses many of the main properties of all the known elements, including their affinities and tendency to interact with each other, key factors in predicting their behaviour in different chemical reactions.

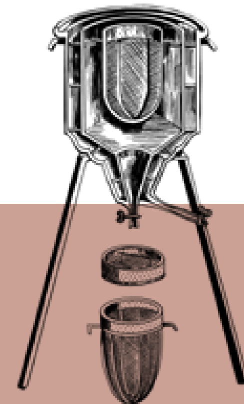


EMISSION SPECTROSCOPE

The most important instrument in the history of the discovery of the chemical elements.

"It is known that several substances have the property of producing certain bright lines when brought into the flame. A method of qualitative analysis can be based on these lines. The lines show up the more distinctly the higher the temperature and the lower the luminescence of the flame itself."

These were the opening words of the article published in 1860 in Annalen der Physik und der Chemie, in which Gustav Kirchhoff and Robert Bunsen explained the basis of the new analytical technique they had developed: emission spectroscopy.
They also described the apparatus they had built to make observations of these line spectra: the spectroscope. This was basically a wooden box or dark chamber with two eyepieces, one for the observer and the other placed in front of the flame into which the substance was then introduced. Inside the box or chamber was a prism that dispersed the spectrum.
Using this technique and apparatus, Kirchhoff and Bunsen discovered two new chemical elements in the same year: caesium and rubidium.



THERMOMETER AND CALORIMETER

Two devices that allow the specific heat of a substance to be measured.

Joseph Black, the discoverer of magnesium, pioneered the use of the thermometer as an analytical measuring instrument, an innovation that enabled him to discover and describe latent heat and specific heat.

The existence of these quantities prompted another “element”, Lavoisier, to invent – together with Laplace – a new instrument for measuring them: the calorimeter.

A calorimeter is a device that measures the amount of heat released during a chemical reaction, from which the heat capacity and specific heat of the substances involved in the reaction can be calculated.

In its most common design, the calorimeter consists of an inner chamber, in which the reaction takes place. This in turn is contained within an outer chamber, which is filled with a substance of known heat capacity, usually water. Thus, from the increase in temperature experienced by the water, the heat released in the reaction can be calculated.

The calorimeter invented by Lavoisier and Laplace contained ice in the outer chamber. The heat released was calculated from the amount of melted ice collected in a container under the calorimeter.

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EUDIOMETER

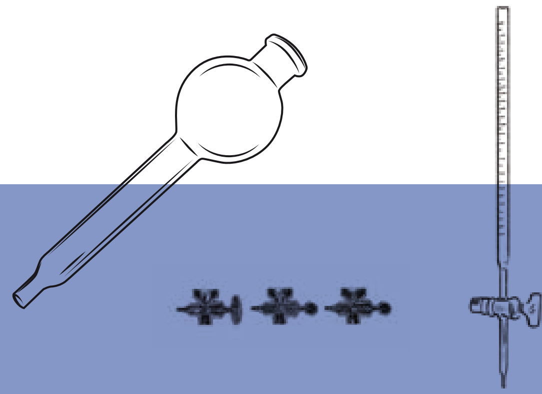
A device inspired by the experiments of Joseph Priestley, who discovered oxygen.

A eudiometer is a laboratory device that measures the change in volume of a gas or gas mixture when it is subjected to a physical or chemical process or transformation.

Joseph Priestley, the "element" who discovered oxygen, was the first to measure the change in volume of one gas when mixed with a known quantity of another gas – in a modified vacuum pump that he himself had designed – as a way of determining its oxygen content. In doing so, he laid the foundation for a new analytical technique: eudiometry.

Based on these experiments, in 1775 the Italian Marsilio Landriani designed the first eudiometer to measure the amount of oxygen in gas mixtures. However, it was Alessandro Volta who, just a couple of years later, perfected and modified the eudiometer, giving it its classic appearance: a thick, glass cylinder with the upper part pierced by a pair of electrodes. The gas under study and a known volume of hydrogen are placed inside the cylinder and made to react by means of an electric spark. The decrease in volume of the mixture allows the oxygen content to be determined.

PIPETTE AND BURETTE



One by Gay-Lussac, the other by Clemens Winkler

In 1824, Gay-Lussac published an article in which he coined the terms “pipette” and “burette” in reference to the laboratory instruments that he himself had designed, and which have been ubiquitous in chemistry laboratories ever since.

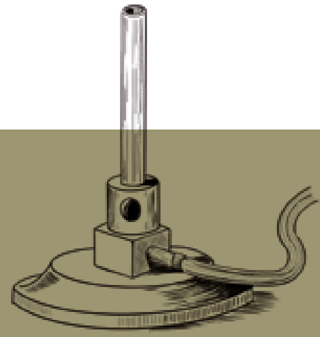
In fact, the current design of the pipette is virtually the same as Gay-Lussac’s design. However, this is not the case with his burette, which was a graduated cylinder with a side arm.

We owe the design of today’s burette largely to another “element”, Clemens Winkler. In his time – the mid-19th century – the locking mechanisms of the instruments consisted of a glass stopper, which imposed many limitations on his experiments with gases.

Winkler needed a stopcock that would allow him to route the gas in the container in different directions. He therefore approached the renowned glassblower and glass instrument maker Franz Hugershoff with his idea of a hollow, glass stopcock with three holes at 90° to each other, connected in pairs with a flexible tube. Following months of testing, Hugershoff managed to create the stopcock designed by Winkler.

This stopcock later inspired the “double-oblique stopcock”, the standard in today’s burettes.

BUNSEN BURNER



Robert Bunsen was always characterised as an avid experimenter. He was also an expert glassblower and used to make his own material, designing and inventing new or improved devices, instruments and laboratory equipment: ice and steam calorimeters, the Bunsen battery, a filtration pump and a thermopile.

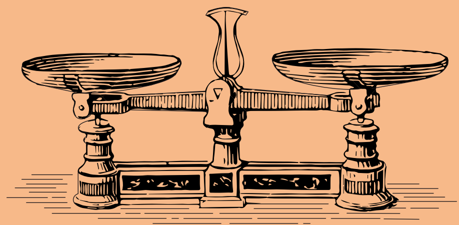
And, of course, the famous Bunsen burner. Devised during the 1850s based on the inventions of Argand and Faraday, this new burner provided a translucent, high-temperature flame, making it ideal for chemical tests and analyses, and replaced the blowtorch as the main heating source in laboratories.

Bunsen used his burner to identify metals and salts by the colour of the flame they produced, which could now be seen without interference from the source. In addition, because of the high temperatures it could reach, he also used it to measure the melting points of many salts.

In the 1860s, he and Kirchhoff developed a new identification technique, emission spectroscopy, and the spectroscope to carry it out. Their gas burners provided the heat and translucent flame needed to stimulate the emission:

“Bunsen’s gas-burner gives a flame of very high temperature and very slight luminosity, and is well adapted for experiments to identify these characteristic lines of the substances.”

ANALYTICAL BALANCE



Although Joseph Black is considered the precursor of the use of the balance in chemical analysis, no “element” made better use of it than Antoine Lavoisier, a fanatic of precision in measurement.

His systematic use of the balance led him to discover and enunciate his famous law of conservation of mass (or matter):

“In a chemical reaction mass is not created or destroyed, it is only transformed.”
He arrived at this conclusion after carrying out innumerable reactions and observing that the total mass of the products in a chemical reaction was exactly the same as the total mass of the reactants.

This was a fundamental law in the subsequent development of chemistry, in the study of how and in what way the different chemical elements combine with each other. It was also fundamental for the formulation of the atomic theory.

Lavoisier discovered that the different chemical elements are composed of indivisible units, known as atoms, which are the same as each other but different to the atoms of the other elements.

Thus, the atoms of the various elements differ in mass. In a chemical reaction, the atoms retain their identity and are not destroyed, but rather combine with each other to form new compounds.

The use of the new, more precise balances enabled another “element”, Jöns Jacob Berzelius, to calculate with excellent precision the atomic mass of the 54 elements known at the time, which was of great significance for Mendeleev’s discovery of the Periodic Table years later.

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THE ELHUYAR BROTHERS

In 1783, while working in the chemical laboratory in Vergara, the Elhuyar brothers isolated and identified a new element, wolfram, from a sample of wolframite mineral, in their race to get ahead of the Swedish chemists of Uppsala who also sought to isolate and identify the new element.

From all the compounds on the shelf, identify the four reagents involved in the process. If you identify them correctly and put them in their respective boxes, the bulb will light up. If you identify all four of them but place them in the wrong order, the light bulb will flash. Good luck!

The Elhuyar brothers managed to isolate and identify this new element via the following process:

Ground wolfamite + Potassium carbonate → Potassium wolframate + Ferrous oxide + Manganese oxide + Carbon dioxide

Potassium wolframate + Nitric acid → Wolframic acid + Potassium nitrate

Wolframic acid + Heat → Wolframic oxide + Water

Wolframic oxide + Graphite powder → Pure wolframate + Carbon monoxide

Ground wolfamite

Potassium carbonate

Nitric acid

Graphite powder