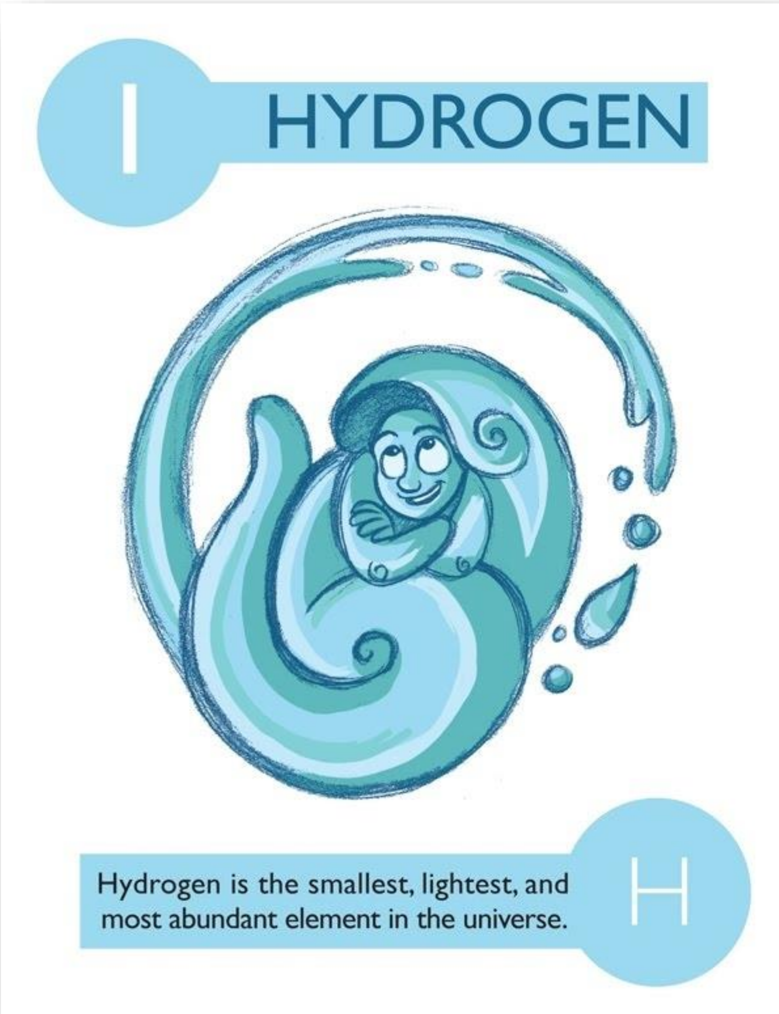
Periodic Table – 30 Second Elements

Periodic Table – 30 Second Elements

Periodic Table – 30 Second Elements

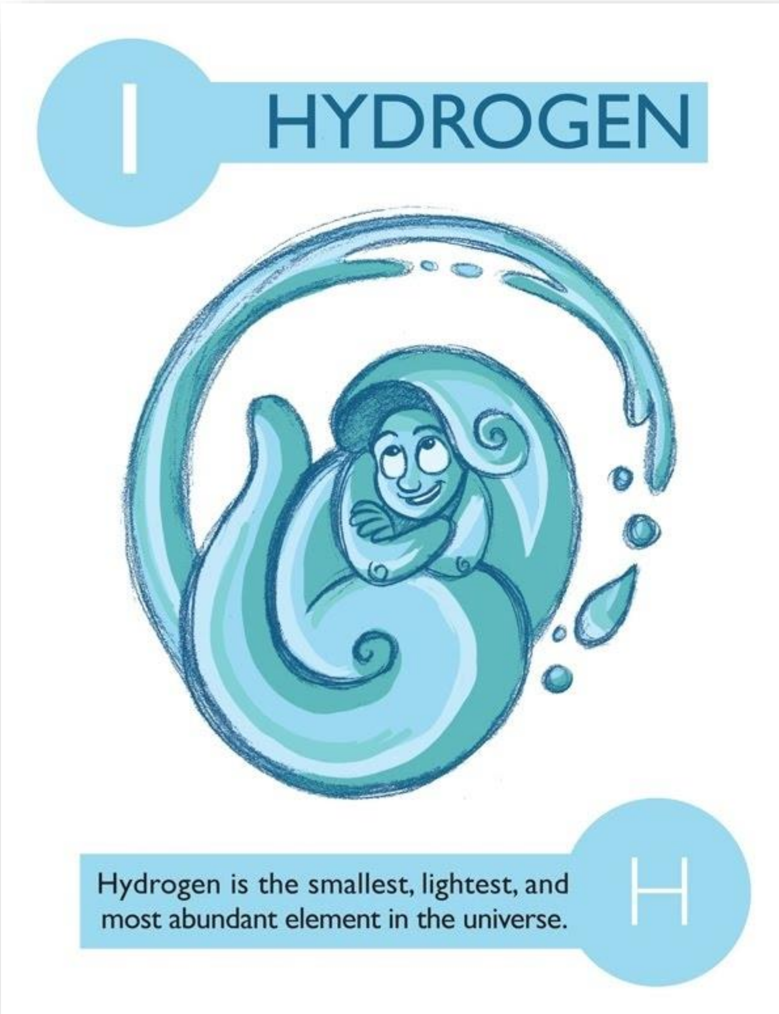


• Hydrogen, H

The most abundant and simplest of the chemical elements – a single proton and a single electron – hydrogen has been around since atoms coalesced following the Big Bang more than 13 billion years ago. Even though stars eat into that initial production, hydrogen still forms 75 percent of the detectible content of the universe. This light, colourless, highly flammable gas is essential for life. Without it, we wouldn't have the sun's heat, water or the organic compounds that form the building-blocks of life. It is only because hydrogen forms weak bonds between molecules that water is a liquid on earth. Without these *hydrogen bonds*, water would boil below –70 °C.

Return to Main Menu

Periodic Table – 30 Second Elements



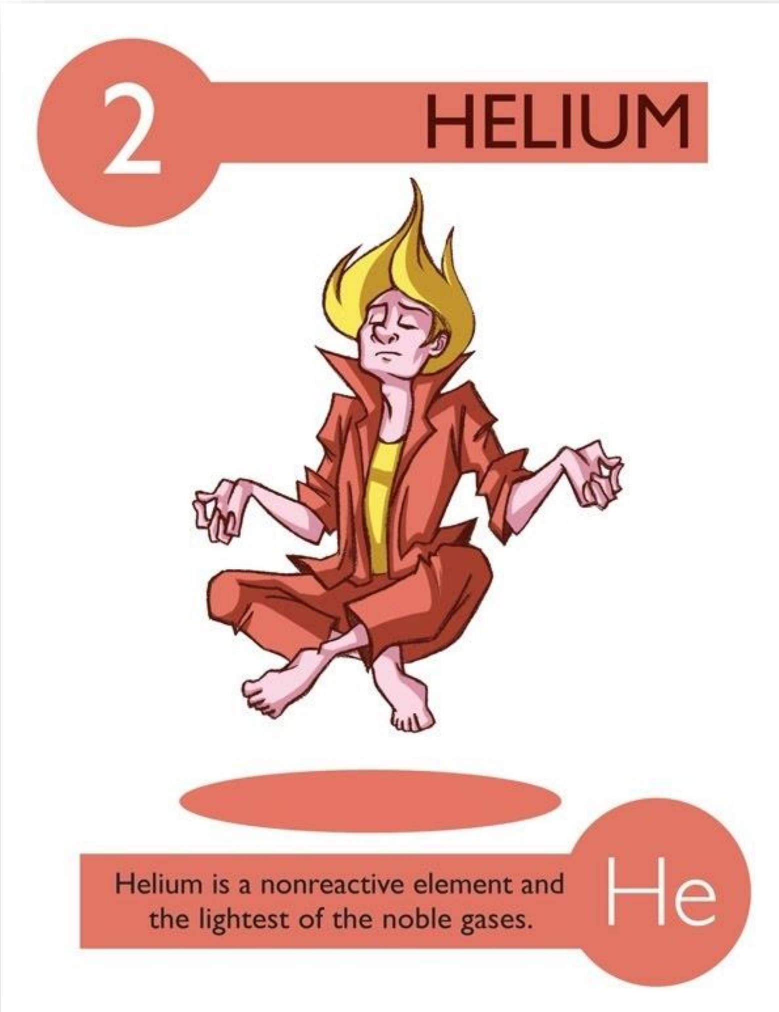
- **Hydrogen**, **H**

Hydrogen was isolated by British scientist Henry Cavendish in the middle of the 18th century and soon put to use; its low density makes it buoyant in air – a natural filling for balloons. French scientist Jacques Charles started this trend in 1783, but hydrogen really took off with dirigibles and zeppelins – until destruction by fire of German airship LZ129 *Hindenburg* in 1937 doomed the hydrogen airship. More recently, hydrogen has been proposed as a replacement for fossil fuels in cars – when combined with oxygen in a hydrogen fuel cell to generate electricity, it produces no carbon dioxide, only harmless water:

$$2H_2 + O_2 \rightarrow 2H_2O$$

Return to Main Menu

Periodic Table – 30 Second Elements

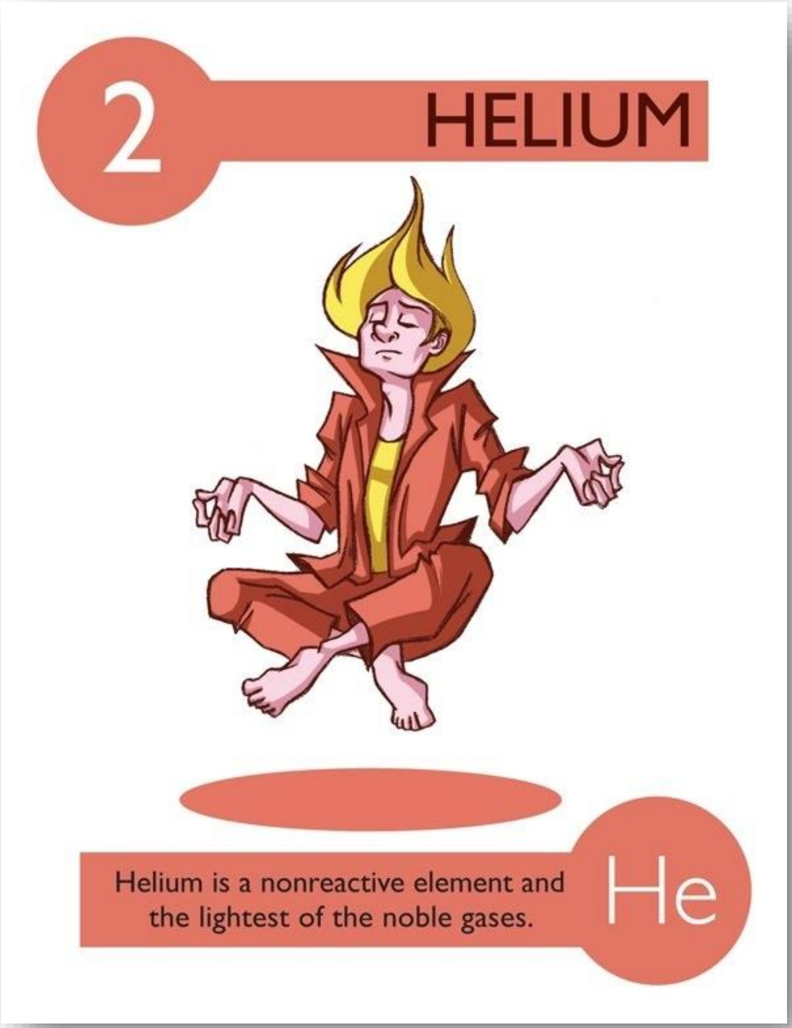


• **Helium**, **He**

This lightest noble gas makes-up nearly one quarter of the matter in the universe by mass – yet it was not noticed until 1868, when British astronomer Norman Lockyer found previously unknown spectral lines in light from the sun. Spectroscopy identifies elements present in a substance from dark lines that appear in a rainbow of light passed through a gas. Each element has a fingerprint of lines that can be used to identify it, even in the remote light from stars. French astronomer Jules Janssen also spotted the unexpected lines, but it was Lockyer who correctly identified it as a new chemical element, which he named helium after the word *helios* – Greek for sun.

Return to Main Menu

Periodic Table – 30 Second Elements

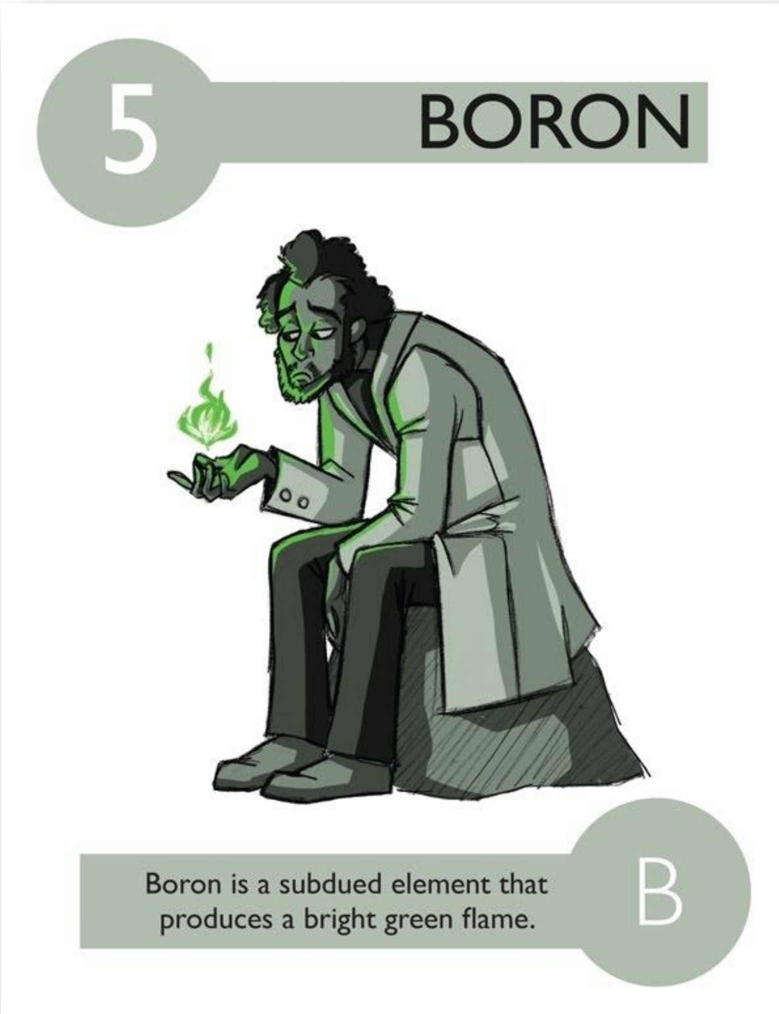


- **Helium**, **He**

In the 1890s, British chemist William Ramsay produced the gas when dissolving the mineral cleveite in acid. Helium is now primarily obtained as a by-product of natural gas extraction. We are familiar with the gas in lighter-than-air party balloons. The gas produces a distinctive squeaky voice when inhaled because the speed of sound in helium is significantly higher than in air. Helium's very low boiling point of just above 4 K (–269 °C) makes it ideal for cooling super conducting magnets in magnetic resonance imaging (MRI) scanners.

Return to Main Menu

Periodic Table – 30 Second Elements



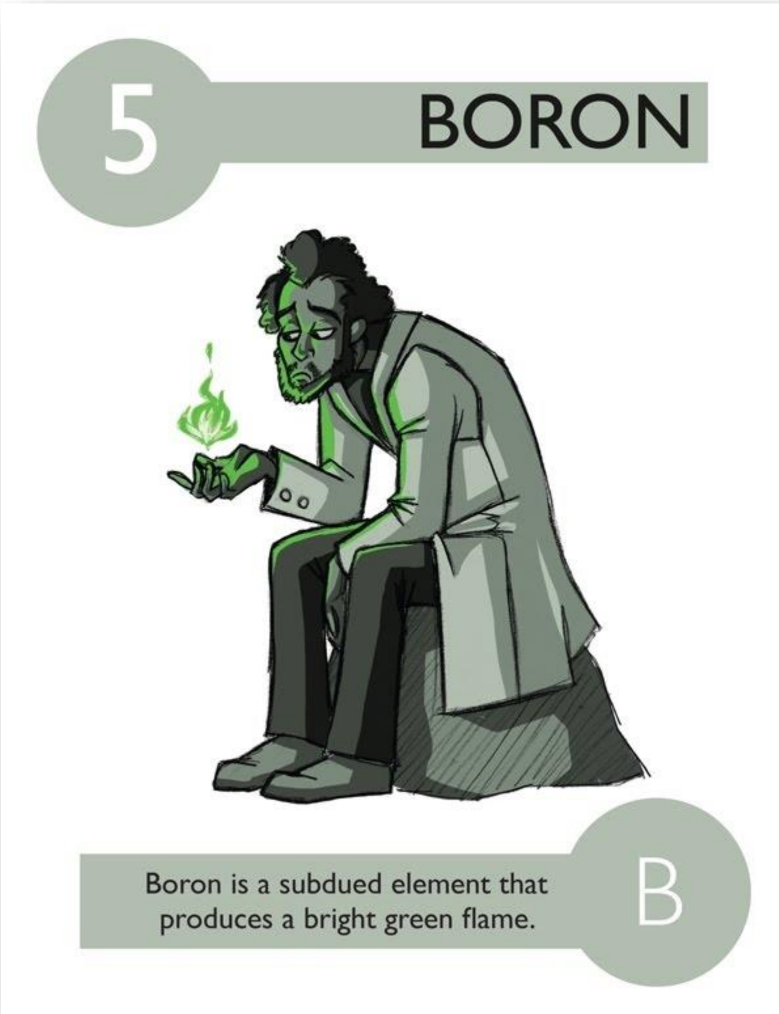
- **Boron**, **B**

Boron is the third lightest solid non-metal, very different from aluminium and the other metals in its Group of the Periodic Table. It was isolated as very hard, dark grains in 1808 by Humphry Davy working in London, and independently, by Louis-Joseph Gay-Lussac and Louis-Jacques Thénard working in Paris.

Boron is scarce but widely distributed throughout the earth’s crust. It is mined from a few rich deposits of calcium borate ($Ca_3(BO_3)_2$) and borax ($Na_2B_4O_7$). The existence of borax has been known since ancient times when it was used as a flux for working with molten metals.

Return to Main Menu

Periodic Table – 30 Second Elements



• Boron, B

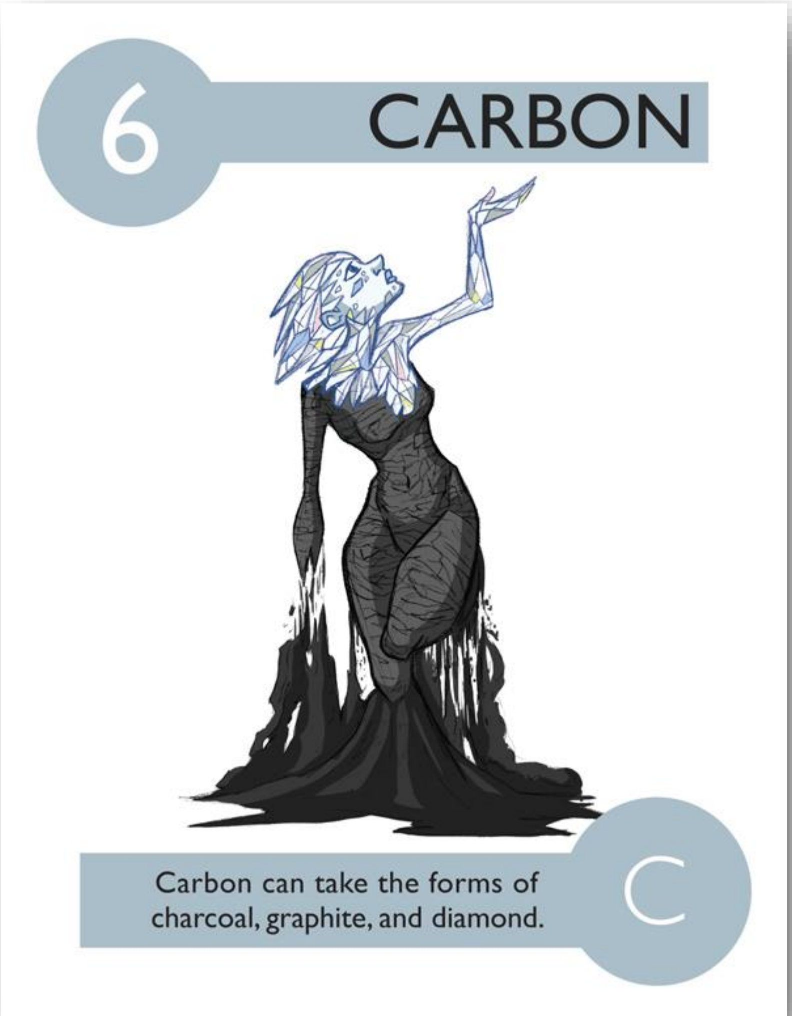
Boron is essential to plant life and as a micronutrient for animals.

Boron combines with carbon to form a very hard ceramic – boron carbide (B_4C) – which is used to make tank armour, bullet-proof vests and also to shield nuclear reactors. One of boron's compounds with nitrogen has the structure of diamond and is almost as hard, but is more heat resistant, and therefore a valuable abrasive. Another one of boron's compounds with nitrogen has the hexagonal structure of graphite and is used as a lubricant.

Boric acid (H_3BO_3) is a weak acid that has antiseptic properties and is one of the few chemicals that can kill cockroaches.

Return to Main Menu

Periodic Table – 30 Second Elements

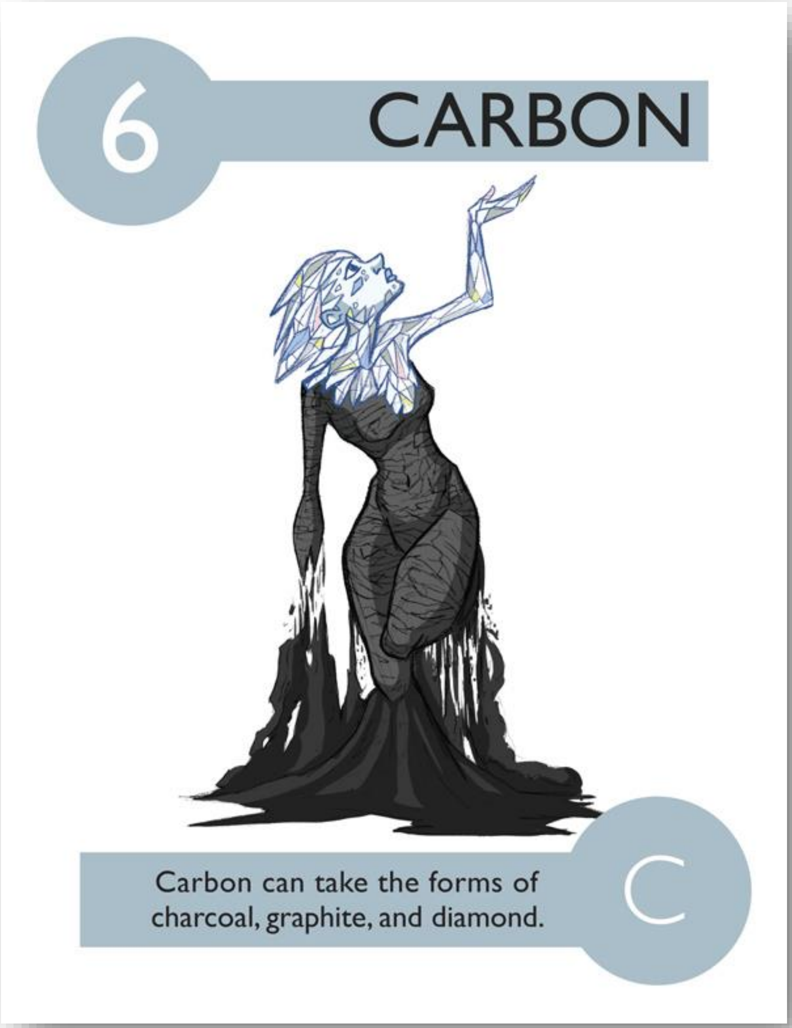


- **Carbon, C**

For mystique, kudos and significance, no element beats carbon. The readiness of carbon atoms to bond with each other into chains, rings and other complex frameworks enables them to provide the scaffolding of life's molecules. Carbon is the fabric of diamonds, formed deep in the earth's mantle – mostly from carbon trapped inside the planet when it formed. Diamond's dirty sibling graphite is pure carbon too, made from sedimented remnants of dead plants that are compressed and altered in the earth's crust, via coal, until only carbon remains. Diamond and graphite differ in how their carbon atoms are bonded.

Return to Main Menu

Periodic Table – 30 Second Elements

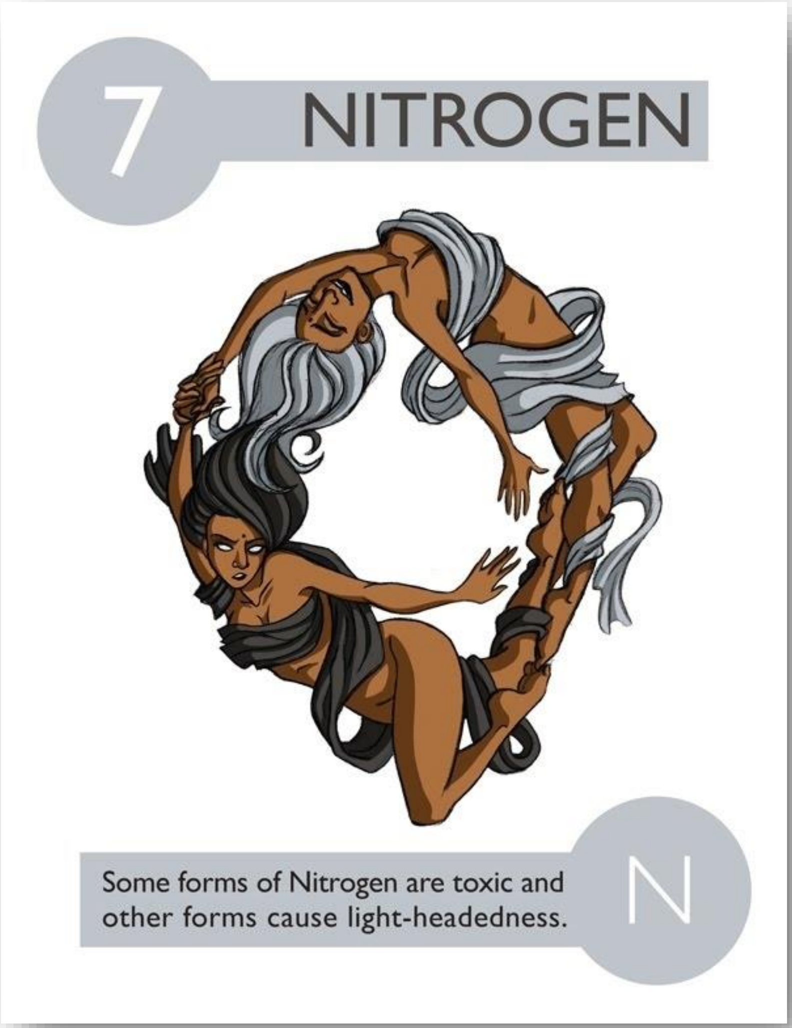


- **Carbon, C**

In diamond, each carbon atom is bonded to four neighbours in a three-dimensional network. In graphite, each carbon atom is bonded to three neighbours in sheets of hexagonal rings. These different structures make the difference between super hard, glittering transparency and soft metallic greyness, between diamond in drill bits and graphite in pencils. Some stars contain carbon and their cores may contract to form planet sized diamonds. Diamond and graphite aren't carbon's only elemental states. Individual sheets of graphite (graphene) tubes of carbon atoms (carbon nanotubes) and hollow molecular balls (fullerenes) are central to nanotechnology.

Return to Main Menu

Periodic Table – 30 Second Elements

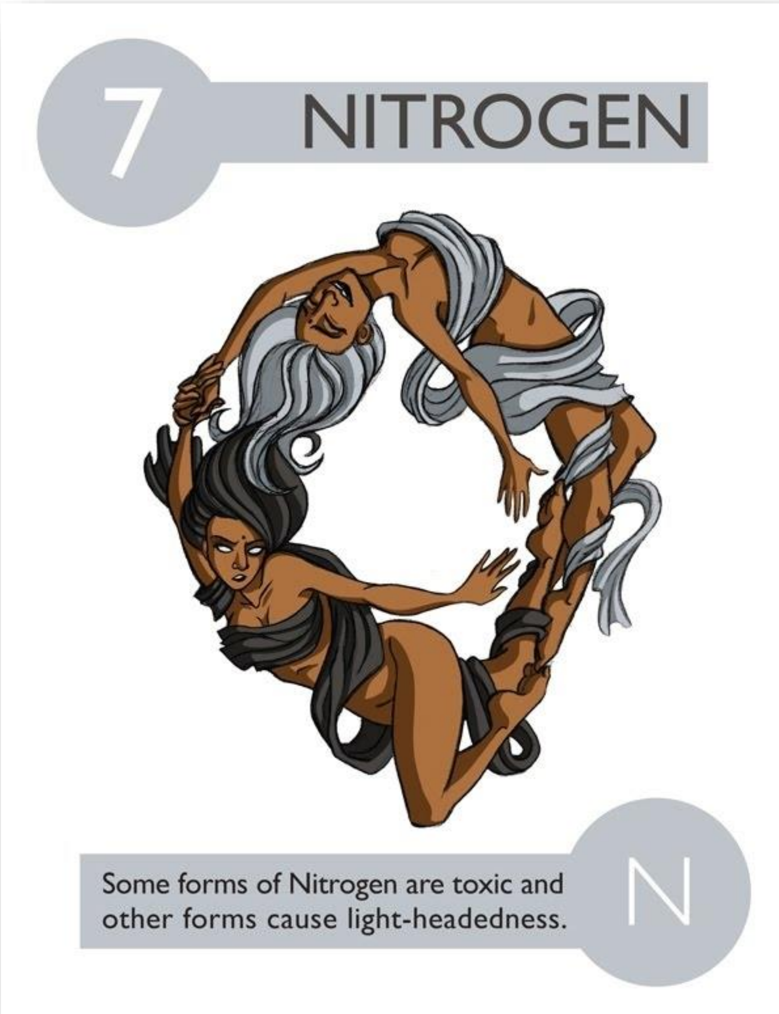


• **Nitrogen**, **N**

Elemental nitrogen constitutes 78 percent of the earth's atmosphere. Nitrogen was first recognised as an element in the modern sense by French chemist Antoine Lavoisier in 1787. Both nitrogen's natural isotopes (^{14}N and ^{15}N) are stable; 14 radioactive isotopes have been found. Radioactive ^{13}N is made for use in positron emission tomography (PET) scans – an imaging process that produces three dimensional images of the body. Liquid nitrogen at a temperature of –196 °C is used principally as a refrigerant for purposes including the preservation of biological samples. There are various oxides of nitrogen (combinations of nitrogen and oxygen).

Return to Main Menu

Periodic Table – 30 Second Elements

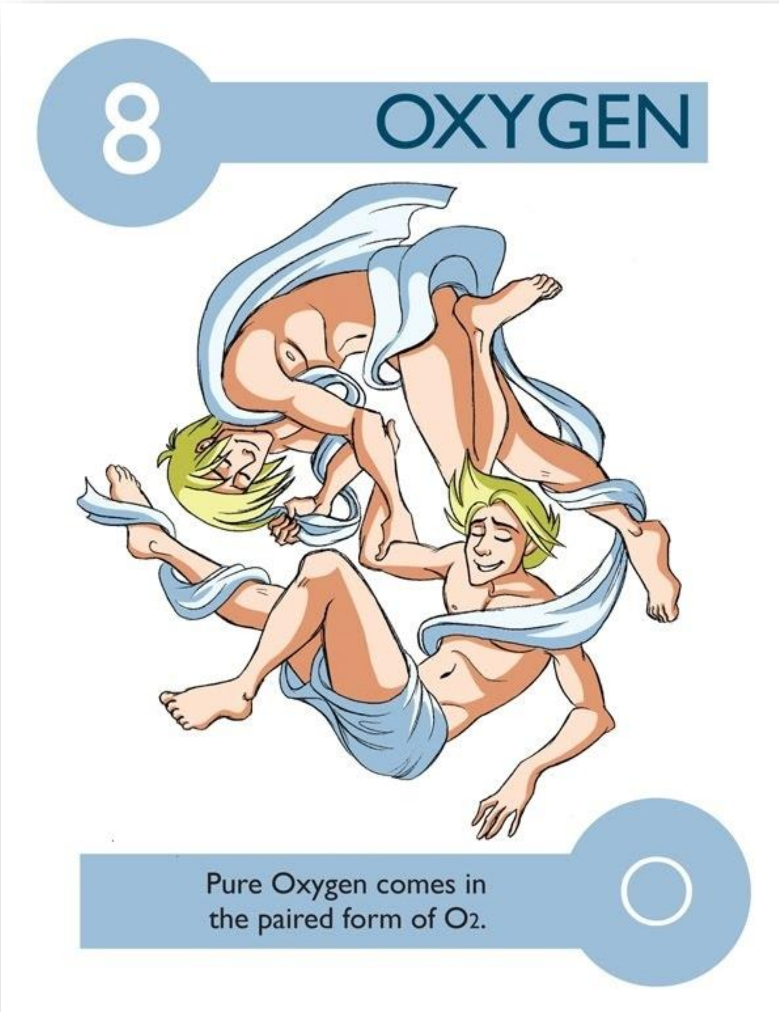


• **Nitrogen**, **N**

One atom of nitrogen and oxygen (NO) makes a muscle relaxant. With more nitrogen (N_2O) it makes *laughing gas*, used as an anaesthetic. More oxygen (NO_2) produces a toxic gas found in vehicle exhausts – one of the sources of acid rain. Nitrogen is essential for life, being part of DNA, all proteins, and of various neurotransmitters. Most of the nitrogen in nature is atmospheric, and it is converted by bacteria in the soil into nitrates (NO_3^-). In the industrial Haber process, nitrogen is combined with hydrogen to make ammonia (NH_3). In the Ostwald process, ammonia is combined with nitrogen to make nitric acid (HNO_3).

Return to Main Menu

Periodic Table – 30 Second Elements

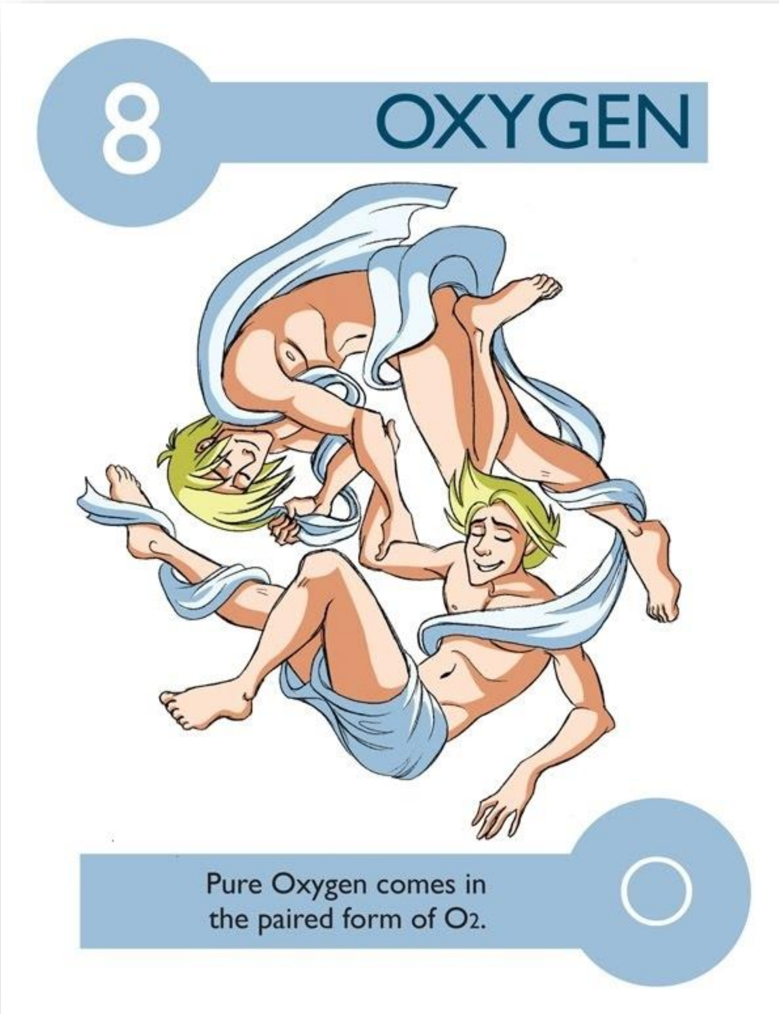


• Oxygen, O

Oxygen is the third most abundant element in the universe, due to its stable *doubly magic* nuclear structure. (The theory of *magic nuclear numbers* is based on studies of nuclei that are especially stable because they contain a particular – *magic* – number of protons and neutrons. When there is a *magic* number of both protons and neutrons, the nucleus is *doubly magic*). The element was recognised in 1774 by French chemist Antoine Lavoisier, overturning the phlogiston theory of combustion (which postulated that things contained a fiery – phlogiston – released when they burnt) and leading to our modern understanding of energy, mass and heat.

Return to Main Menu

Periodic Table – 30 Second Elements



• Oxygen, O

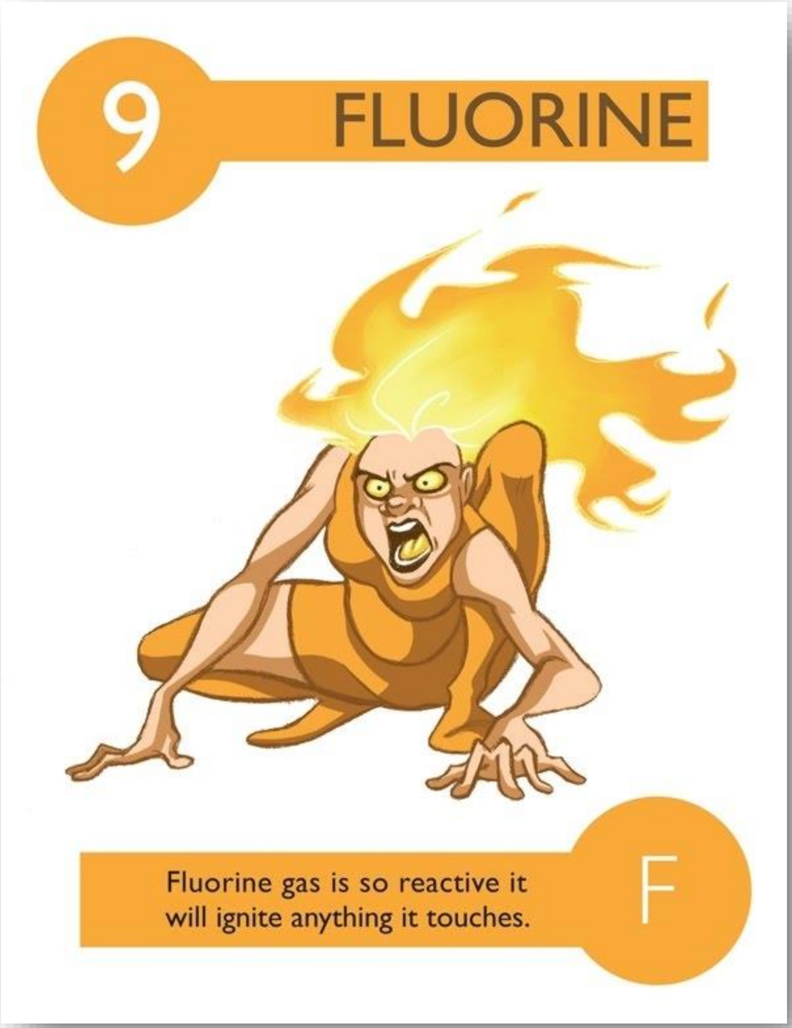
Lavoisier named the element oxygène, from Greek words meaning "begetter of acids" because he believed it to be present in all acids. Elemental oxygen is a highly reactive oxidising agent. In meteorites, oxygen is always found chemically bonded, usually in silicate minerals. The earth's atmosphere was originally oxygen free, but today 21 percent of the atmosphere consists of diatomic oxygen molecules (O_2). This is a by-product of the biological process of photosynthesis:

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

Therefore, scientists examining planets outside our solar system look for the presence of O_2 as an indication of life.

Return to Main Menu

Periodic Table – 30 Second Elements

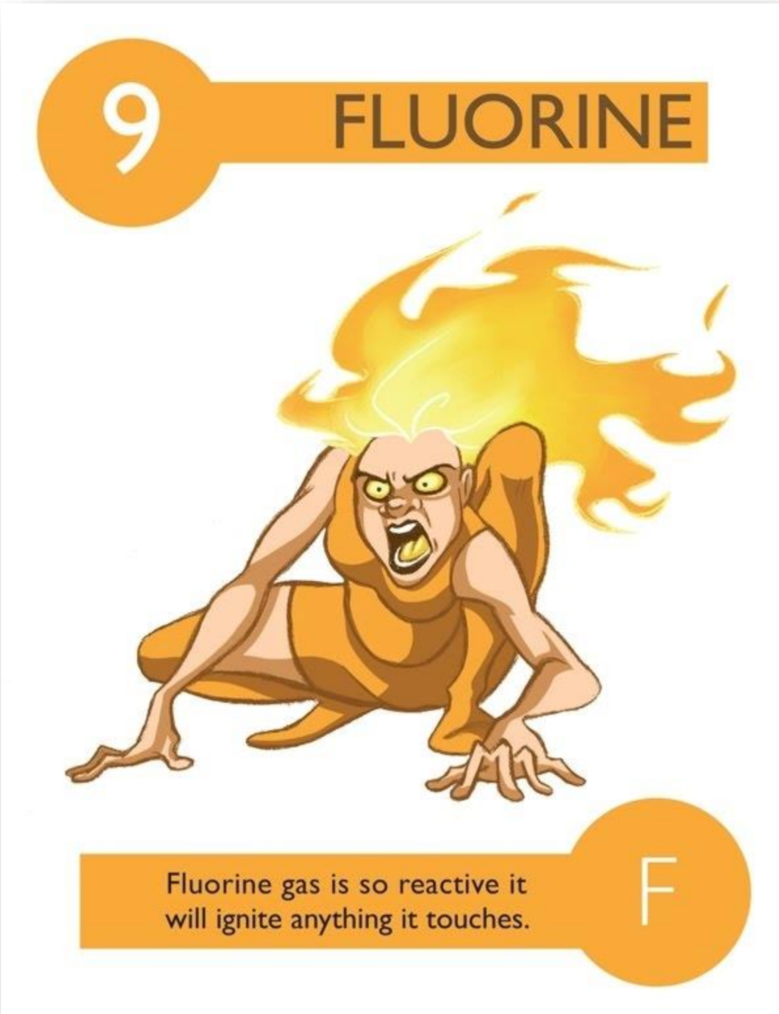


- **Fluorine, F**

Early chemists knew that the mineral fluorspar (calcium fluoride, CaF_2), used in welding metals and etching glass, contained an unknown element, but they could not isolate it. This element was eventually obtained in 1886 by French chemist Henri Moissan, as the pale yellow gas fluorine, by the electrolysis of potassium fluoride in liquid hydrogen fluoride. Fluorine is still produced by this method and is used in the manufacture of products such as Teflon. Teflon, a fluorinated polymer, is used for cable insulation, non-stick pans and the wet-weather fabric Gore-Tex; another use for Gore-Tex is in artificial veins and arteries.

Return to Main Menu

Periodic Table – 30 Second Elements

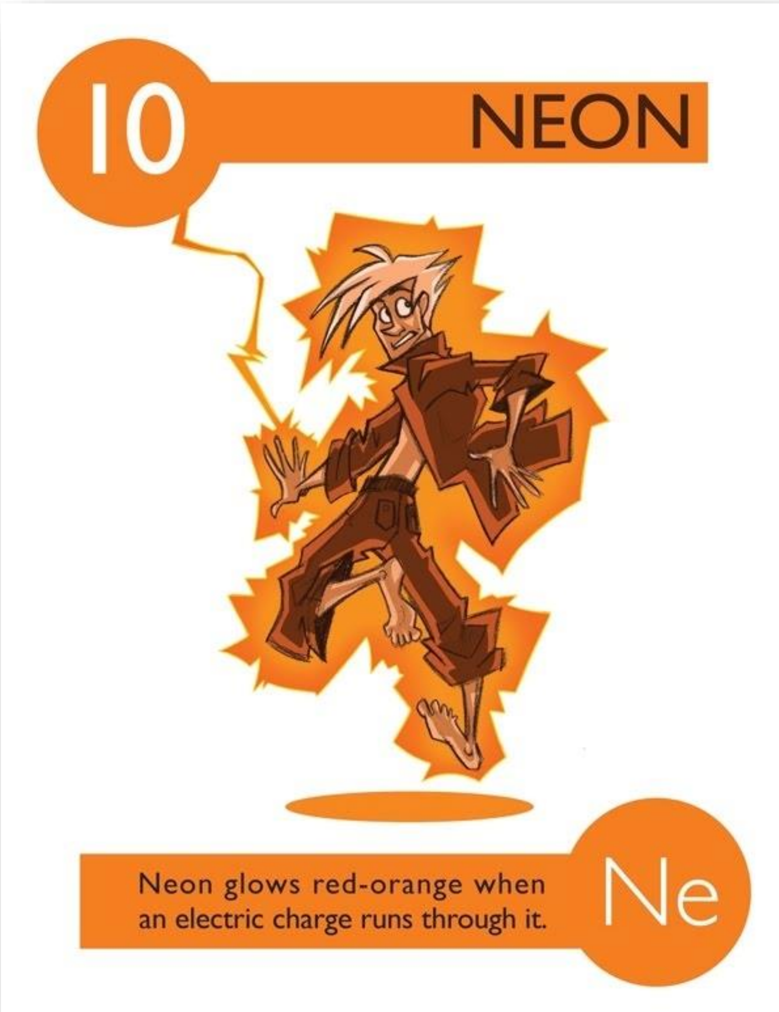


- **Fluorine, F**

Fluorine is now generally diluted with nitrogen. When polythene containers are treated with this gas, an impenetrable fluorinated layer is formed. These containers make ideal fuel tanks because they are less likely than conventional tanks to rupture in a crash. Fluorine is also used to make uranium hexafluoride (UF_6) and thereby extract the isotope ^{235}U (the fuel of nuclear reactors). The fluoride ion (F^-) strengthens bones and teeth by converting the calcium phosphate of which they are made into a harder mineral, fluoroapatite ($Ca_5(PO_4)_3F$). Some medical molecules contain fluorine in their structure, such as the antifungal medicine fluconazole.

Return to Main Menu

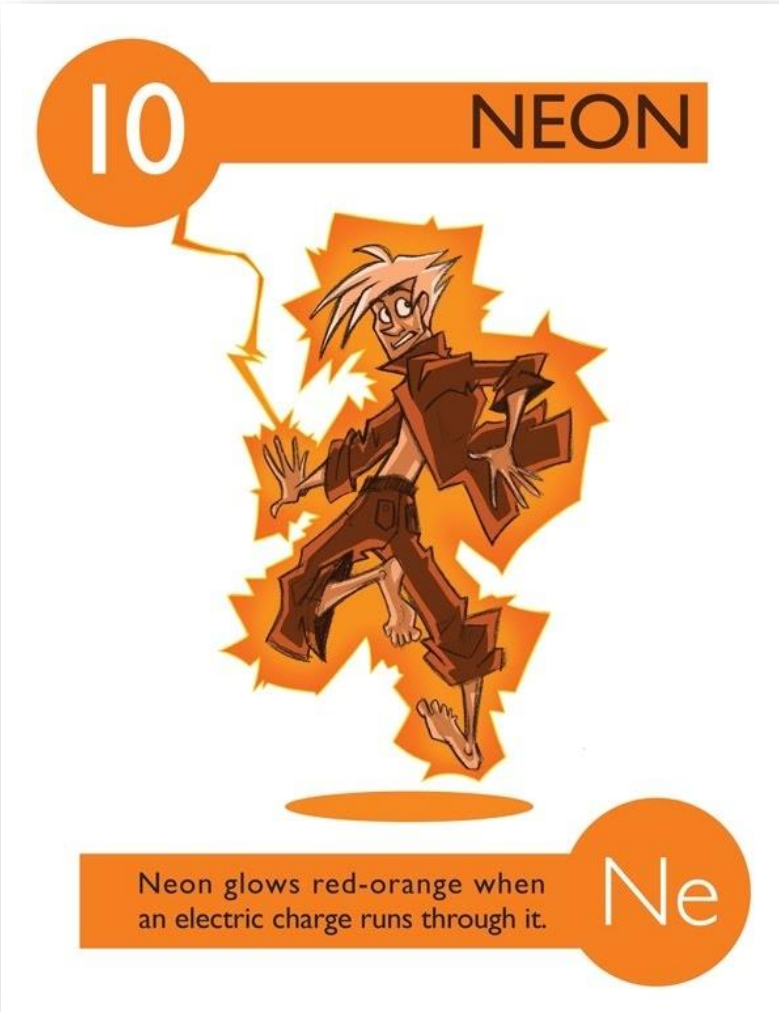
Periodic Table – 30 Second Elements



- **Neon**, **Ne**

During the 1890s, new technology used to liquefy air enabled the British chemist William Ramsay to separate out minor gaseous constituents whose existence had hardly been suspected. He isolated five new chemical elements now known as noble gases, including neon, which constitutes about one part in 60 000 of air. This remarkable achievement earned him the *Nobel Prize in Chemistry* in 1904. Ramsay confirmed that these gases were unique elements by examining the characteristic spectrum of light they produced when excited by an electric discharge. His co-worker, Morris Travers, was thrilled to note a “blaze of crimson light” in the case of neon.

Periodic Table – 30 Second Elements

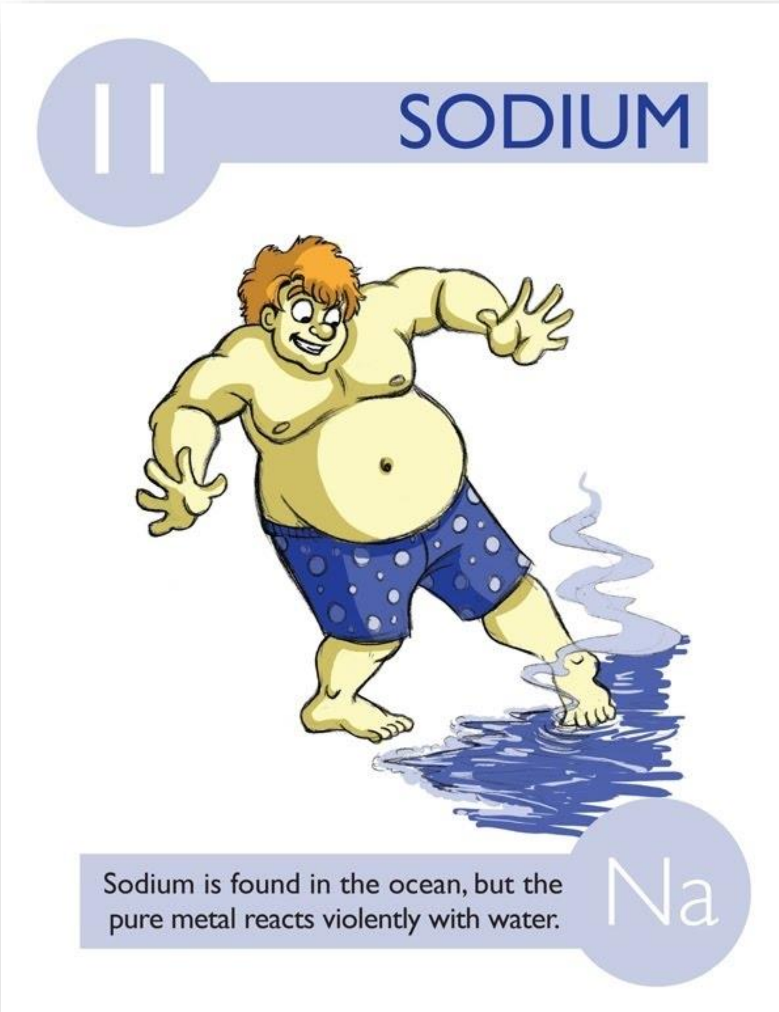


- **Neon, Ne**

Neon is so inert that it forms no chemical compounds at all. Yet, despite this lack of reactivity, it is one of the elements most widely known outside the laboratory – because of its signature light. The light is produced when electrons in orbit around the nuclei of neon atoms, having been excited by the electric discharge, return to their *ground state* (normal positions) releasing the energy that they have absorbed. In the modern era, "neon" has become a byword for all kinds of illuminated messages, although neon itself only produces red light. Other inert gases yield other colours when they are similarly placed in an electric discharge.

Return to Main Menu

Periodic Table – 30 Second Elements

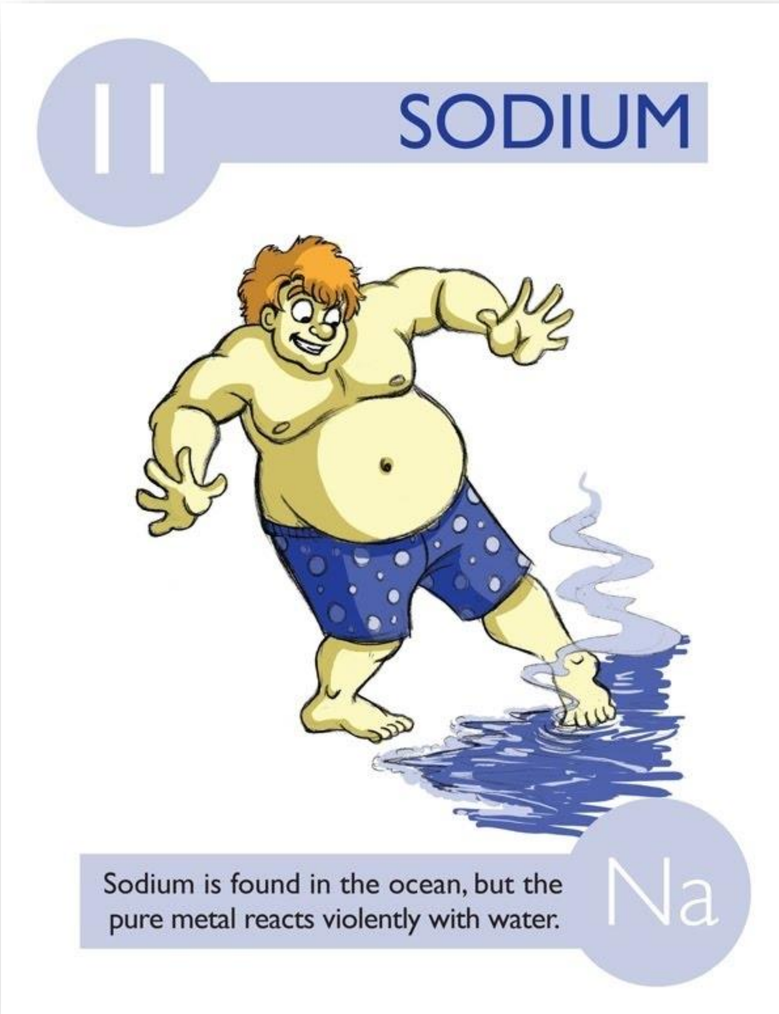


• Sodium, Na

This soft, silver-tinted alkali metal is known for its reactivity. Drop a small piece into water and watch it react energetically as it converts to sodium hydroxide and hydrogen, giving off plenty of heat. Despite being such a dramatic element, sodium is named after its more sedate salt; the word *sodium* comes from *soda* – not a fizzy drink, but sodium carbonate (Na_2CO_3) an alkaline compound derived from ashes. Soda is derived from the Arabic *suda* (meaning "headache") because soda was a popular cure for headaches. The chemical symbol is short for *natrium*, derived from *natron*, the old name for hydrated sodium carbonate.

Return to Main Menu

Periodic Table – 30 Second Elements

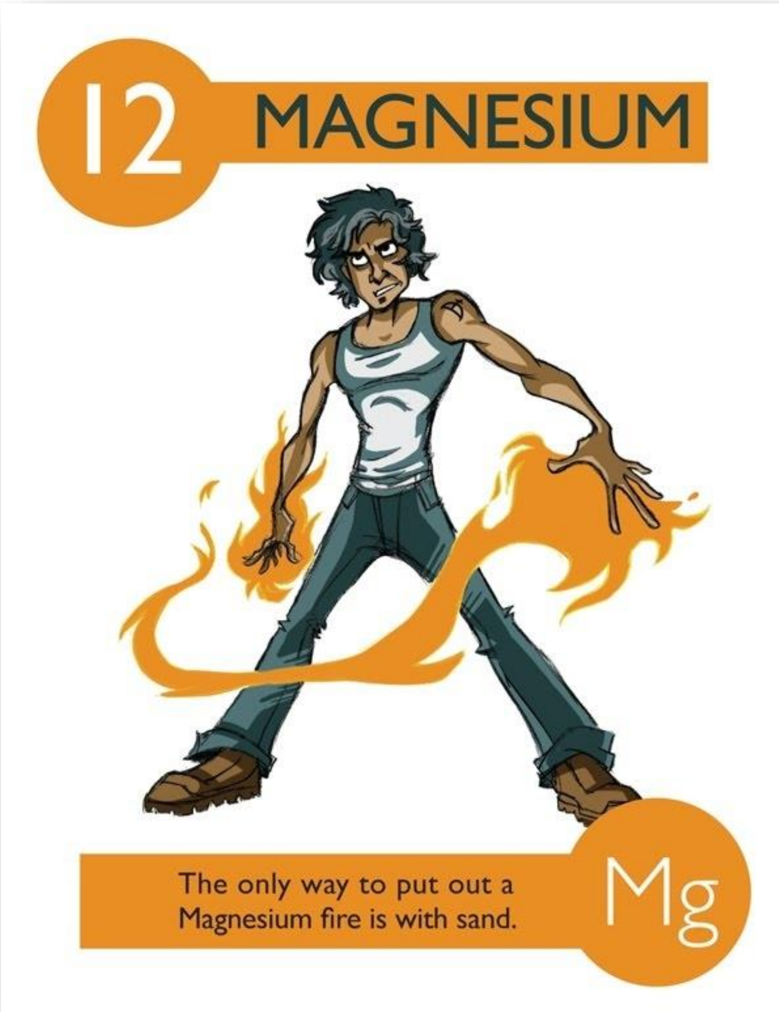


- **Sodium**, **Na**

We come across sodium daily in the yellow glow of street lamps, produced by the strong lines in sodium's emission spectrum, but we are probably most familiar with sodium in common salt (sodium chloride - NaC*l*). Sodium is important to many living things, including humans. It helps to regulate our blood pressure and builds up the electrical gradients essential for neurons to fire in our brains. In modern times, our diets tend to contain too much salt, resulting in raised blood pressure and associated health problems.

Return to Main Menu

Periodic Table – 30 Second Elements

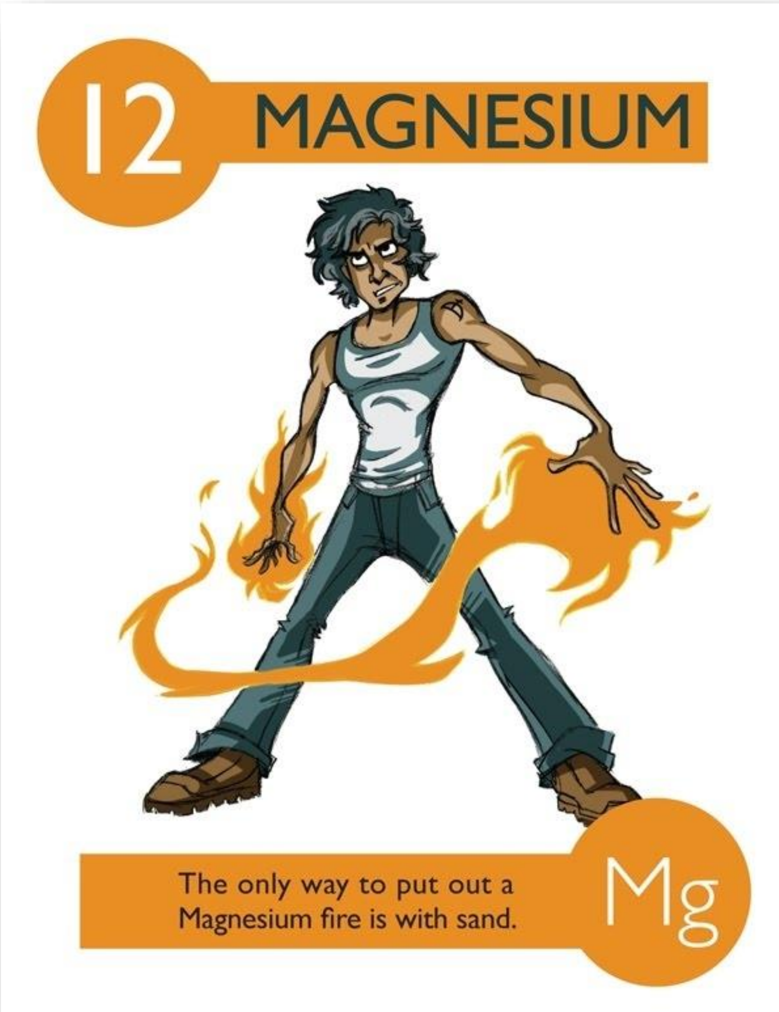


- **Magnesium, Mg**

Magnesium is a silvery metal that combines strength and lightness. It is the third most widely used metal after iron and aluminium. Adding a few percent of aluminium to magnesium improves its corrosion resistance and welding qualities. This alloy is used for bicycles, car and aircraft seats, lightweight luggage and power tools. Magnesium burns with a bright white light and magnesium powder was once used for photographic flashbulbs. Its most infamous use was in the firebombs dropped during the Second World War. The main magnesium minerals are dolomite and magnesite – both forms of magnesium carbonate ($MgCO_3$).

Return to Main Menu

Periodic Table – 30 Second Elements



- **Magnesium**, **Mg**

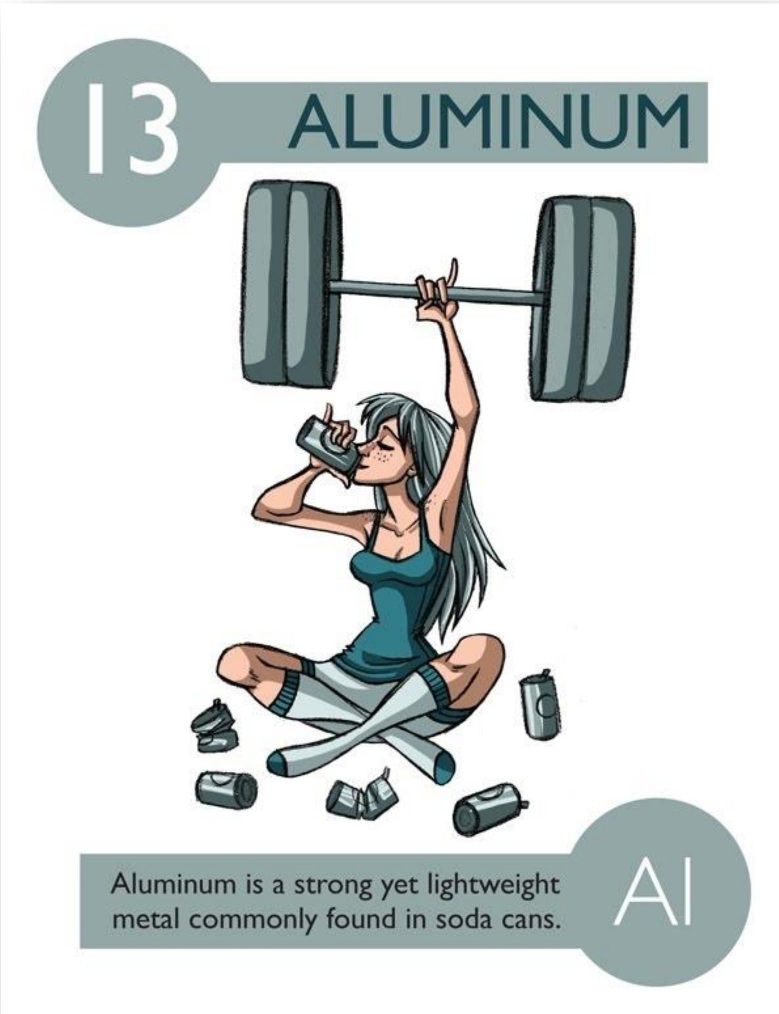
Magnesium is at the heart of the chlorophyll molecule, used by plants to trap carbon dioxide and water, converting them into glucose and oxygen:

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

Magnesium is an essential part of our diet, but we store around three years' supply in our body. Foods with high levels of magnesium include nuts and chocolate. Magnesium is abundant in seawater and was once extracted from this source. Once magnesium starts to burn, it is almost impossible to extinguish. When magnesium burns in air it reacts with both oxygen (to form magnesium oxide – MgO) and nitrogen (to form magnesium nitride – Mg_3N_2).

Return to Main Menu

Periodic Table – 30 Second Elements

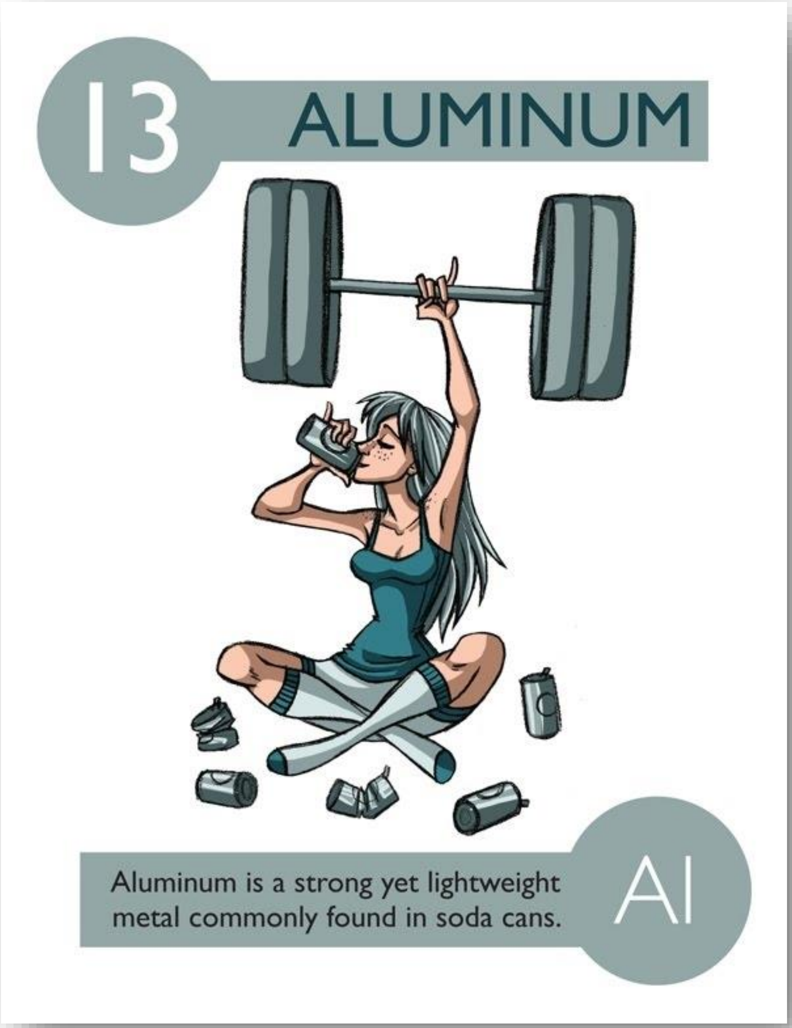


- **Aluminium**, ***Al***

Stable aluminium ^{27}Al is created when hydrogen fuses with magnesium in large stars or supernovae. The most abundant metal, aluminium makes-up about 8 percent by weight of the earth's solid surface. It is about one third the density of iron or copper, can be drawn into wires or rolled into thin foil. Highly corrosion resistant and non-magnetic, it possesses excellent conductive properties, although it is inferior to copper in this respect. Light, cheap and ubiquitous, aluminium is the first metal to have attained widespread use since the discovery of iron. It was first isolated in the 1820s and was introduced as a new metal at the *Exposition Universelle* in Paris in 1855.

Return to Main Menu

Periodic Table – 30 Second Elements



- **Aluminium**, ***Al***

At the time of its discovery, aluminium was more expensive than gold, and remained an exotic novelty for 31 years until the availability of relatively cheap electricity allowed aluminium to be extracted from alumina (Al_2O_3) by electrolysis on a large scale. Cheap aluminium relies on cheap electricity: it takes three times more electrical energy to produce one ton of aluminium than is needed to make a ton of steel. This is a great case for recycling, which consumes only 5 percent of the energy needed to produce the metal from its main ore, bauxite. Aluminium forms hard, light, corrosion resistant alloys that are used in aviation and food processing equipment.

Periodic Table – 30 Second Elements

• Silicon, Si

Every valley is really a silicon valley. Silicate minerals, containing frameworks of silicon and oxygen atoms, comprise most of the earth's crust. Silicon is the second most abundant element in the earth's crust, after oxygen. However, despite this ubiquity, pure silicon was not isolated until 1824 because it is hard to separate from oxygen. Much of mineral chemistry centres on the various ways that silicate ions (SiO_4^{4-}) – tetrahedra with silicon at the centre and oxygen at the four corners – can be joined into orderly, crystalline networks that house metallic elements such as sodium and calcium. In glass, this silicon-oxygen network is melted and frozen into static disorder.

Return to Main Menu

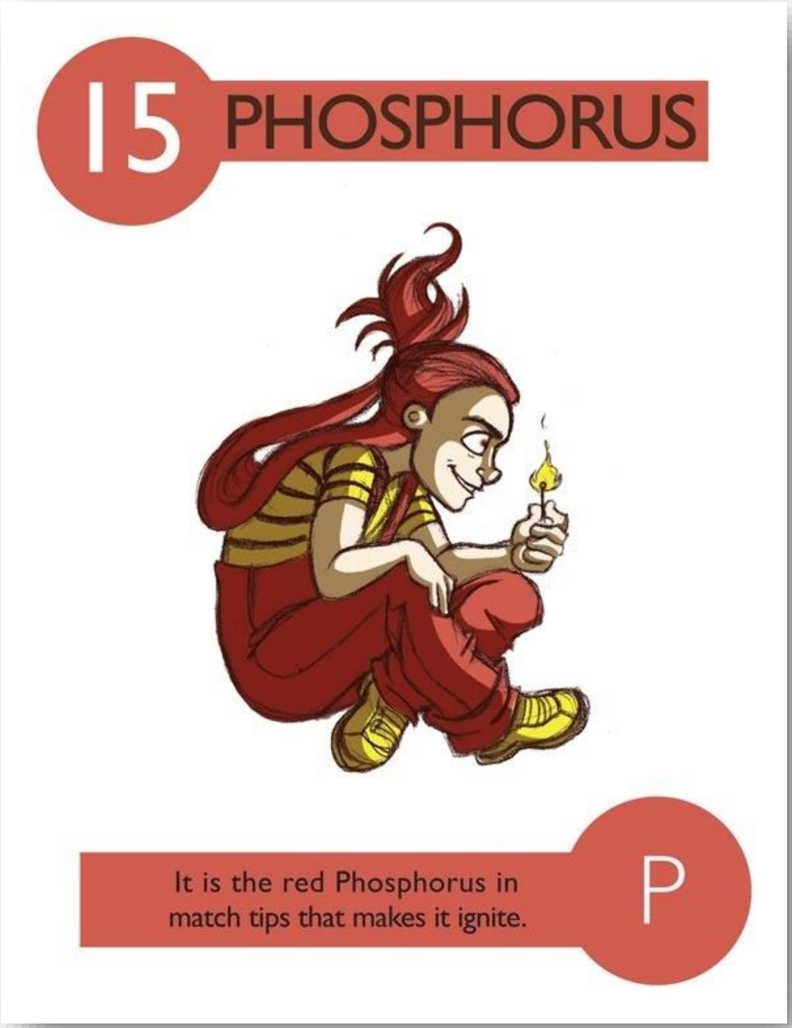
Periodic Table – 30 Second Elements

• Silicon, Si

Today, the ultra-pure silicon needed for microelectronics is mostly made by electrolysis of low-purity silicon or its compounds, followed by melting and controlled crystallisation to make near-perfect crystals needed for silicon wafers. Silicon is a semiconductor. It contains just a few mobile electrons that can carry an electric current. The number of these mobile electrons, and hence the electrical conductivity, can be controlled by adding small quantities of impurities, or *dopants*, such as boron or phosphorus. Silicon is regularly confused with *silicone*, a class of polymer whose backbones are chains of alternating silicon and oxygen atoms.

Return to Main Menu

Periodic Table – 30 Second Elements

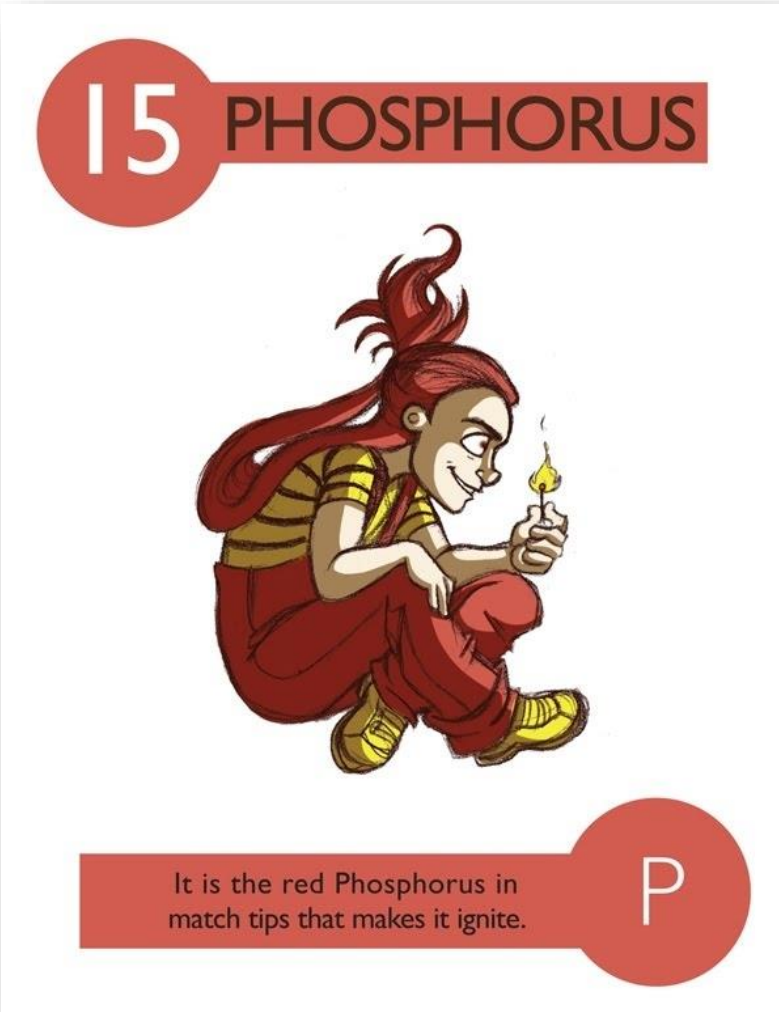


- **Phosphorus, P**

In 1669, phosphorus became the first element to be discovered since ancient times, and in spectacular fashion. German alchemist Hennig Brandt extracted it from the residue of dozens of buckets of urine provided by his neighbours in Hamburg, and he was rewarded with a substance that glowed in the dark. The pure element, which takes different forms – white, red, violet and black – is too reactive to exist in nature. White phosphorus is a deadly poison. Its use in early matches caused bone disorders and "phossy jaw" (toothaches, gum swelling, jaw abscesses and eventual brain damage) in workers who handled it. In modern matches, red phosphorus is used instead.

Return to Main Menu

Periodic Table – 30 Second Elements

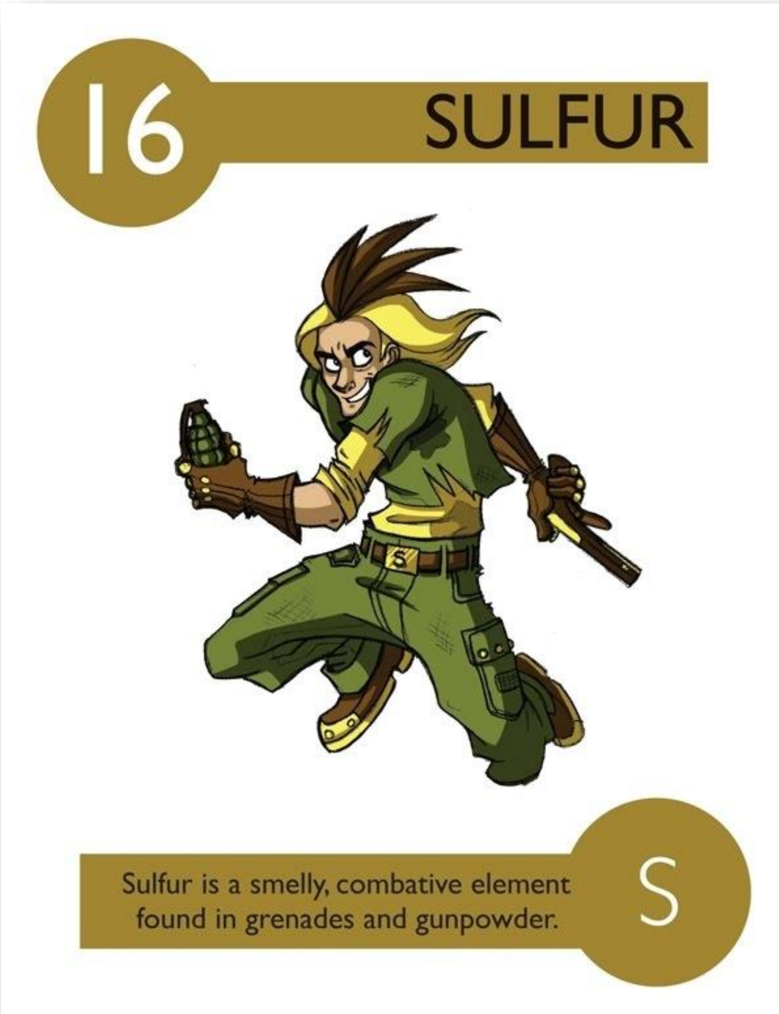


- **Phosphorus**, **P**

White phosphorus is today used in incendiary bombs, flares and smoke grenades. The main source of phosphorus is phosphate-rich rock, in which phosphorus and oxygen form the phosphate ion (PO_4^{3-}) which combines mainly with calcium to form $Ca_3(PO_4)_2$, $CaHPO_4$ and $Ca(H_2PO_4)_2$. Phosphorus is essential to life, forming part of DNA, cell membranes and molecules that transfer energy around cells. Bones and teeth consist mainly of calcium phosphate, which is also present in milk. Present in some organic compounds, phosphorus is found in flame retardants, herbicides and insecticides, and also the outlawed nerve poison *sarin* ($C_4H_{10}FO_2P$).

Return to Main Menu

Periodic Table – 30 Second Elements

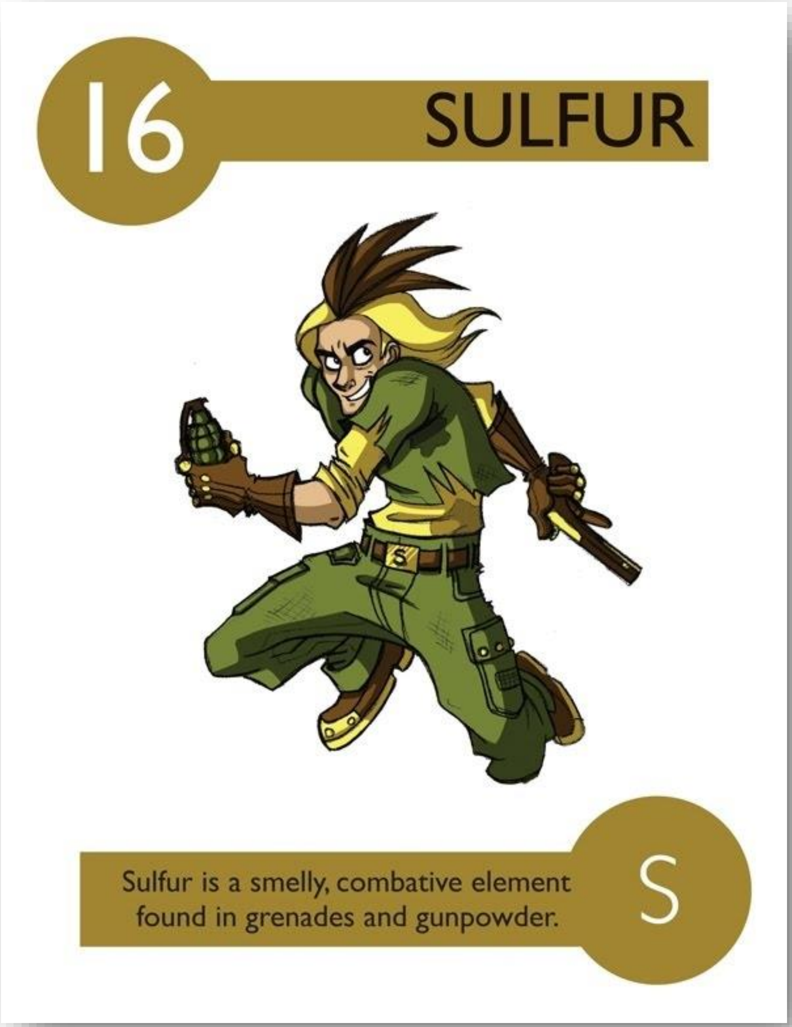


- **Sulfur**, **S**

If the devil had an element, then this would be it. Sulfur burns with pungent vigour, for which reason it was called brimstone (*byrnstan* or "burning stone") in Old English. Flaming sulfur has caused plenty of suffering already – it was a component of the incendiary weapon *Greek fire* (developed *ca.* 672 BCE) and of gunpowder. Combined with oxygen, sulfur forms acrid oxides that dissolve in water to form sulfuric acid (H_2SO_4). On the planet Venus, sulfuric acid condenses into clouds that rain acid onto the planet's surface. Earth's acid rain – formed from sulfurous fumes released when coal is burned – is less potent, but still corrodes stone and kills trees over time.

Return to Main Menu

Periodic Table – 30 Second Elements

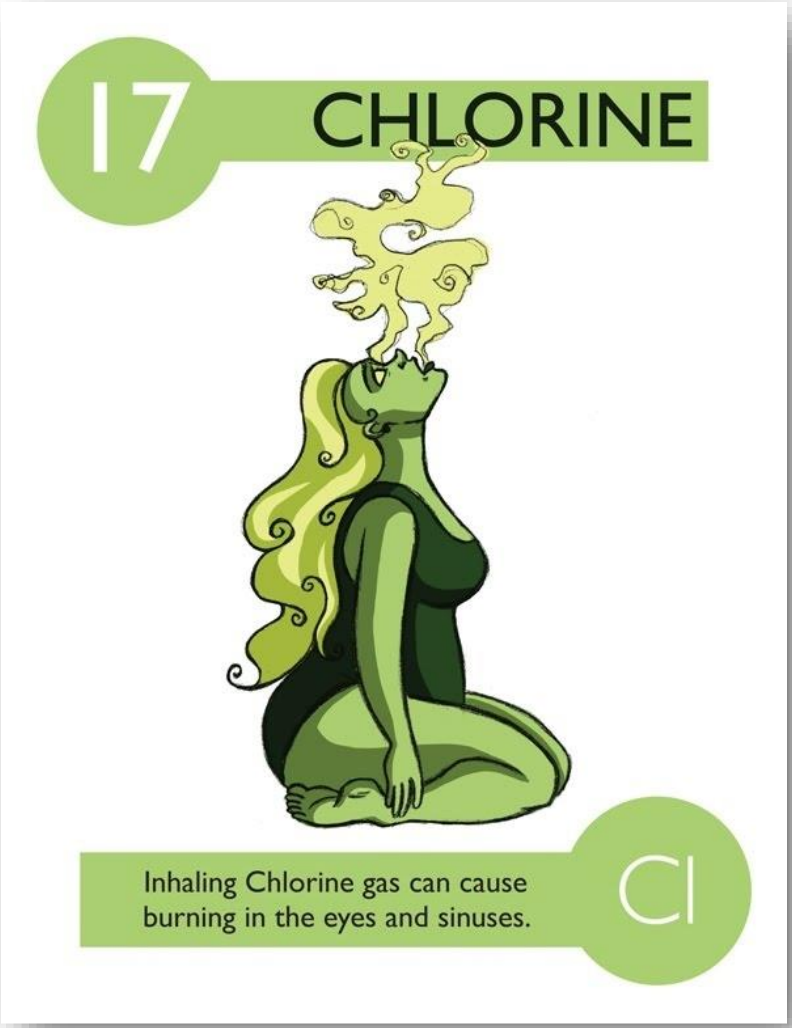


- **Sulfur**, **S**

Despite all of this, sulfur is essential for life. It is a component of two of the amino acids that make-up proteins (cysteine and methionine) and we each contain approximately 145 g of the element. Bonded to carbon, sulfur atoms act like links that bridge the chain-like molecules of certain carbon-based polymers. In hair and wool, two conjoined sulfur atoms bridge molecules of the main protein constituent, keratin. Hair straightening uses a chemical to break these S–S bonds and loosen the coils that they induce. Sulfur bridges also link the carbon polymers in natural rubber during the stiffening process of vulcanisation.

Return to Main Menu

Periodic Table – 30 Second Elements

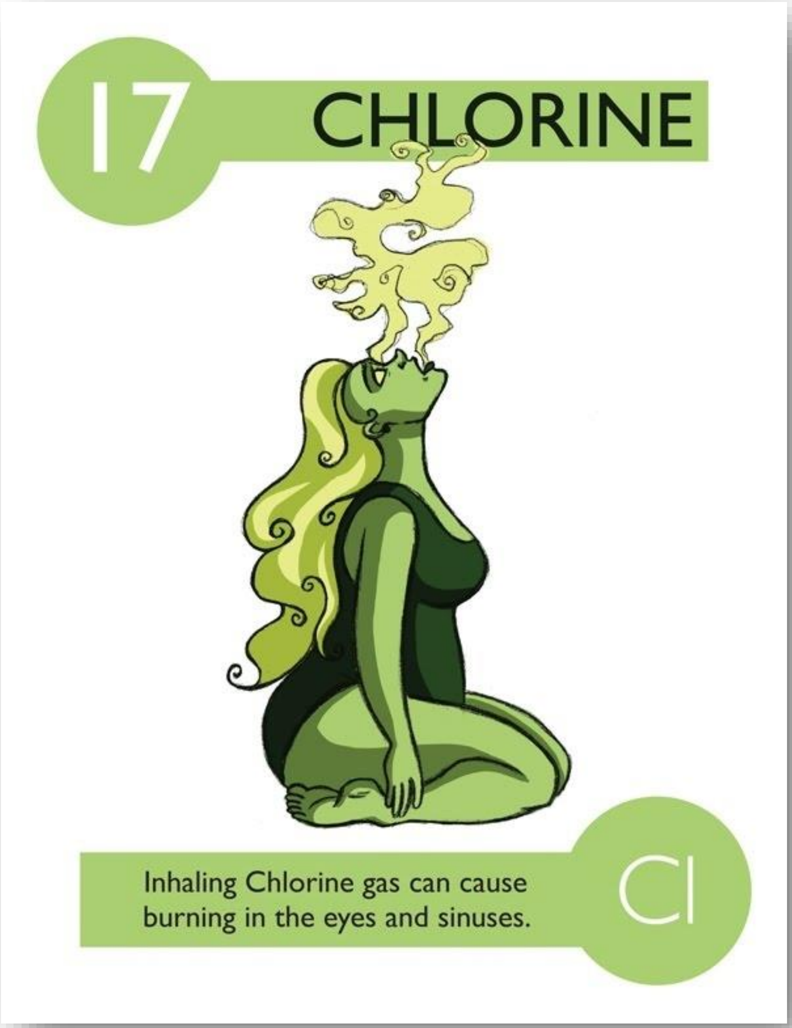


- **Chlorine, C*l***

Chlorine was identified as an element and given its modern name by British chemist Humphry Davy in 1810. Chlorine is widely available thanks to its presence in seawater. Although we think the sea is salt (sodium chloride) water, it actually contains separate sodium ions (Na^+) and chloride ions (Cl^-) from different sources. Salt only forms when water is evaporated. Chlorine is produced from saline solution by *electrolysis*: the negatively charged chloride ions are attracted to the positive electrode where they each lose a single electron (a process known as oxidation) to form chlorine atoms which in turn bond together to form chlorine molecules (Cl_2).

Return to Main Menu

Periodic Table – 30 Second Elements



- **Chlorine**, **C*l***

As a powerful oxidising agent, chlorine is widely used to kill bacteria. When chlorine attacks bacteria, its oxidising action breaks down the cell membrane, killing the micro-organism. Chlorine's disinfectant and antiseptic qualities make it valuable in bleaches and in treating drinking water, in addition to its role in swimming pools. Chlorine's dark side was first unleashed on 22nd April 1915, when 6000 cylinders of the element were used against Algerian troops of the French army near Ypres. This terrifying weapon was the work of German chemist Fritz Haber. Chlorine gas burns away the lining of the lungs, leaving victims drowning in the fluid that oozes out.

Return to Main Menu

Periodic Table – 30 Second Elements

- **Argon**, **Ar**

Argon is all around us – there are approximately 50 trillion tons of it in the earth's atmosphere – yet it wasn't isolated from air until the late 19th century. This is because argon doesn't do anything to make itself known. Like the other elements that share it's Group in the Periodic Table, it is a noble gas, almost completely unreactive (the quality for which it is named – argon is Greek for *inactive*). Argon does not gain, lose or share any electrons by undergoing chemical reactions because it has a complete valence shell of electrons.

Argon was discovered by chemists studying the composition of the earth's atmosphere, of which it makes up one per cent.

Return to Main Menu

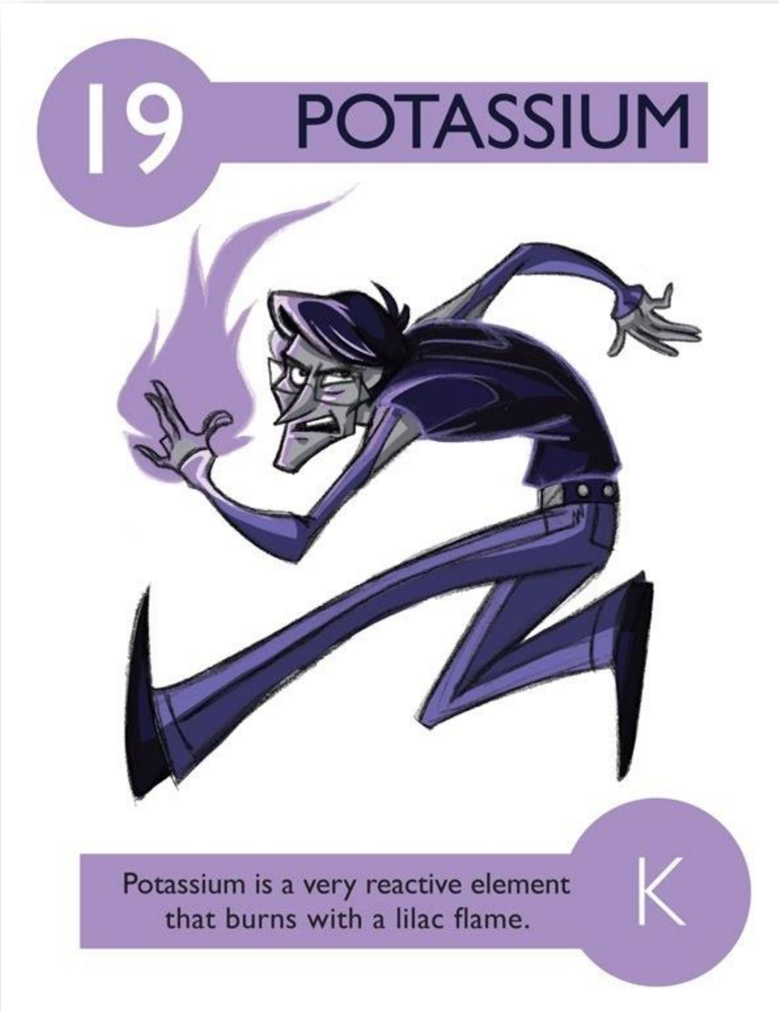
Periodic Table – 30 Second Elements

- **Argon**, **Ar**

British chemist Henry Cavendish noticed an inert fraction of air in 1785, but didn't follow it up, and not until 1894 did his compatriots Lord Rayleigh and William Ramsay isolate the inert component from atmospheric nitrogen. Today, three quarters of a million tons of argon are extracted annually from liquefied air, because its very inertness makes it useful. You can fill light bulbs, fluorescent tubes and double glazed windows with it, or use it as a propellant for aerosols, without worrying that it will react or be toxic. It is possible to make argon react, but only just. Argon hydrofluoride (HArF) was made in 2000 by reacting solid argon with hydrogen fluoride at –246 °C.

Return to Main Menu

Periodic Table – 30 Second Elements

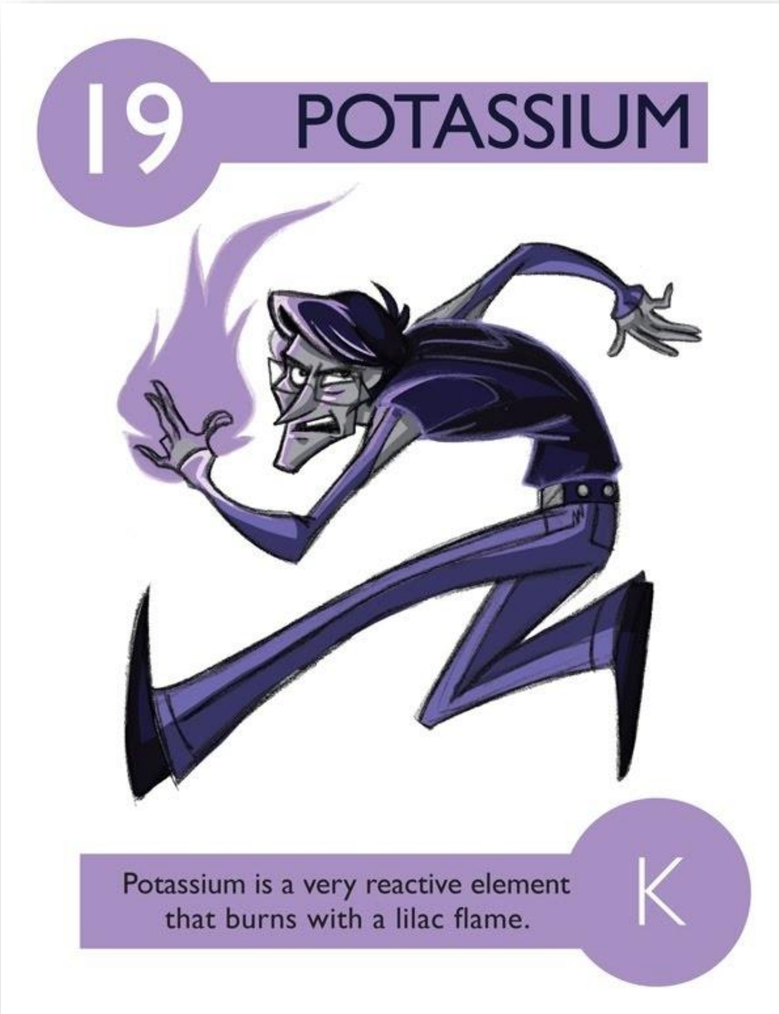


- **Potassium, K**

Potassium is a soft, silvery, alkali metal that was first isolated by British chemist Humphry Davey in 1807. It is too reactive to be used as the pure metal, but its salts are important. For centuries, potassium nitrate (KNO_3) potassium carbonate (K_2CO_3) and potassium aluminium sulfate ($KAl(SO_4)_2$) have been used in gunpowder, soap making and dyeing respectively. Today, potassium sodium tartrate ($KNaC_4H_4O_6$) is used in baking powder, while potassium hydrogen sulfite ($KHSO_3$) is added to wines to stop rogue yeasts growing, and potassium benzoate ($C_7H_5KO_2$) is used as a food preservative.

Return to Main Menu

Periodic Table – 30 Second Elements



• **Potassium**, **K**

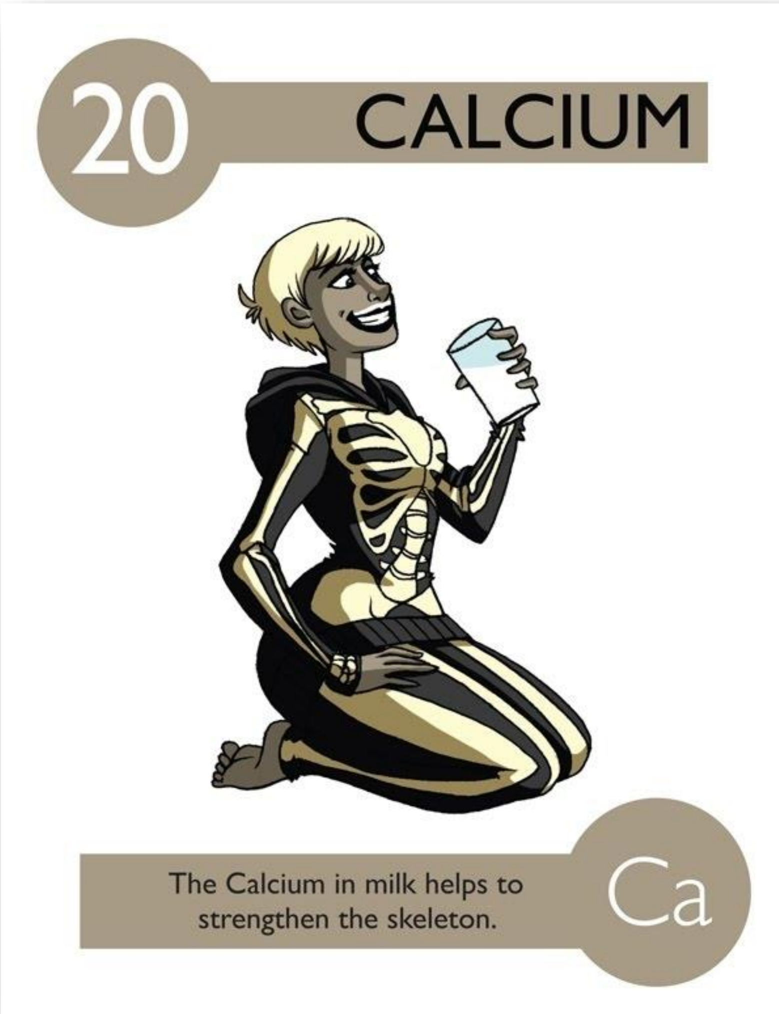
All fertilizers contain potassium, and it is mined on a massive scale – around 35 million tons a year – mainly as the mineral sylvite (KC*l*). Around 200 tons per year of pure potassium are produced, and most of it is converted to potassium superoxide (KO_2) which is used in submarines and space vehicles to remove CO_2 and regenerate O_2 in the air:

$$4KO_2 + 2CO_2 \rightarrow 2K_2CO_3 + 3O_2$$

Potassium is an essential element for living things because, along with sodium, it plays an essential role in the operation of the central nervous system. Potassium-rich foods include peanuts and bananas.

Return to Main Menu

Periodic Table – 30 Second Elements

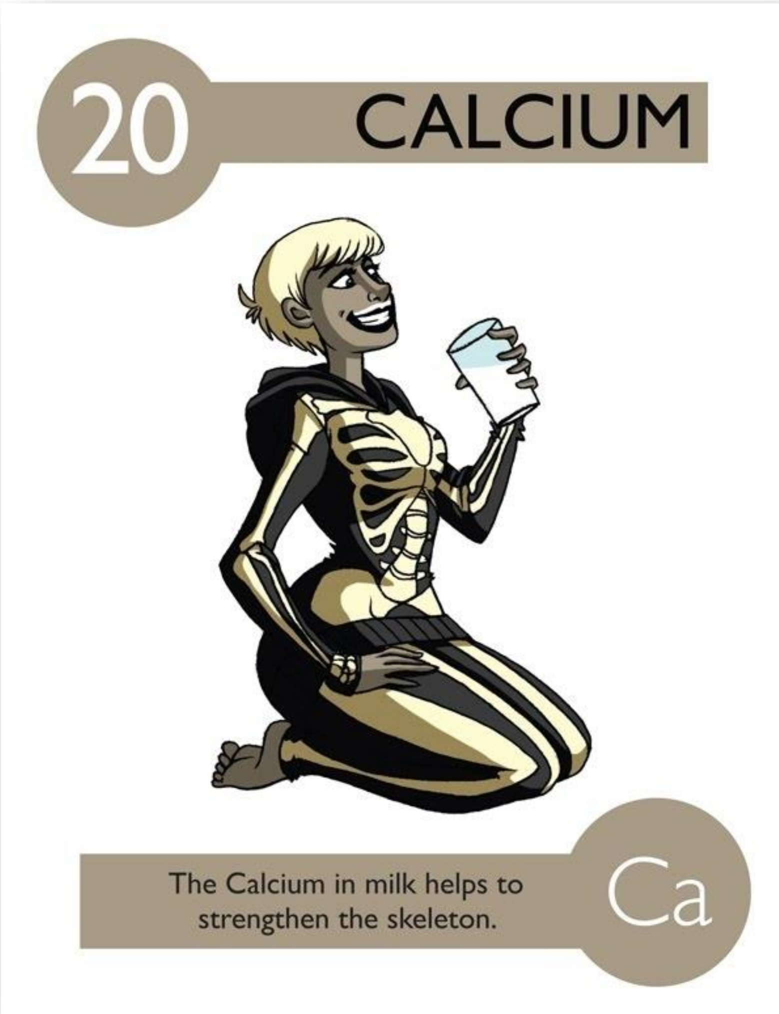


• **Calcium, Ca**

Calcium is a silvery-white, fairly soft, metal that is too reactive to be found in nature as the pure element. It was first isolated in 1808 by British chemist Humphry Davy. After aluminium, it is the most abundant metal in the earth's crust. Over hundreds of millions of years, countless creatures in the oceans, and some on land, have used it to make shells of calcium carbonate ($CaCO_3$); their remains collect on the sea floor and eventually form limestone. Lifted up on to continents, it is slowly dissolved by carbonic acid in rain and carried back to the sea to go through the cycle again, helping to stabilise the level of atmospheric carbon dioxide.

Return to Main Menu

Periodic Table – 30 Second Elements



- **Calcium, Ca**

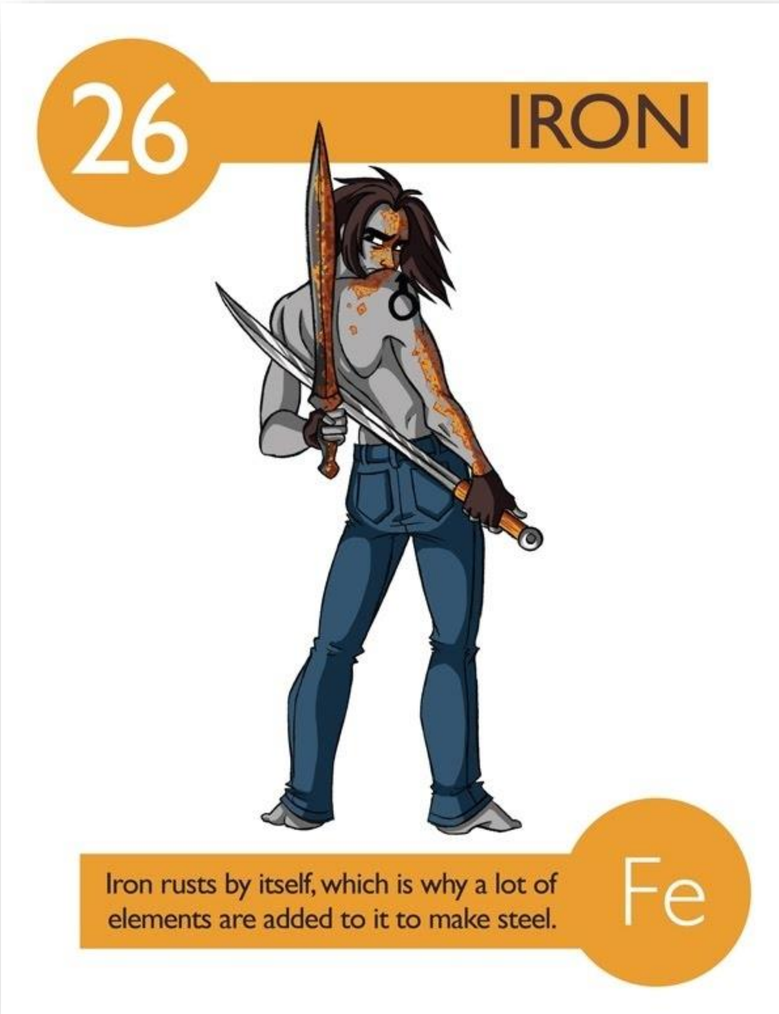
Calcium phosphate ($Ca_3(PO_4)_2$) is a constituent of animal bones, teeth and various physiological processes. Ancient people knew the uses of calcium compounds. As early as 4000 BCE, ancient Egyptians heated limestone to prepare lime for use in buildings:

$$CaCO_3 \rightarrow CaO + CO_2$$

In dry climates, calcium sulfate ($CaSO_4$) forms gypsum, from which plaster is still made. In 1823, British engineer Goldsworthy Gurney found that, in a jet of burning hydrogen, lime gives-off a bright light or *limelight*, an early source of stage lighting.

Return to Main Menu

Periodic Table – 30 Second Elements

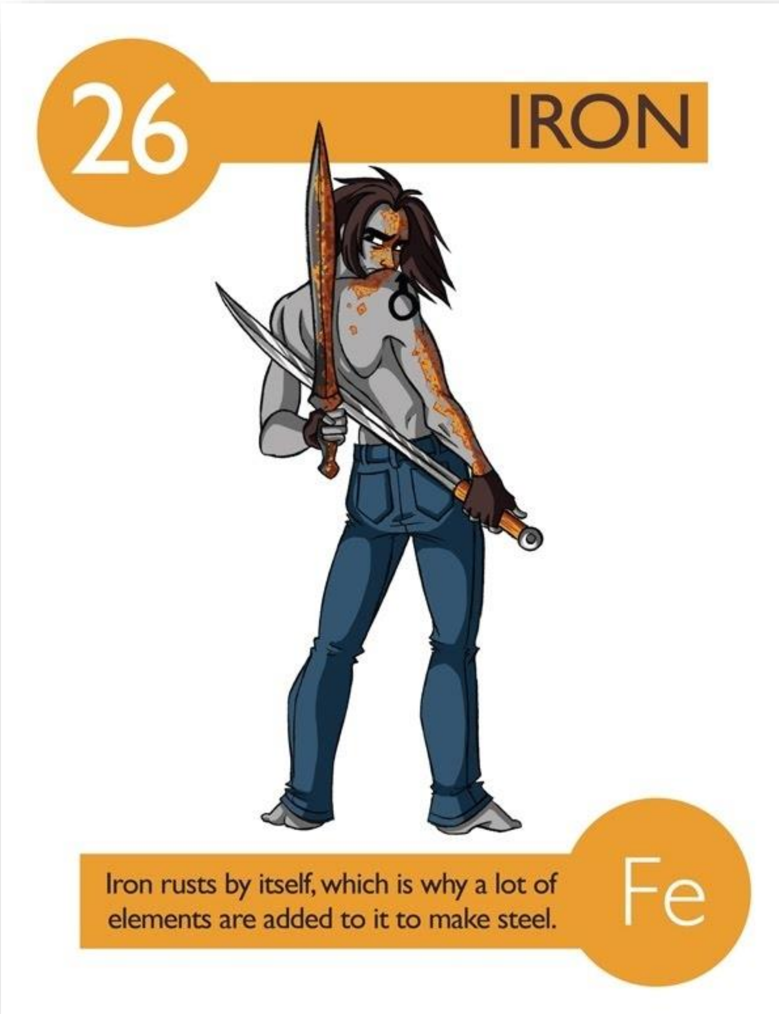


- **Iron, Fe**

Of all the elements, iron has the most stable nucleus, prone neither to nuclear fusion (merging) or nuclear fission (splitting). Iron makes up about 5 percent of the earth's crust, making it the fourth most abundant element there. The earth's core is mostly iron, molten in the outer core and solid in the middle. The flow of magnetic liquid iron creates the earth's geomagnetic field which helps to protect life from the solar wind and cosmic rays. Iron in haemoglobin makes blood red and transports oxygen about the body. The importance of iron can be judged from the phrase *Iron Age* used to describe a period of human history (beginning in the Middle East *ca*. 1500 BCE).

Return to Main Menu

Periodic Table – 30 Second Elements

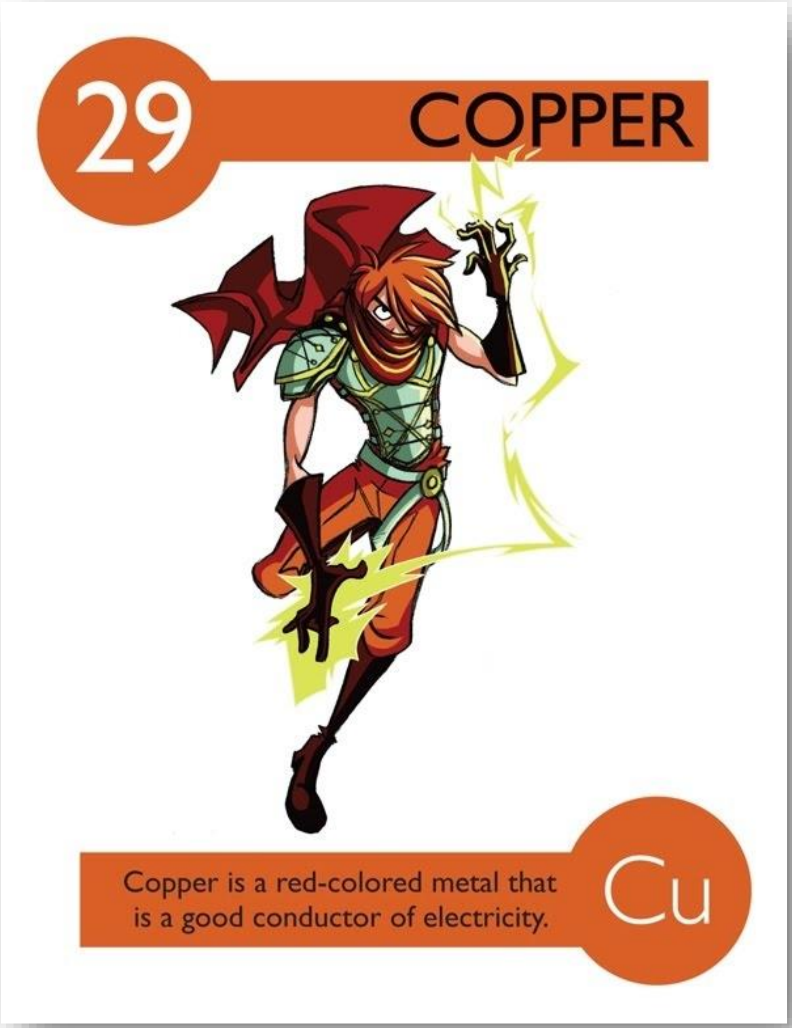


- **Iron, Fe**

The Hittites, early iron smelters, migrated over Asia Minor, just as the iron clad Romans later conquered half the world. Swords made in the earlier bronze age didn't stand a chance against hard, gleaming steel. Steel is iron mixed with a little carbon, which makes it harder. Because charcoal is used to extract iron from its ore, what you get is inevitably steel instead of pure, softer iron. The best steel requires precise control of carbon content, which became possible in the mid-19th century. Only then could engineers build steel bridges without fear that the structures would crack.

Return to Main Menu

Periodic Table – 30 Second Elements

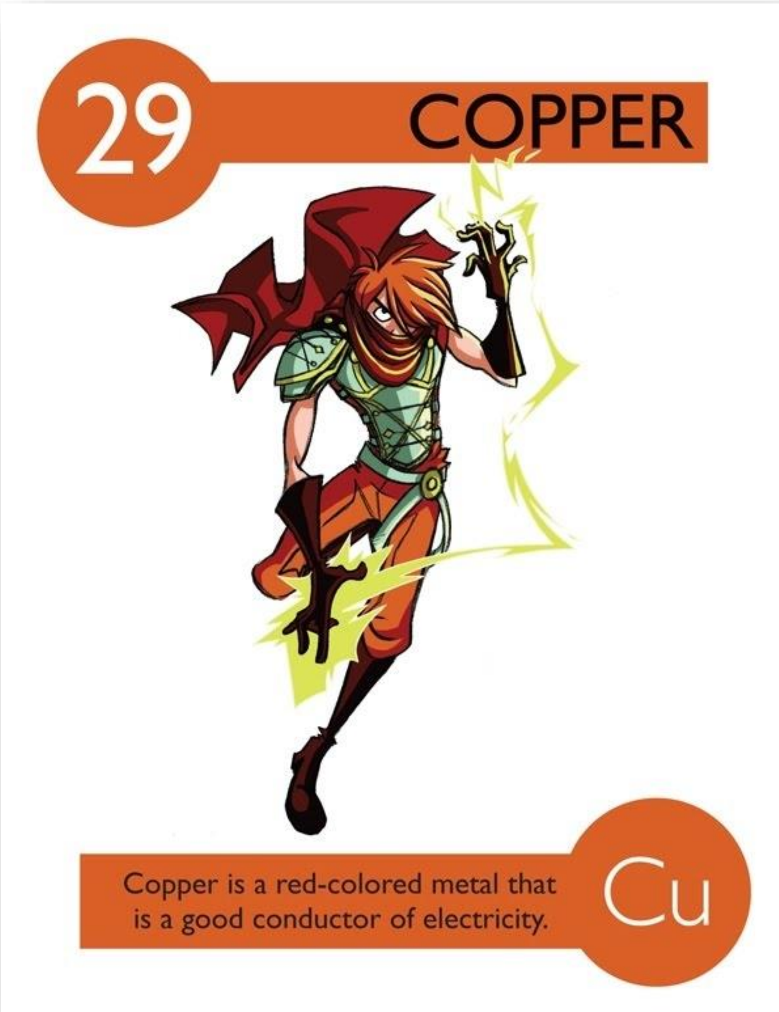


• Copper, Cu

Familiar, reddish-orange copper is not considered a precious metal, but it is precious enough to those who strip it from unwatched buildings. An unusually good conductor of both heat and electricity, copper is widely used to make foil, wires, and pipes. Found naturally in the free state, copper also occurs chemically combined in many minerals, usually in association with sulfur. It is harder than zinc but softer than iron, and acquires strength by mixing with other metals in more than 1000 combinations. Combined with 10 percent tin, it forms the alloy bronze, which gave its name to an age of human development that lasted three millennia (*ca*. 3600 – 600 BCE).

Return to Main Menu

Periodic Table – 30 Second Elements



- **Copper**, **Cu**

During the Bronze Age, weapons and implements were chiefly made of copper and its alloys. Freshly exposed copper has street appeal, ages gracefully to an earthly mahogany and, with weather, becomes robed – like the *Statue of Liberty* – in a layer of green copper(II) carbonate ($CuCO_3$). Its compounds, commonly encountered as copper(II) salts, often produce blue or green colours in such minerals as turquoise and malachite. The element is present in minute amounts in the animal body and is essential to normal metabolism.

Return to Main Menu

Periodic Table – 30 Second Elements

- **Arsenic, As**

Arsenic is a metalloid, best known as its oxide (white arsenic – As_2O_3) used as a poison over many centuries. White arsenic was scraped from the flues of copper refineries when ores rich in arsenic were smelted and, despite its toxicity, became popular in medicine from 1780 onwards – as "Dr. Fowler's Solution", which was prescribed for all sorts of aliments but with little benefit. The organoarsenic drug Salvarsan, discovered in 1909, cured parasitic infections of the blood such as syphilis, and white arsenic reappeared as the medicine arsenic trioxide, now used to treat leukaemia.

Return to Main Menu

Periodic Table – 30 Second Elements

- **Arsenic, As**

Accidental arsenic poisoning appeared to be a threat in the 19th century due to the green pigment copper(II) arsenite ($CuHAsO_3$), used in wallpapers. When it became damp, the pigment could produce trimethylarsine ($(CH_3)_3As$) vapour – which was thought to be causing arsenic poisoning. It wasn't until 2005 that it was shown that this gas is not particularly toxic. Arsenic-based weed killers and wood preservatives have now been phased out, and today arsenic is more likely to be used as the semiconductor gallium arsenide (GaAs). Arsenic is present in foods such as prawns, but in a form that poses no risk to health. When heated strongly, arsenic sublimes.

Return to Main Menu

Periodic Table – 30 Second Elements

- **Silver**, **Ag**

Among metals, silver stands supreme in three ways: it is the best conductor of electricity, it is the best conductor of heat and it gives the best reflectance (a technical measure of how well a surface reflects light). These features are exploited commercially in grinding wheels, electronics and mirrors. Silver solder is used to attach industrial diamonds to grinding wheels because it dissipates the heat generated more efficiently. Silver is widely used for electrical and electronic devices because it makes and breaks electric circuits cleanly. In addition to making mirrors, it is used to make trophies and special tableware.

Return to Main Menu

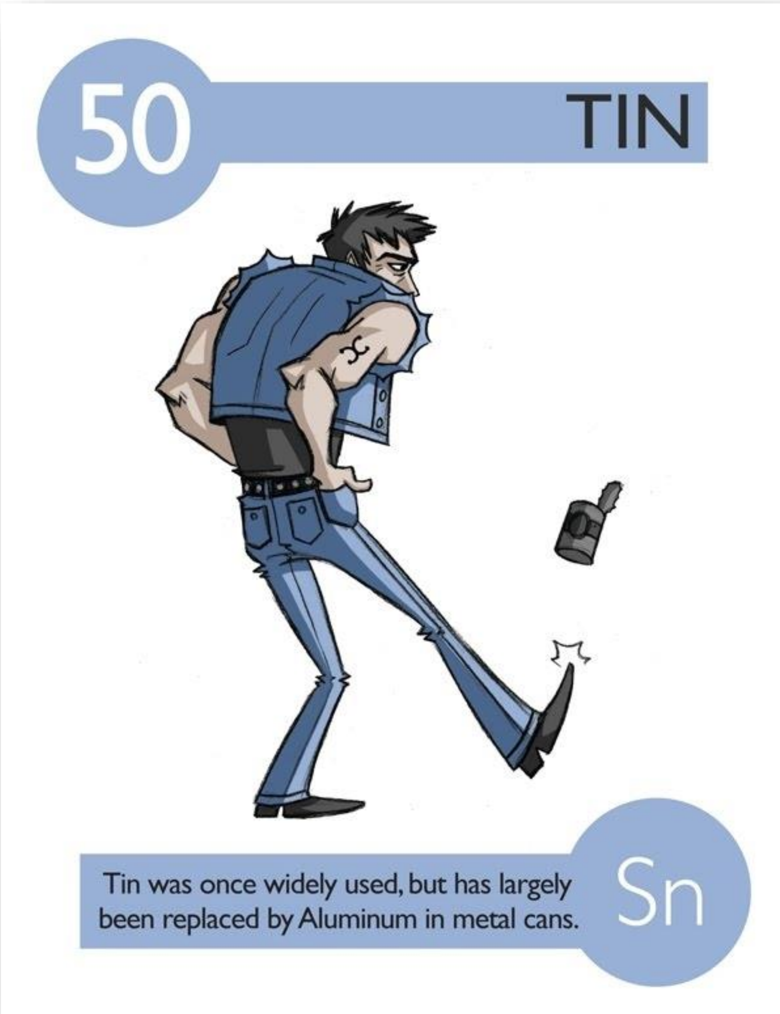
Periodic Table – 30 Second Elements

• **Silver, Ag**

The main silver ore is acanthite (silver sulfide – Ag_2S) but most silver is obtained as a by-product in the refining of copper and lead. Silver salts are sensitive to light and are an essential component of photographic films. Now they feature in reactive sunglasses. Sunlight converts colourless silver ions (Ag^+) to metallic silver by taking an electron from a copper atom, and the glass darkens. When the light fades, the electron returns to the copper, reforming the colourless silver ions once again. Silver is deadly to bacteria and viruses, and silver nitrate ($AgNO_3$) used to be applied to wounds as an antiseptic. It is now added to paints to keep surfaces free of pathogens.

Return to Main Menu

Periodic Table – 30 Second Elements

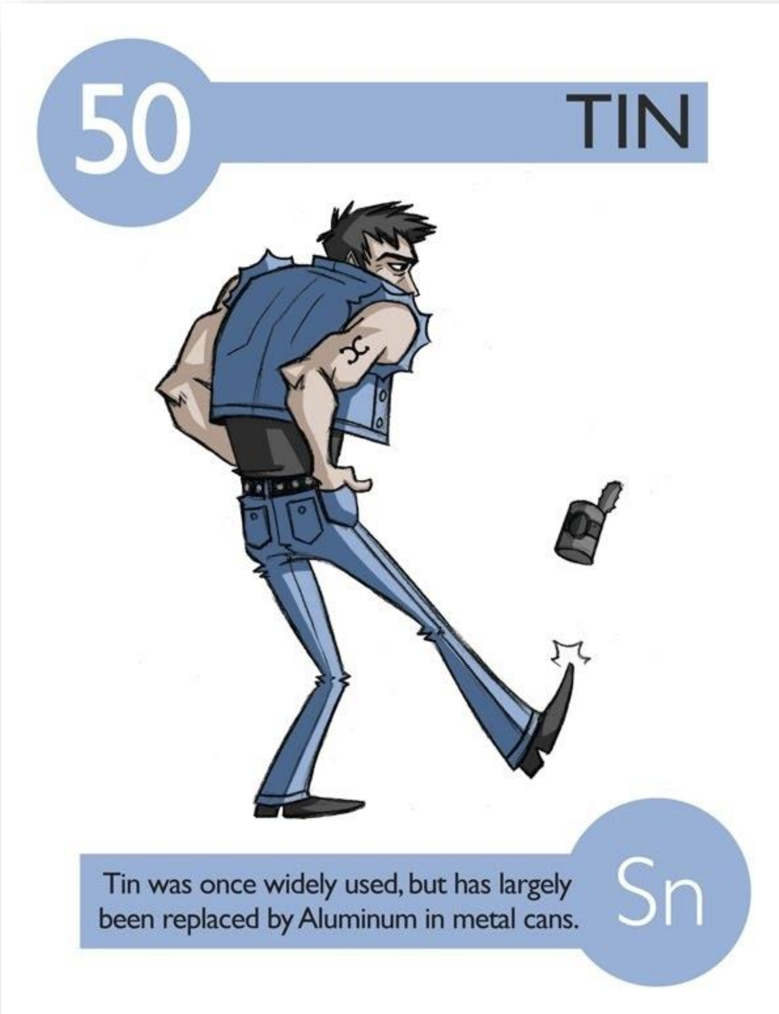


• **Tin**, **Sn**

Because tin does not oxidise well in air, it keeps its silvery appearance longer than most metals. This, combined with its ease of working and the ready availability of tin(IV) oxide ore (SnO_2) means that it has been used for more than 5 000 years. Tin is rarely used alone, because at around 13 °C, it changes from a malleable metal to the α-tin allotrope, also known as *grey tin*, a cubic crystalline structure that is brittle and powdery. However, tin has been widely used in alloys (a mixture of a metal and at least one other chemical element) since around 3000 BCE, notably as an additive to copper to form bronze, a durable alloy that transformed early civilisation.

Return to Main Menu

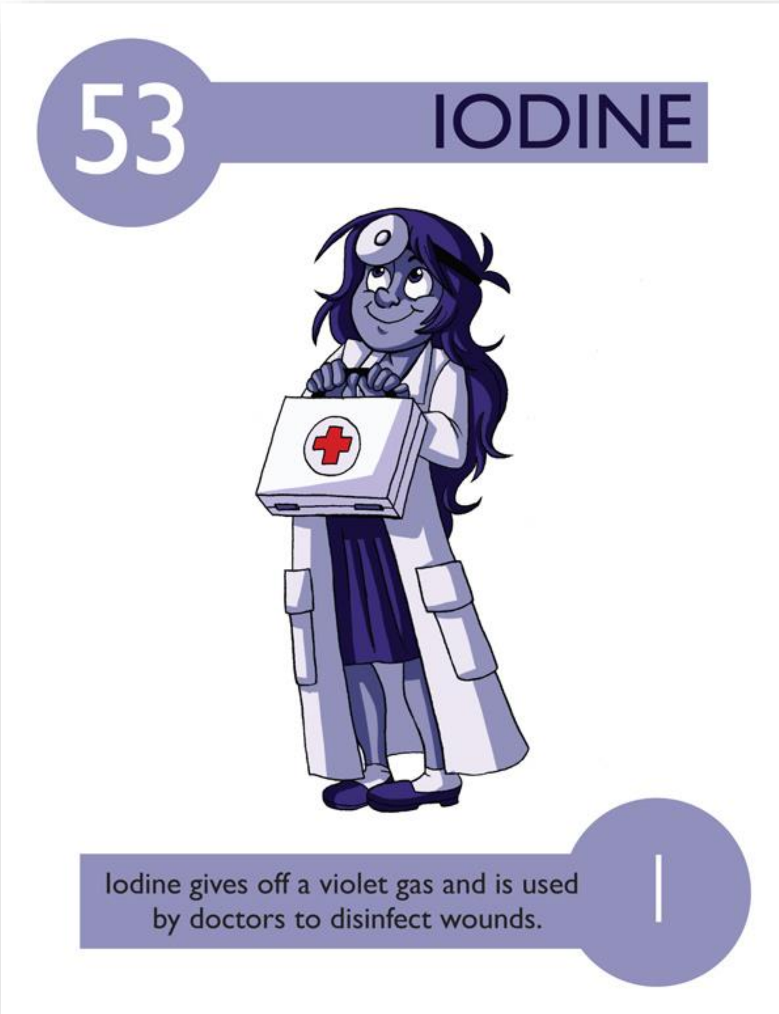
Periodic Table – 30 Second Elements



- **Tin**, **Sn**

When the main constituent of the alloy is tin with a small amount of copper (and often antimony) added, the result is pewter, a more easily worked metal that has long been used for plates and drinking vessels. Now, tin is most likely to be found in solder and on plating on food "tins" to prevent corrosion of the steel underneath. Tin also turns-up in organometallic compounds (compounds in which at least one carbon atom of an organic compound is bonded to a metal) notably tributyltin oxide. This chunky molecule with the formula $C_{24}H_{54}OSn_2$ is widely used as a wood preservative because of its effectiveness as a biocide and fungicide.

Periodic Table – 30 Second Elements

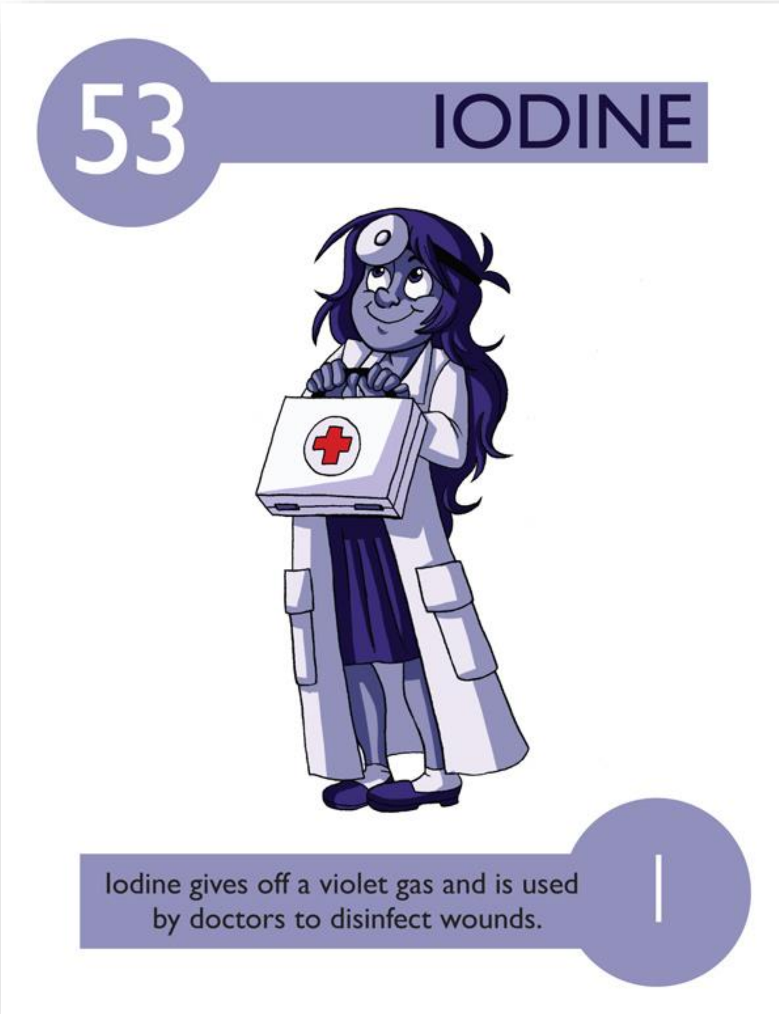


- **Iodine**, **I**

Among the non-metallic elements, iodine is probably the one with which we are most familiar in the home. It lives in the medicine cupboard, where the properties it shares with its fellow halogens – such as the more reactive chlorine – make it ideal for disinfecting cuts and grazes. Iodine was discovered by accident. In 1811, French chemist Bernard Courtois was using seaweed as a raw material at his family's saltpetre works in Paris. He noticed a bright violet vapour in the reaction vessel which later condensed to form shiny black crystals. His compatriot, Joseph Louis Gay-Lussac confirmed that this was a new chemical element and suggested the name iodine.

Return to Main Menu

Periodic Table – 30 Second Elements



- **Iodine**, **I**

Iodine's medical applications were quickly realised. It began to be used to treat goitre, a deficiency of the thyroid gland. The knowledge that iodine is relatively abundant in seawater and marine plants explained why sea sponges had proved to be an effective folk remedy for goitre before.

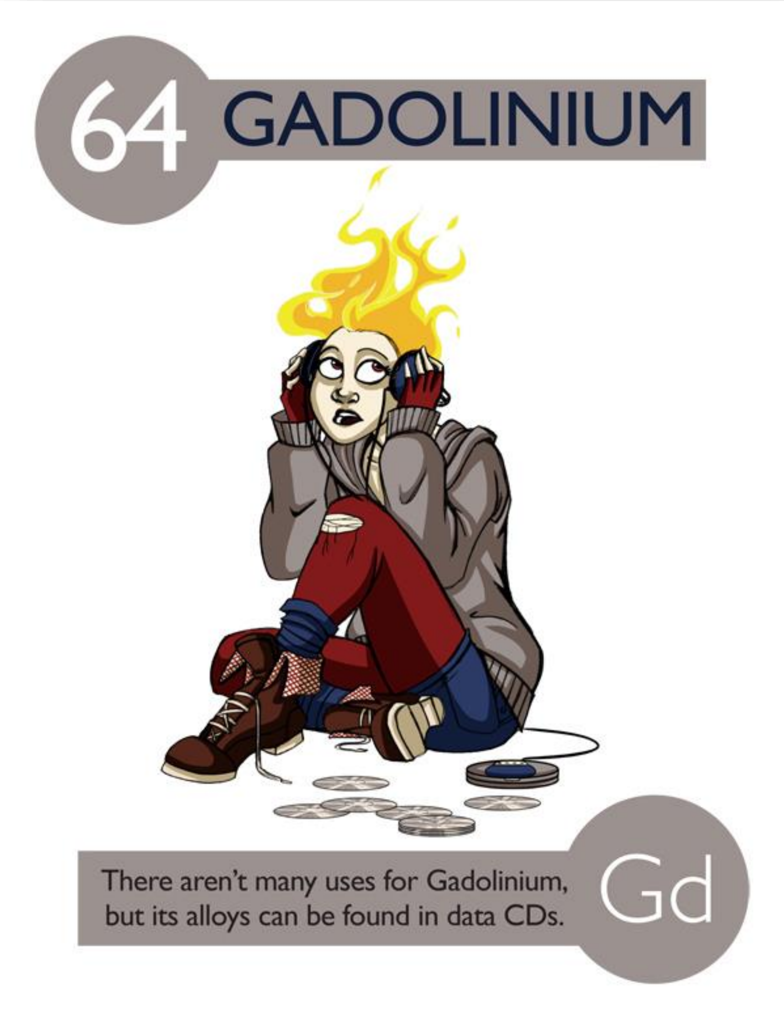
Because iodine atoms are bulky and form relatively weak covalent bonds, they are easily detached from certain molecules. This makes the element useful in organic chemistry where molecules containing iodine undergo *substitution reactions*, *e.g.*:

$$CH_3I + NaOH \rightarrow CH_3OH + NaI$$

Replacing iodine with another atom or group of atoms can be used to make medicines.

Return to Main Menu

Periodic Table – 30 Second Elements

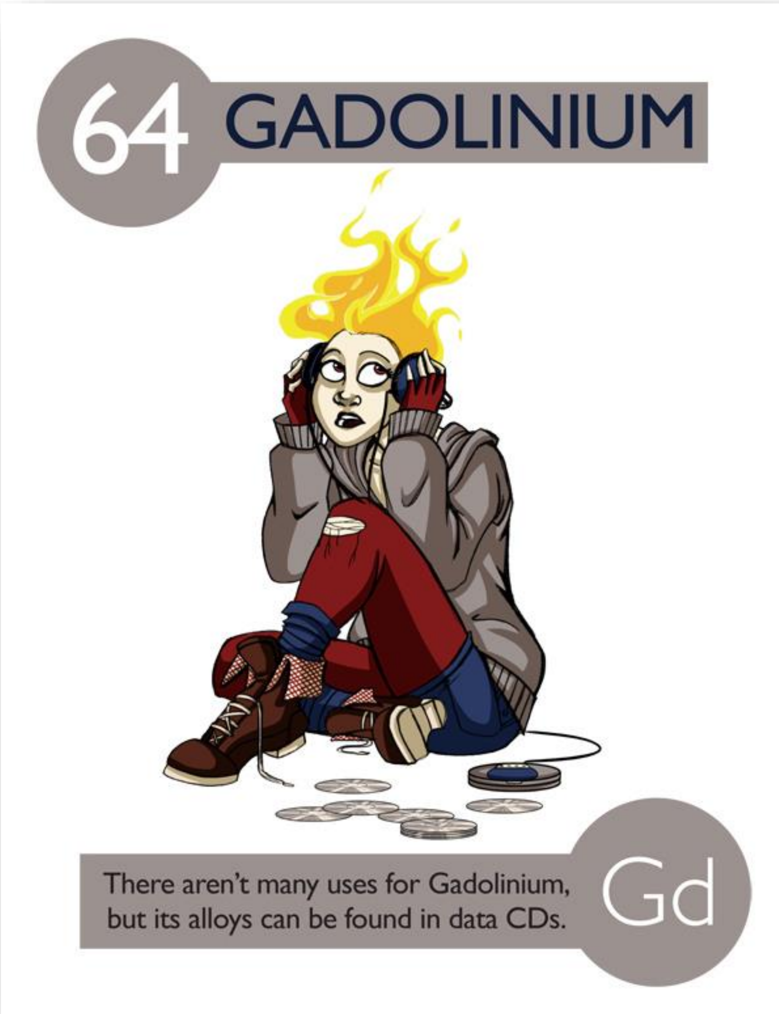


- **Gadolinium, Gd**

Gadolinium has an unusual trait shared only by the transition metals iron, cobalt and nickel – ferromagnetism. This is the mechanism by which certain materials form permanent magnets when placed in a magnetic field; the materials become magnetic and remain so after the external magnetic field is removed. Gadolinium is a stronger ferromagnet than the other three naturally occurring elements – but only when supercooled to –273 °C. When not supercooled, gadolinium is ferromagnetic below 20 °C and paramagnetic above 20 °C (paramagnetic materials are attracted by a magnetic field but do not retain magnetic properties once the field is removed).

Return to Main Menu

Periodic Table – 30 Second Elements



- **Gadolinium, Gd**

This suggests that gadolinium could be used in magnetic components used to sense hot and cold.

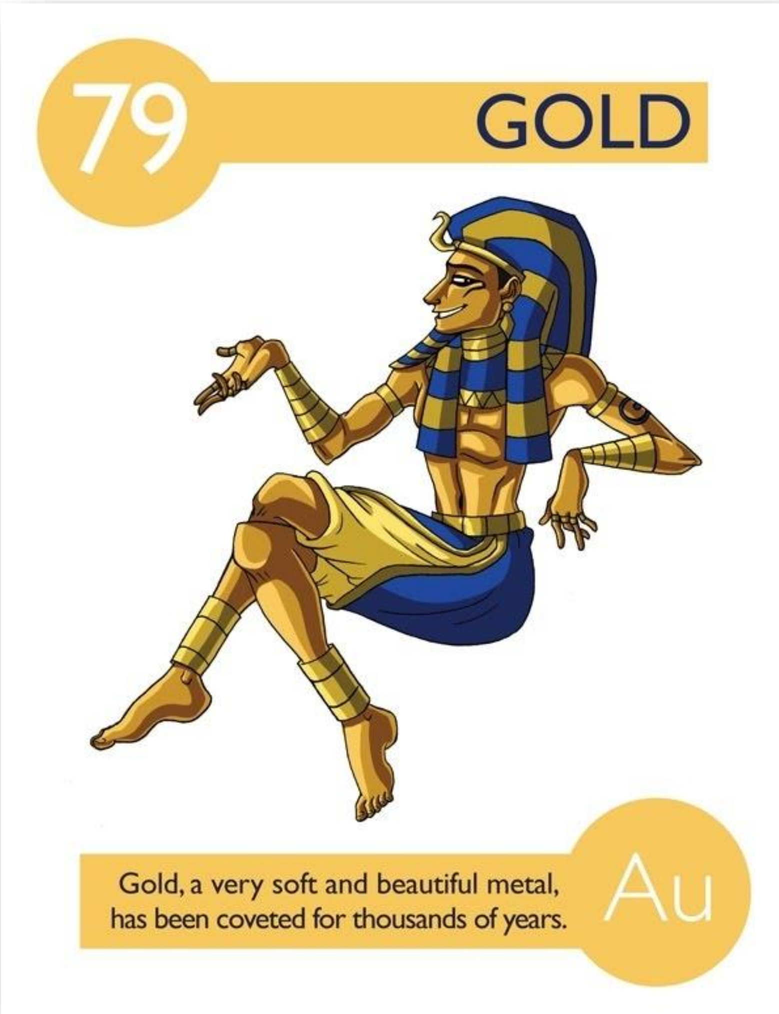
Gadolinium is used in nuclear reactor control rods because it has the highest known capacity to absorb neutrons of any natural isotope of any natural element.

Gadolinium-gallium garnets and gadolinium-yttrium garnets are manufactured for use in microwave applications and in the fabrication of optical components.

Gadolinium forms trivalent ions (Gd^{3+}) that have fluorescent properties, making gadolinium compounds useful as green phosphors in consumer electronics and as imaging components in x-ray systems.

Return to Main Menu

Periodic Table – 30 Second Elements

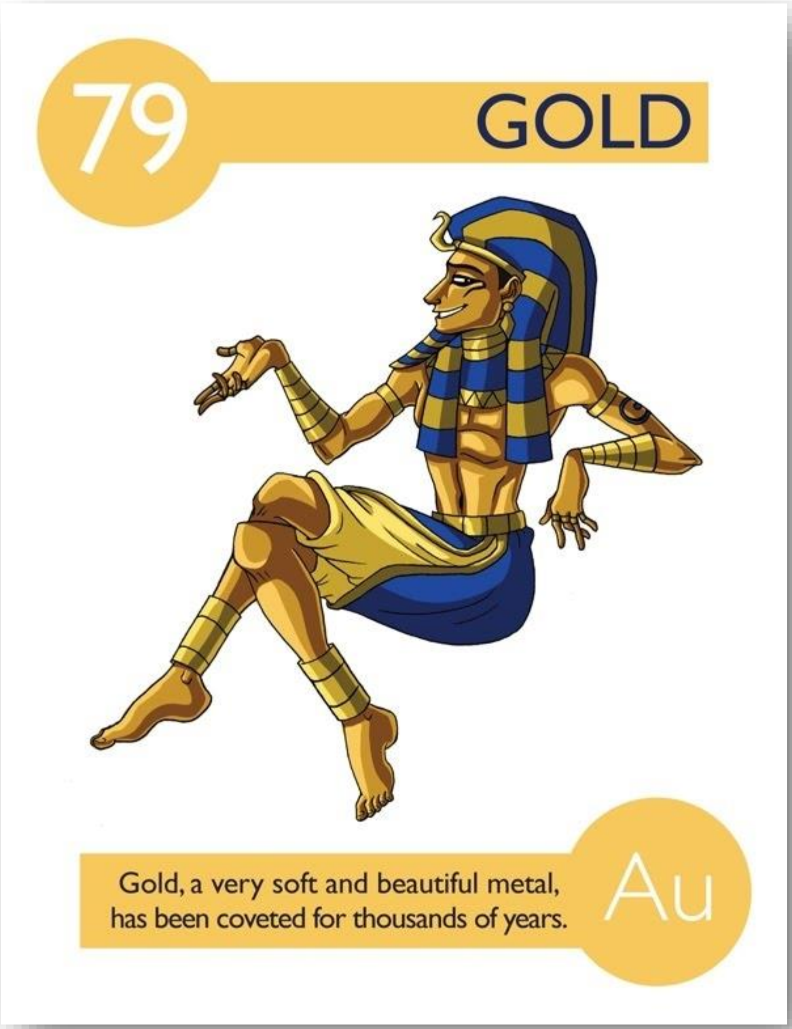


- **Gold**, **Au**

Technically a transition metal, gold is used above all in jewellery and as a currency – reflecting its ease of working, its rarity and its attractive shine. It differs from the usual silvery colour of most metals because some of its electrons move so fast (close to the speed of light) that relativistic effects change the shape of their orbits, altering the energy of the photons that they absorb and re-emit. Because gold is so dense, practically all of the earth's gold is thought to be deep within the planet. The metal that we dig up arrived later, when gold bearing asteroids and meteorites hit the earth's surface. It has been estimated that all of the gold ever mined would only occupy 8 000 m^3.

Return to Main Menu

Periodic Table – 30 Second Elements

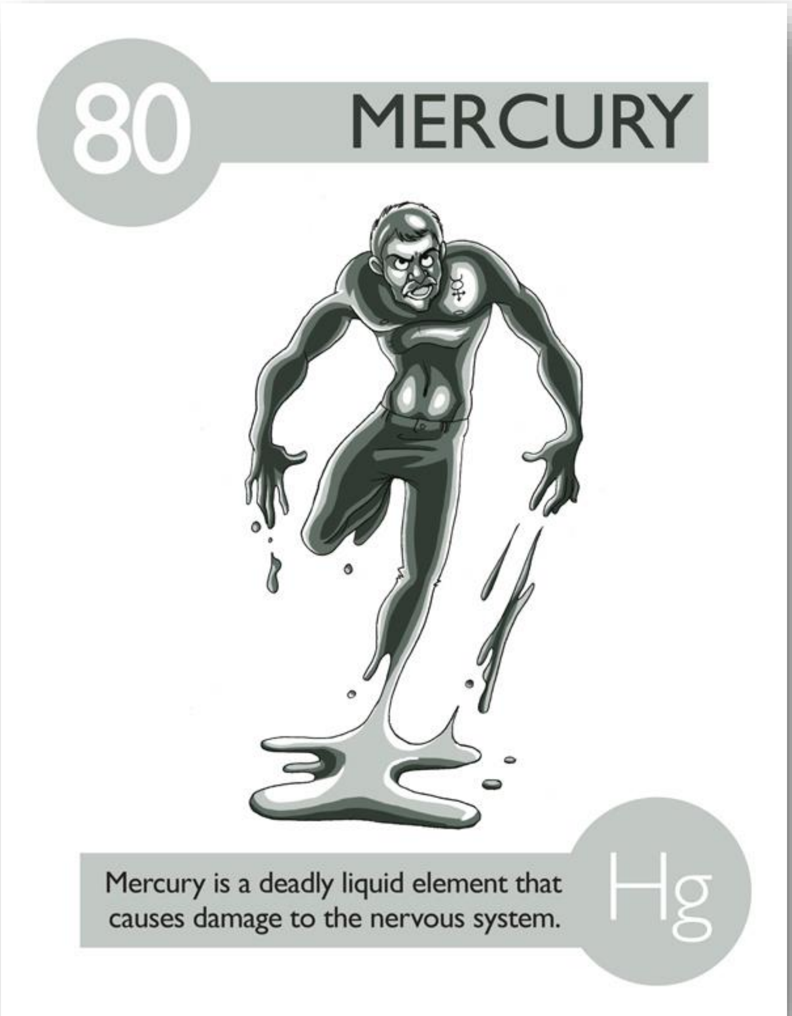


- **Gold**, **Au**

From earliest times, gold has found its way into jewellery, and this still accounts for 50 percent of production. Another 40 per cent is converted into gold bars and coinage. The remainder has the most practical use – because it does not oxidise in air and is an excellent conductor of electricity, gold is used for circuit boards, plugs and electrical contacts.

Although gold is relatively unreactive, which is why it does not oxidise in air and remains shiny, it will dissolve in *aqua regia* (Latin for *royal water*), a mixture of concentrated nitric acid and concentrated hydrochloric acid. Gold typically reacts to form gold(I) chloride ($AuCl$) and gold(III) chloride (Au_2Cl_6).

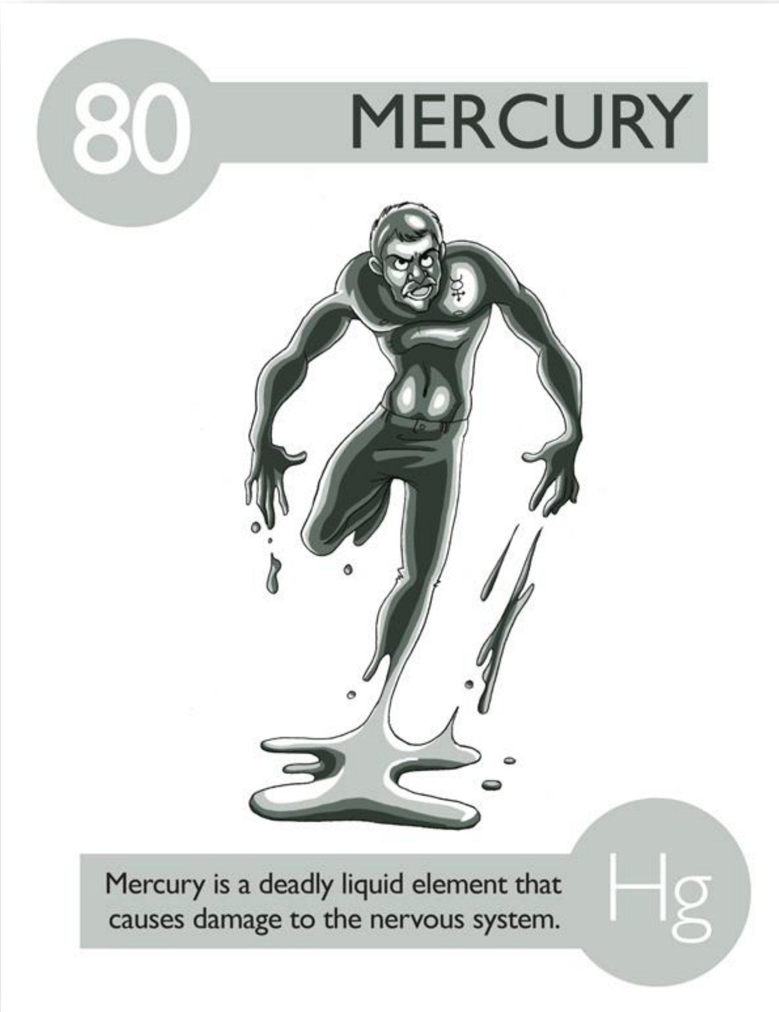
Periodic Table – 30 Second Elements



- **Mercury**, **Hg**

Mercury is the only liquid metal and, with the non-metal bromine, one of only two elements that are liquids at room temperature and pressure. Its liquid nature makes it distractingly beautiful – the Islamic rulers of medieval Spain placed mercury pools in their gardens, in which visitors would dabble their fingers. The element is usually obtained from its ore cinnabar or vermilion (mercury sulfide – HgS) which is also the pigment used to produce the red colour in some Hindu rituals. Mercury has been used as a medicine for thousands of years in forms such as the laxative calomel (Hg_2Cl_2) and the disinfectant mercurochrome ($C_{20}H_8Br_2HgNa_2O_6$).

Periodic Table – 30 Second Elements

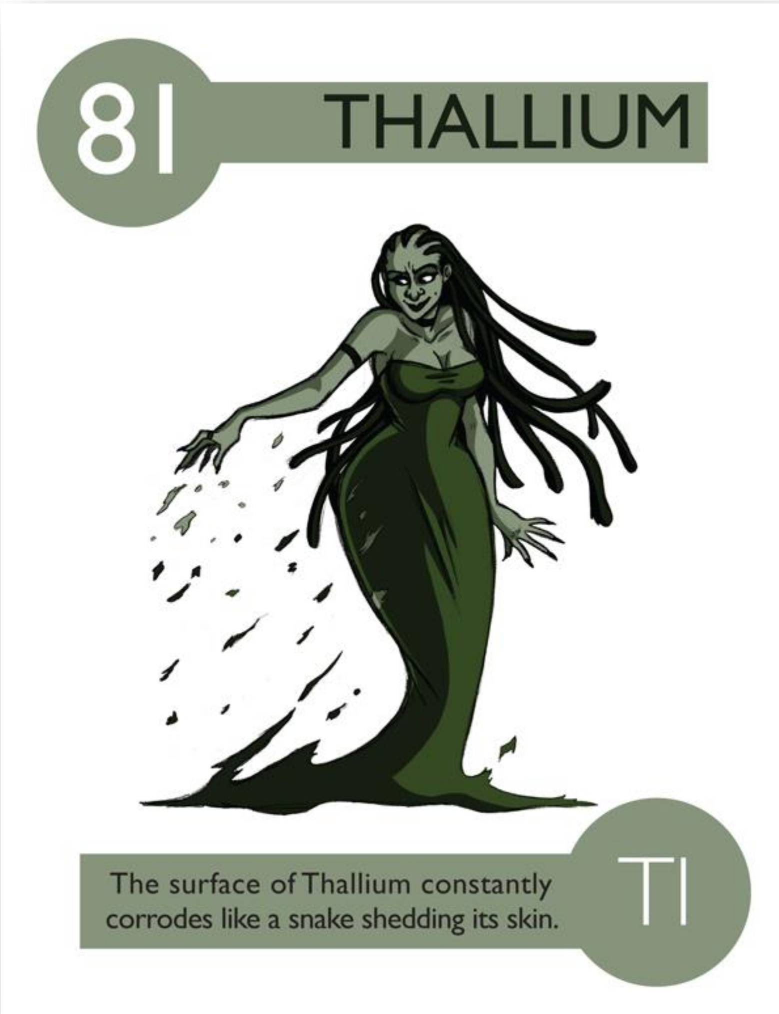


- **Mercury**, **Hg**

More reactive compounds of mercury were also used to treat syphilis. Mercury is especially favoured in Chinese medicine. The element is nevertheless highly poisonous. Mercury used to treat animal fur in hat-making produced acute psychological as well as physical symptoms of illness, inspiring the phrase “as mad as a hatter” and the character of the Hatter in Lewis Carroll’s 1865 novel *Alice’s Adventures in Wonderland*. Organomercury compounds were also responsible for one of the worst recorded cases of industrial pollution - the Minamata Bay incident in Japan. Less toxic alternatives are being found for many of mercury’s uses, *e.g.* in dental amalgams.

Return to Main Menu

Periodic Table – 30 Second Elements

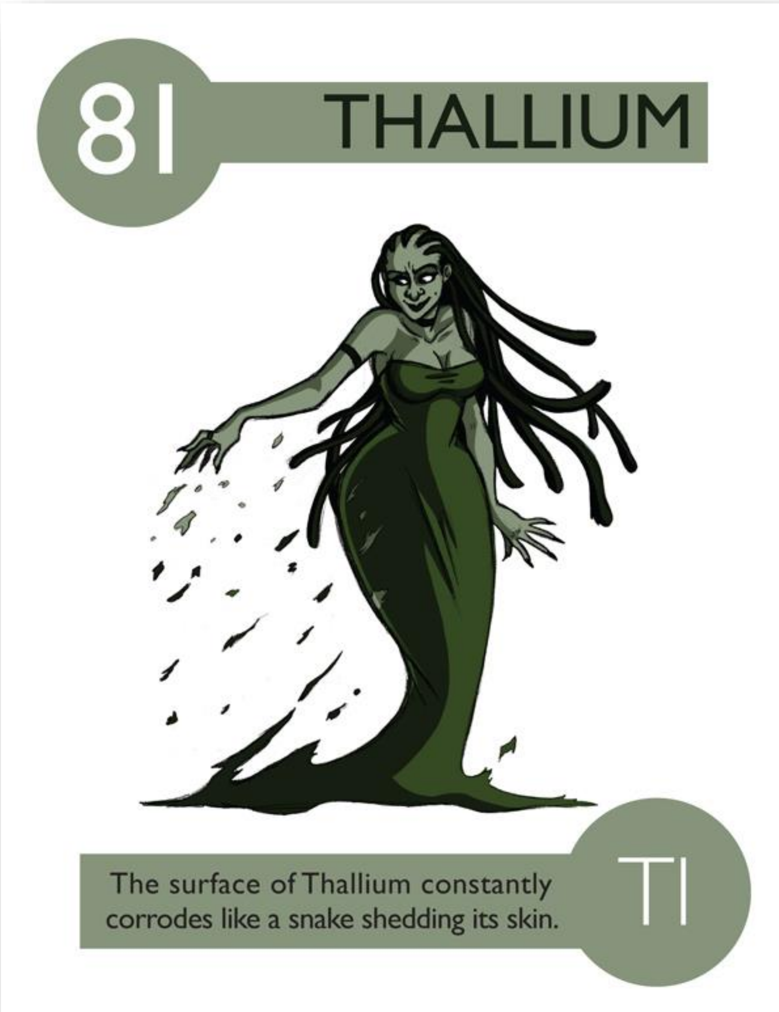


- **Thallium, T*l***

Thallium can be murder, as it was in Agatha Christie's novel *The Pale Horse*. Toxic to humans, thallium accumulates slowly in tissues, around 1 g being enough to cause death in about two weeks. Odourless and tasteless, it gives no warning of its presence, then causes rapid hair loss and severe nervous and gastrointestinal disorders; although the initial effects may escape notice for a day or two, the presence of thallium salts can readily be detected post-mortem. Until the 1960s, thallium(I) sulfate (Tl_2SO_4) was used to poison rats. However, as a non-selective poison, it was also found to be toxic to the American bald eagles that consumed the dead rodents.

Return to Main Menu

Periodic Table – 30 Second Elements



- **Thallium, T*l***

By 1972, when one quarter of all sick or dead bald eagles had suffered thallium poisoning, the United Stated banned its use as a poison, followed in subsequent years by several other countries. Thallium is used today in low-melting point glass, photoelectric cells, switches and mercury alloys for low range mercury thermometers. William Crookes and Claude-Auguste Lamy discovered thallium independently in 1861 in residues of selenium bearing ores used in sulfuric acid production. Both used the newly discovered technique of flame spectroscopy – in which thallium produces a prominent green spectral line – to confirm the existence of the new element.

Return to Main Menu

Periodic Table – 30 Second Elements

- **Lead**, **Pb**

Lead is one of the dozen or so elements that were known to people in the ancient world. Although it is not as strong as other metals, its softness and low melting point made it easy for them to work, and they found many uses for it. Lead forms a thin layer of white lead(II) carbonate ($PbCO_3$) when exposed to air. This prevents further corrosion, making it ideal for roofs, pipes and drains. The Romans used lead mined in Britain across their empire in these ways. Its colourful ores – black, white and red – were also used in cosmetics. The Latin word for lead is *plumbum*, which explains its chemical symbol Pb and the origin of words such as "plumbing".

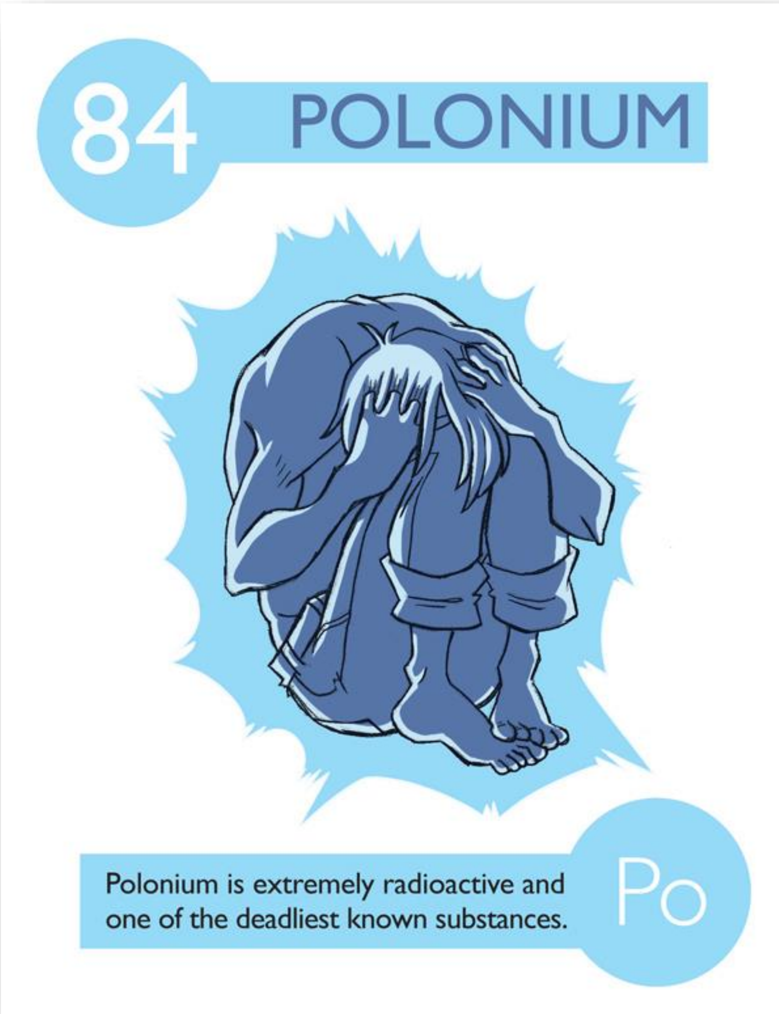
Periodic Table – 30 Second Elements

- **Lead**, **Pb**

Its high density gave lead further applications as weights for fishing, in plumb lines for architecture and as dice. The Romans even used the highly soluble salt lead(II) ethanoate ($Pb(CH_3COO)_2$) to sweeten wine. In modern times, lead was used to make printer's type and for bullets. Although the poisonous nature of lead compounds was recognised even in ancient times, it was only in the 20^{th} century that many of its modern uses – including domestic plumbing, paint, glass, solder and pewter – were restricted. One of the remaining uses of lead is in car batteries. Invented in 1859, the lead-acid battery is cheap and can deliver a large current.

Return to Main Menu

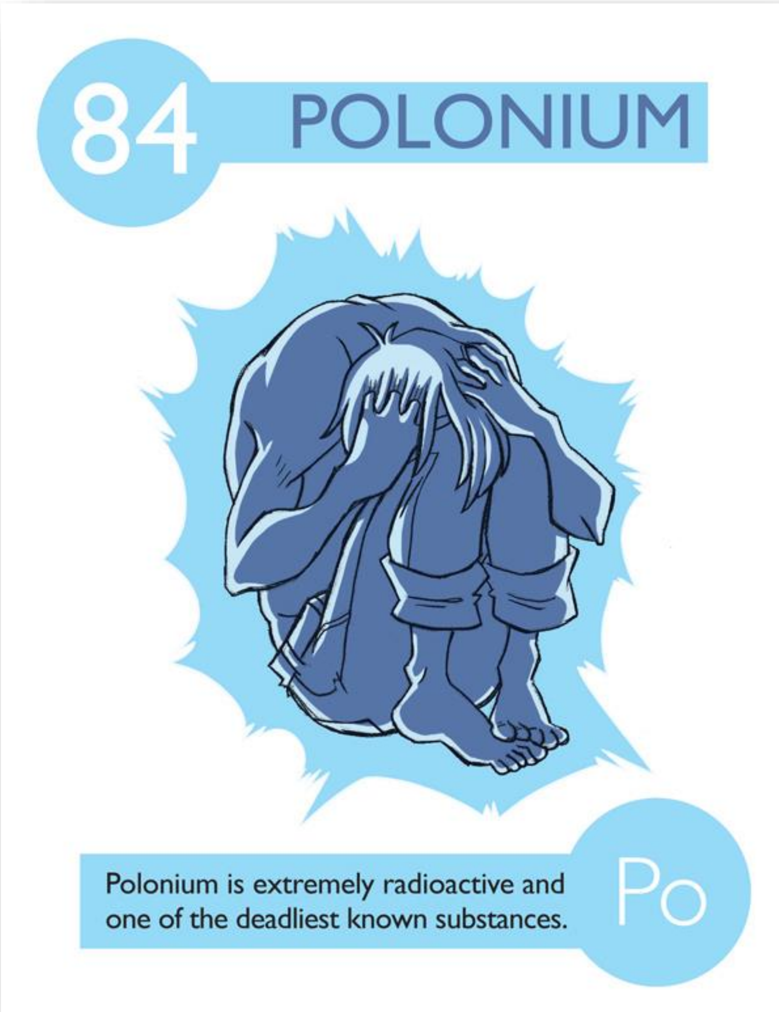
Periodic Table – 30 Second Elements



- **Polonium**, **Po**

A chemical curiosity from the bottom of the Periodic Table, polonium is a silvery-white metal of which few people have even seen a speck. This mysterious element is known less for its chemistry that for its physical properties. It was discovered in Paris in 1898 by the physicists Marie and Pierre Curie, who together isolated it as one of the minor but more radioactive components of pitchblende – a uranium containing mineral. So radioactive is the metal that it has few uses. However, trace amounts of polonium are incorporated into anti-static devices for the textile, electronics, printing and munitions industries, where sparks would pose a risk of fire or explosion.

Periodic Table – 30 Second Elements

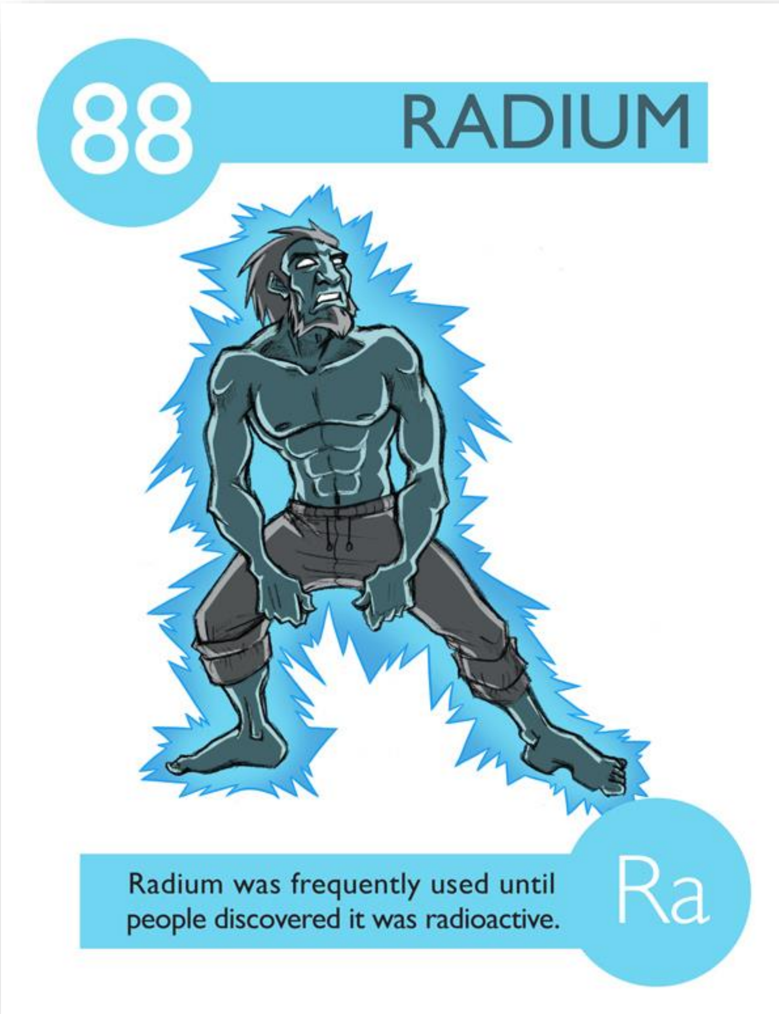


- **Polonium, Po**

In a remarkable example of fighting fire with fire, the ions (charged particles) produced by polonium's intense radioactivity neutralise any localised build-up of static electricity.

Polonium became notorious in 2006 when Alexander Litvinenko, a high-profile Russian expatriate living in London, became mysteriously ill. Doctors at London hospitals took several days to diagnose that he was suffering from radiation poisoning, the result of swallowing a drink laced with polonium widely believed to have been administer by Russian agents. Litvinenko died in agony three weeks later.

Periodic Table – 30 Second Elements

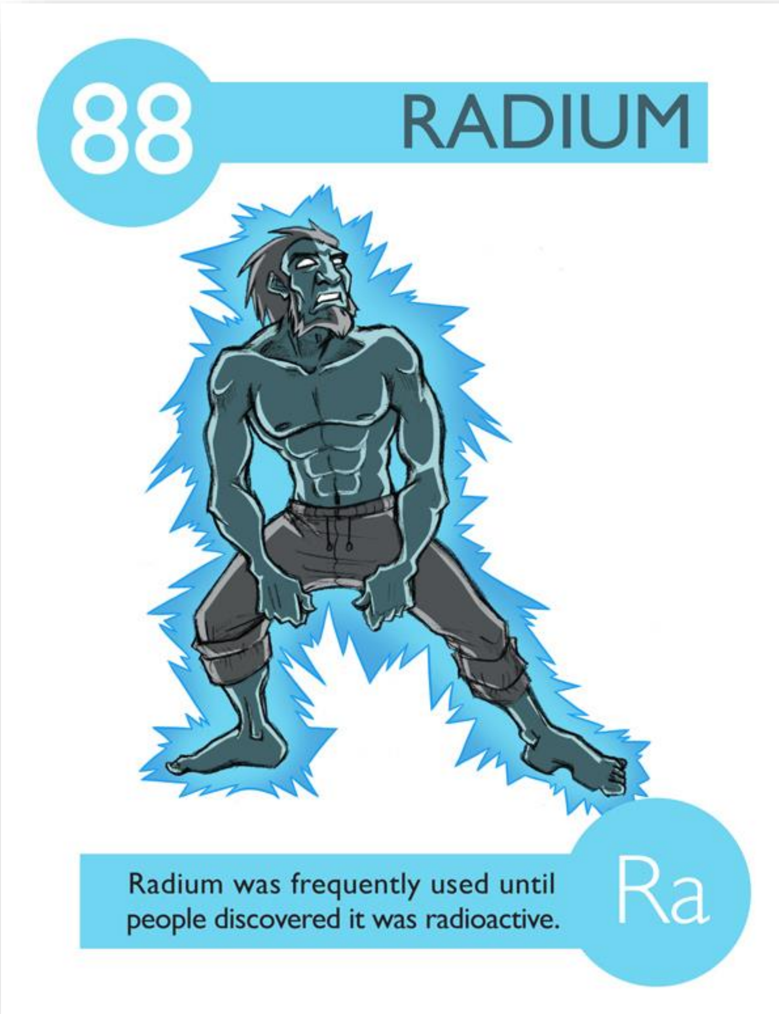


- **Radium**, **Ra**

The alkaline earth metal radium is the most radioactive substance in nature. Radium was isolated in 1902 by French-Polish chemist Marie Curie and husband Pierre from the waste material left after uranium was extracted from pitchblende. This took months of back-breaking work – the Curies worked through tons of material to provide just 0.10 g of radium. After discovering that the new element produced skin burns when handling it, the Curies and medical colleagues found that radiation from the element could destroy tumours. This was the first example of radiation-based cancer treatment, leading to the development of modern radiotherapy.

Return to Main Menu

Periodic Table – 30 Second Elements

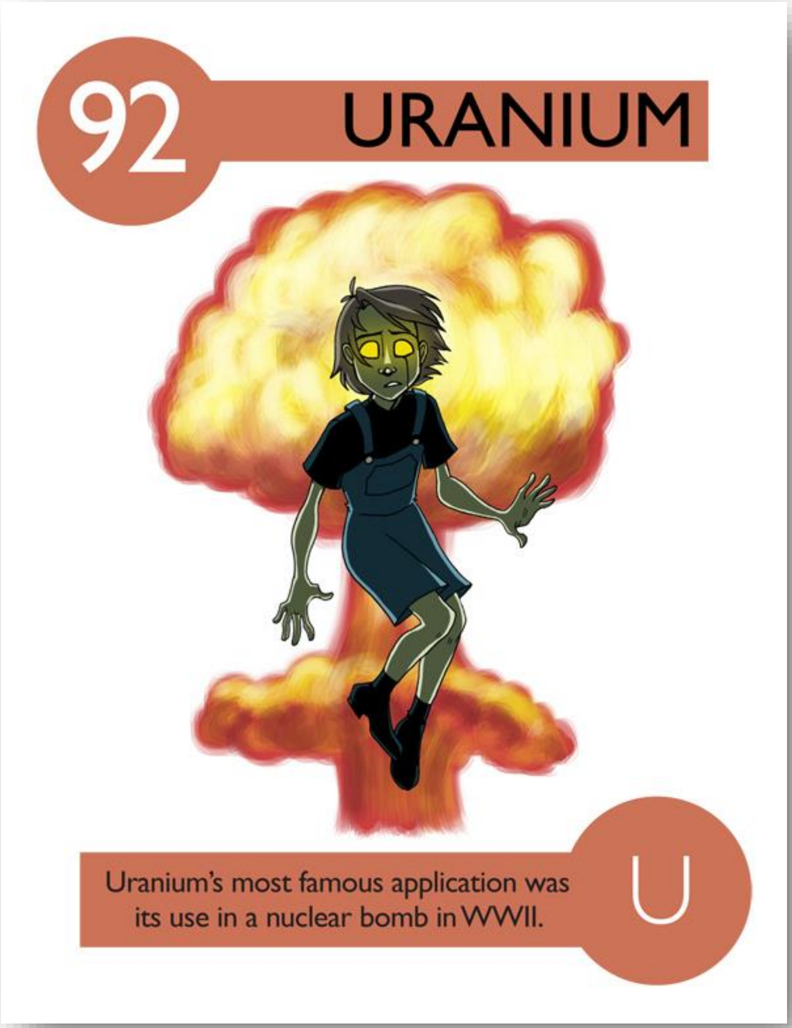


- **Radium**, **Ra**

Radium, with its eerie blue glow, was seen as a natural source of energy and incorporated into everything from toothpaste to hair restorer. It was widely used in luminous paint, until women workers painting clock dials began to develop anaemia and cancer. The dial painters had been licking their brushes to bring them to a point, ingesting radioactive material in the process. As a result, over 100 workers died from radiation poisoning. Marie Curie's own death from aplastic anaemia was almost certainly a result of exposure to radiation; even now her notebooks are kept in lead-lined boxes and only handled by people wearing protective clothing.

Return to Main Menu

Periodic Table – 30 Second Elements

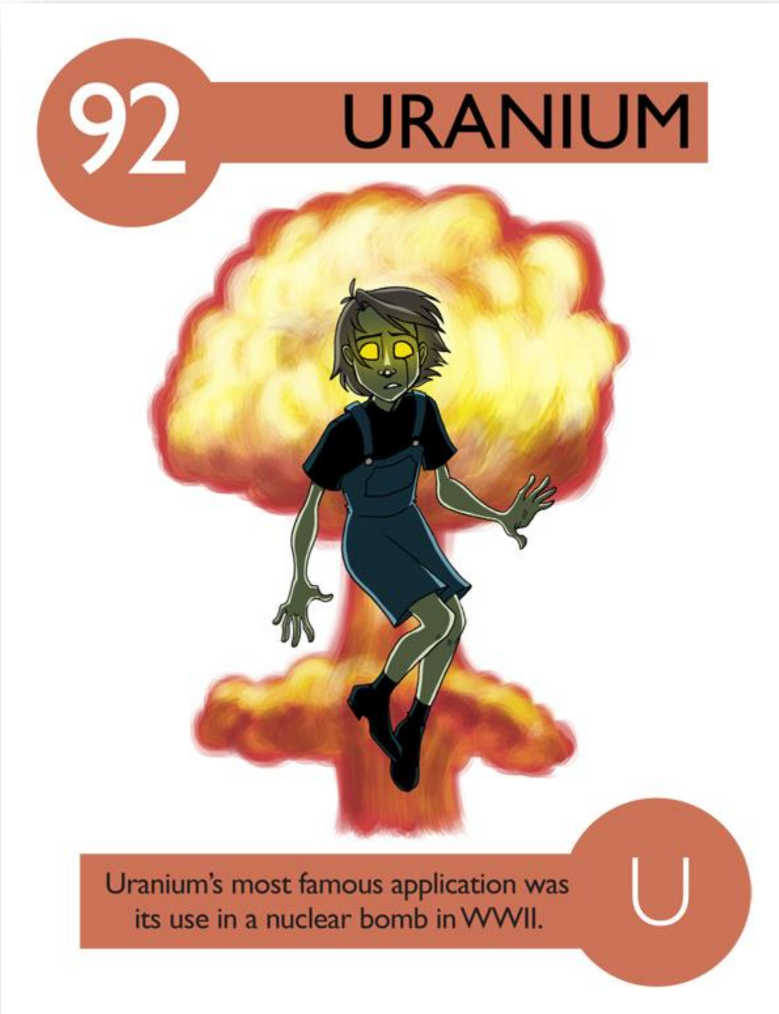


- **Uranium**, **U**

People used to eat off uranium, and some people still do. The element was discovered in the mineral pitchblende in 1789, and in the 19th century it was used to make a bright orange glaze for tableware and a colouring agent for green glass. Orange uranium-ware was still being made in the 1940s, albeit using less radioactive *depleted uranium*, whilst at that same time uranium was being processed by the *Manhattan Project* into the nuclear bomb that destroyed Hiroshima, Japan, in 1945. The radioactivity of uranium was discovered in 1896 by French scientist Henri Becquerel, who found, while investigating x-rays, that uranium compounds emit a new type of "ray".

Return to Main Menu

Periodic Table – 30 Second Elements



- **Uranium**, **U**

It became clear that the energy leaking from uranium in this way was enormous, and that it was coming from the atomic nuclei. In 1938, German chemists Otto Hahn and Fritz Strassmann in Berlin – together with Austrian physicist Lise Meitner – found that the nucleus of a uranium atom may split in half (undergo *fission*) when it absorbs a neutron, raising the possibility of a sustained uranium chain-reaction that could liberate its nuclear energy more quickly. In a nuclear reactor, the chain-reaction is controlled; in a bomb, it becomes a runaway process, releasing the nuclear energy in an explosion.

Return to Main Menu

Periodic Table

Presentation on

Periodic Table – 30 Second Elements

by Dr. Chris Slatter

chris_slatter@nygh.edu.sg

Nanyang Girls' High School

2 Linden Drive

Singapore

288683

8th November 2016

References

Eric Scerri (2013), *30 Second Elements*, Icon Books Ltd., ISBN 978-1848315945

http://www.kcdstudios.com