



Atoms and Elements

WORDS

billion = a number with 9 zeros

building block = the pieces or parts of an object

consist = are made up of

compound = is made up of two or more elements

diameter = a straight line from one side of a circle to the other

electrical charge = electricity that is put into an electrical object, like a battery

hydrogen = a colourless gas that is the lightest of all elements

iron = a hard metal that is used to make steel

lead = a soft grey metal that melts very easily. It can be found in pencils.

mass = the amount of material in something

nucleus = the middle part of an atom with protons and neutrons

orbit = to travel around an object in a circle

outer = far away from the centre

oxygen = a gas that is in our air and that we need to live

shell = path, layer

weight = how heavy something is

Introduction



An atom is the smallest **building block** of everything that exists. The smallest object you can see under a microscope has more than 10 **billion** atoms .

There are over a hundred different types of atoms, that we call elements. They form the world we live in.

Well known elements are **hydrogen**, **oxygen**, **iron** or **lead**. When two elements get together they form a **compound**. For example, water has two atoms of hydrogen and one atom of oxygen.

Atoms all have about the same size, but they have different **weights**. Plutonium is one of the heaviest atoms , about 200 times heavier than hydrogen , which is the lightest element.

Parts of the Atom

An atom **consists** of three parts : protons, neutrons, electrons.

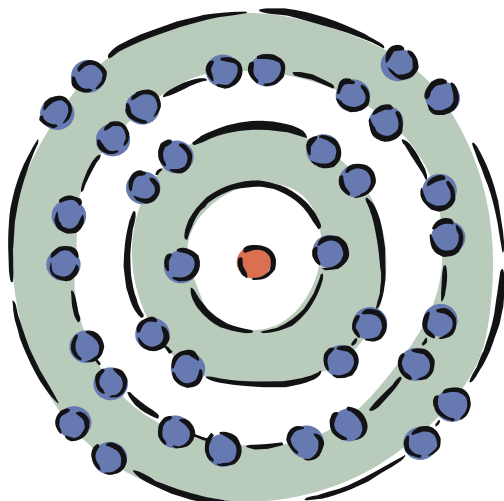
Protons and neutrons are in the centre of an atom, which is called the **nucleus**. It is very small if you compare it with the whole atom and it has almost all of an atom's **mass**. If an atom had a **diameter** of about 6 km the nucleus would only be as big as a tennis ball. The rest of the atom outside the nucleus is mostly empty.

Electrons fly around in an atom very, very quickly. They have almost no **mass** and travel around the nucleus millions of times every second.

The parts of an atom have **electrical charges**. Each proton carries a positive electrical charge and each electron has a negative electrical charge. Neutrons have no charge. In most cases an atom has the same number of protons and electrons. It is electrically neutral.

The energy of the nucleus keeps the electron inside the atom—just like the Earth keeps the moon in its **orbit**. But electrons have energy themselves. They want to break away from the **nucleus**. If an electron has a lot of energy it moves around farther away from the nucleus.

Electrons move around the nucleus in up to seven round paths , called **shells**. The first **shell** is closest to the nucleus. It can hold two electrons. The second **shell** can hold 8, the third 18 and the fourth 32 electrons. In most atoms, the **outer shells** are never completely filled with electrons. The inner electrons travel fastest, the outer ones are the slowest.





Atoms and Elements

WORDS

bombard = to shoot at

complicated = not easy

create = make

electrical charge = electricity that is put into an electrical object, like a battery

gain = to get one more of something

hydrogen = a colourless gas that is the lightest of all elements

lab = short word for laboratory

laboratory = a special room in which scientists make experiments

lose = if you don't have something anymore

naturally = by nature and not with the help of scientists

nucleus = the middle part of an atom with protons and neutrons

particle = a very small piece of something

periodic table = a list of elements that are in groups

radioactivity = if an atom sends out energy when the nucleus breaks apart

ray = a line of light

scientist = a person who is trained in science

uranium = a heavy white metal that is radioactive and used to produce nuclear power and bombs

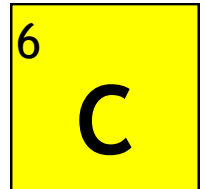
Properties of an Atom

Atomic Number

The atomic number tells you how many protons an atom has. For example, every **hydrogen** atom has the atomic number 1 because it only has 1 proton.

Elements that have atomic numbers of up to 92 can be found in nature, those over 92 are **created** by **scientists** in a **laboratory**.

The atomic number tells us where we can find an element in the **periodic table**. This table shows all the atoms in groups.



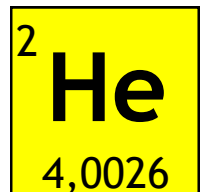
Atomic Mass

The atomic mass is the number of protons and neutrons in an atom. Although all atoms of the same element have the same number of protons, they sometimes have more neutrons. Such atoms are called isotopes.

For example, **hydrogen** has three isotopes. Most of the time a hydrogen atom has one proton and one neutron. Sometimes you can find hydrogen isotopes that have two or three neutrons, but they too have only one proton.

In most lighter elements the **nucleus** of each atom has the same number of protons and neutrons. but heavier elements have more neutrons than protons. **Uranium**, for example has 92 protons and 146 neutrons. It's atomic mass is 238.

The atomic mass is never a whole number, because **scientists** do not just add protons and neutrons together. They use a **complicated** formula.



Electric charge

Normally, an atom is electrically neutral. But it can **gain** or **lose** electrons when it crashes with other atoms. Atoms that **gain** or **lose** electrons are called ions. They have an **electric charge**.

Atoms that **lose** electrons become positive ions, atoms that win electrons become negative ions.

Radioactivity



In some atoms the nucleus can change **naturally**. Such an atom is radioactive. When a nucleus changes it produces **rays**.

In nature, there are some elements that are radioactive, like uranium or radium. In **labs scientists** can produce **radioactivity** by **bombarding** atoms with smaller **particles**.



Atoms and Elements

WORDS

bombard = to shoot at

carbon = a chemical substance that is in coal, oil or diamonds

chlorine = a greenish yellow gas with a strong smell

combine = to get together with

create = make

creature = anything that is living

feature = characteristic, quality

fission = when you split atoms to produce energy

hydrogen = a colourless gas that is the lightest of all elements

inorganic = everything that is not organic

liquid = something that is not solid or gas, like water

nucleus = the middle part of an atom with protons and neutrons

organic = something that is living or is made by living things

oxygen = a gas that is in our air and that we need to live

react = to change when mixed with something else

reactor = a large machine that can produce nuclear energy

scientist = a person who is trained in science

share = to have the same

sodium = a silver white metal that usually exists together with other chemicals, for example in salt

solid = an object that is not a gas or a liquid

split up = to divide into two or more parts

tie = to hold together

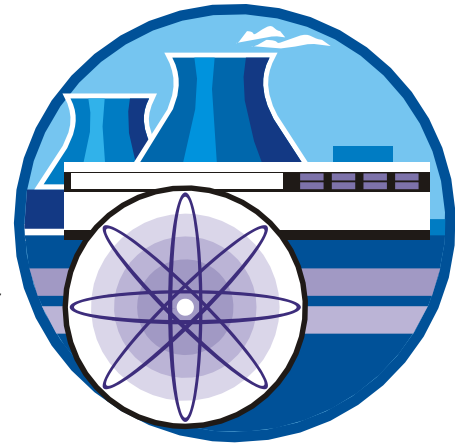
uranium = a heavy white metal that is radioactive and used to produce nuclear power and bombs

Atomic energy

In the 1930s and 40s **scientists** found out that if they **bombarded** a **uranium** atom with a neutron the **nucleus** would **split up** into two parts. When this happens energy is set free. We call this nuclear **fission**.

Fission was first used in atomic bombs that the Americans dropped over Japan to end the Second World War. The bombs **released** so much energy that they killed hundreds of thousands of people. Later on scientists found out how this energy could be used in a **peaceful** way.

In the 1950s the first atomic **reactors** were built. They produced energy by **splitting** atoms.



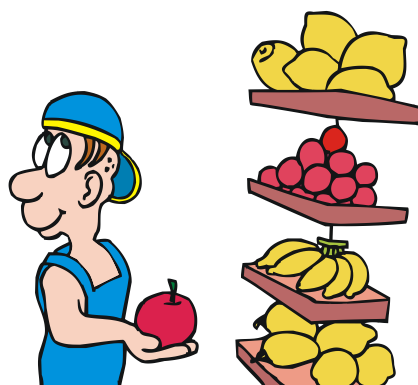
Compounds

Compounds are groups of two or more elements that are **tied** together. They are **created** when two different atoms **share** the same electron or when electrons travel from one atom to another.

Every compound has certain **features** and a chemical formula. Water, for example, is a compound that has two **hydrogen** atoms and one **oxygen** atom in it. Its chemical formula is H₂O. When **sodium** (Na) **combines** with **chlorine** (Cl) you get a compound called salt (NaCl). **Carbon** and hydrogen atoms form methane, or natural gas (CH₄).

Compounds can be divided into two groups: **organic** compounds always have carbon atoms in them. You can find them in all living **creatures**, in plants and in a lot of our food, for example sugar and fat. All other compounds are called **inorganic** compounds.

Compounds can be **solids**, **liquids** or gases. They may also turn into many different colours. Some compounds **react** very quickly, others don't react at all.





Atoms and Elements

WORDS

carbon = a chemical substance that is in coal, oil or diamonds

charge = electricity that is put into an electrical object, like a battery

combine = to put together

common = you can find it very often

compound = is made up of two or more elements

condense = if a gas becomes a liquid

engine = motor, a machine that produces power

fuel = material like coal or oil that can be burned to make energy

hydrocarbon = a compound made up of hydrogen and carbon

inhale = to breathe in something

liquid = fluid, something watery

molecule = the smallest unit made up of two or more atoms

nitrogen = a gas that has no smell or colour; it forms most of the Earth's atmosphere

petrol = a liquid that comes from oil. It makes your car drive

power = to make something run or work

power plant = a building where electricity is produced

noble gas = a pure gas that does not combine with other materials

occur = it can be found

oxygen = a gas that is in our air and that we need to live

rise = to go up

structure = the ways things are connected to each other

suffer from = to have pain

use = function, purpose

Important Elements

Hydrogen

The hydrogen atom is the smallest that we know and it has a very simple **structure**: one proton with a positive **charge** and one electron with a negative **charge**.

Hydrogen **occurs** as a gas that you can't see and can't smell. It is about 14 times lighter than air. When you **combine** two atoms of hydrogen with one atom of **oxygen** you get a water **molecule** H_2O . Like **nitrogen**, hydrogen can also be **condensed** to a **liquid** that freezes at $-259^\circ C$ ($-434^\circ F$) and boils at $-252^\circ C$ ($-423^\circ F$)

Hydrogen is one of the most **common** elements in our universe. The sun and many stars are made of hydrogen. It can also be found in the earth's crust. Hydrogen is in many **compounds** of animals and plants.

Hydrocarbons are compounds that only have hydrogen and **carbon** in them, like petroleum, natural gas or plastic.



Hydrogen has many **uses**. When two hydrogen atoms get together they form a molecule and give off a lot of heat. That's why, together with **oxygen**, hydrogen makes a good **fuel**. It, for example, **powers** the **engines** of space rockets. **Power plants** use hydrogen to produce energy. There are even cars that run on hydrogen fuel. When you add hydrogen to coal you can make **petrol**.

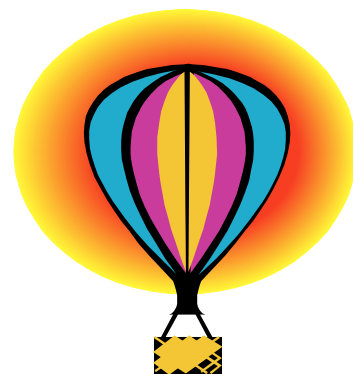
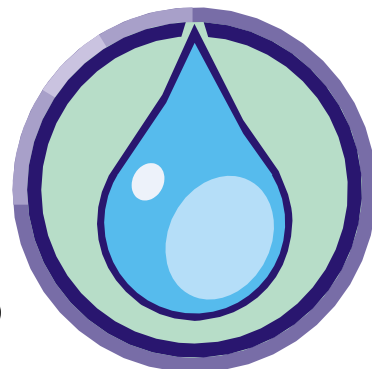
Helium

Helium is a light, colourless gas that you can't smell. It belongs to the group of **noble gases** because you cannot **combine** it with other elements. It has two protons and two neutrons.

Like hydrogen, we can find helium everywhere in our universe. On Earth, helium can be found in natural gas and in the atmosphere. It is so light that it **rises** and escapes into the atmosphere.

Helium is used to fill balloons. They can **rise** very high because helium is lighter than air. It is also safer than hydrogen because it does not burn.

People who **suffer from** asthma sometime **inhale** helium and oxygen because helium can enter the lungs more easily.





Atoms and Elements

WORDS

acid = a strong liquid that can burn holes in materials or damage your skin

amino acid = one of the substances that combine to form proteins

boil = when a liquid becomes hot enough it turns into a gas

bond = two or more things become fixed together

carbon dioxide = the gas that is produced when people or animals blow out air or when carbon is burned

chain = line that is connected

creature = anything that is living

drilling heads = the bottom part of a tool that you use to drill a hole into the earth to find oil or gas

fertilizer = something that you put into the soil to make plants grow

graphite = a soft black material you can find in pencils

haemoglobin = a red substance in your body that has iron in it and carries oxygen

isotope = different forms of an element

limestone = a kind of rock that has calcium in it

liquid = fluid, something watery

mass = the amount of material in something

melt = if something changes from solid to liquid

mixture = combination, mix

nitrogen = a gas that has no smell or colour; it forms most of the Earth's atmosphere

occur = can be found

ore = a rock that has metal in it

polish = to make something bright and shiny

pressure = the weight or power that you put on something

pure = something that is not mixed with anything else

surface = the top layer of an object

Nitrogen

Nitrogen is a colourless gas that you can't smell. It makes up about 78 % of the Earth's atmosphere.

Nitrogen's chemical symbol is N. Its atomic number is 7 and its **mass** is 14. Nitrogen gas has two atoms **bonded** together to form a molecule. The gas can be made into a **liquid** that freezes at -209° and **boils** at 195° C.

All plants and animals must have nitrogen to live. It is part of all **amino acids**. Plants produce these **acids** themselves, animals only produce some of them and get the rest by eating other animals and plants,

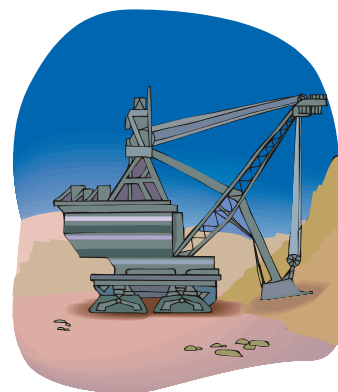
Nitrogen is also used as a **fertilizer**, which plants need to grow.

Iron

Iron is a silvery, white metal that you can find in rocks. Its chemical symbol is Fe, for ferrum. It has 26 protons and a mass of 56.

The industry gets **pure** iron out of **ore** that is **melted** at a high temperature about $1,500^{\circ}$ C.

All plants, animals and human beings need iron. Most iron in our body is in the red blood cells where it helps to form **haemoglobin**. **Haemoglobin** carries **oxygen** to all parts of our body. We also need iron in your muscles. So it's important to eat enough food with iron in it, or else you might get tired and weak



Carbon

Carbon is one of the most important elements. All living **creatures** have carbon in them and the industry uses carbon in many ways.

Carbon's chemical symbol is C. Its atomic number is 6 and it has a mass of 12, but there are other **isotopes** of carbon too.

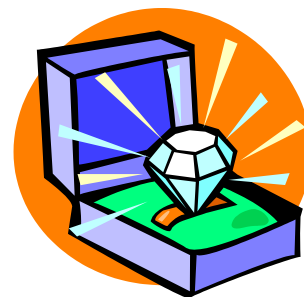
Carbon atoms like to form **bonds** with other atoms. They can link together with other elements and form very long **chains**.

A lot of carbon on Earth is found together with other elements. **Carbon dioxide** is in the air that we breathe out. Minerals, like **limestone** have carbon in them. **Mixtures** of carbon and hydrogen are in petroleum and natural gas.

Pure carbon does not **occur** very often on Earth. The best known forms of pure carbon are diamonds and **graphite**.

Diamonds are the hardest objects on Earth. They are in the Earth's crust, formed under high temperatures and **pressure**. Diamonds are very valuable. Most of them are used in industry—to cut or **polish** other objects or as **drilling heads** in oil fields.

Graphite is a soft grey or black mineral. Like diamonds, graphite is formed under the **surface** of the Earth. It is used in pencils and, because it is lightweight you can find it in spaceships, tennis rackets and bicycles.





Atoms and Elements

WORDS

alloy = a metal that is made up of two or more metals mixed together

artist = a person who paints or makes drawings

bacteria = very small living things that can lead to illnesses

chlorine = a greenish yellow gas with a strong smell

combine = to get together with

common = everyday, to be found very often

compound = is made up of two or more elements

copper = a reddish-brown metal used to make wires and pipes

corrode = to rust

crown = a top for a bad tooth

decorate = to make something look nice by putting objects on it

in combination with = together with

jewellery = small things made of gold or silver that you wear

magnesium = a silver, white metal that burns with a bright white flame

mine = to dig large holes in the ground to get raw materials

ore = a rock that has metal in it

ounce = a unit for measuring weight = 28.35 grams

poisonous = a substance or material that can hurt or kill you

pure = something that is not mixed with anything else

pots and pans = steel objects that are used for cooking

rust = a reddish-brown substance that forms on iron or steel when it gets wet

shape = the form that something has

sheet = layer

sodium = a silver white metal that usually exists together with other chemicals, for example in salt

tin = a soft white metal that is often used to cover and protect steel

wire = thin metal that has the form of a thread; it is used to carry electricity or telephone signals

Chlorine

Chlorine is a **poisonous** greenish-yellow gas with a strong, bad smell. In nature, it can only be found together with other elements, especially in minerals. Together with **sodium** it forms salt (NaCl).

Chlorine is used to make water clearer and **purier**. In swimming pools it kills **bacteria**. We also use chlorine to clean metal. The industry uses chlorine **compounds** to produce paper, plastic, medicine and paint.

Chlorine often **combines** with other elements because it easily **accepts** free electrons from them. It has 17 protons and an atomic mass of 35.

Aluminium

Aluminium is a very light silver metal that can be formed into any **shape**. It is one of the most **common** elements on Earth. About 8% of the Earth's crust is made up of aluminium. But you always find it **in combination** with other elements, never in its **pure** form.

Aluminium is often used as an **alloy**—together with **copper**, **magnesium** or **tin**. When it is formed with these elements, aluminium becomes very valuable.

Such **alloys** are very light, but strong. They do not **corrode** and electricity and heat can pass through them easily.

Aluminium can be as strong as steel. It is very often used to make cars and trucks as well as containers for ships. Industries make cans, **pots** and **pans** out of aluminium.



Most of our aluminium is found in rocks called bauxite. About 500 kg of aluminium can be made out of a ton of bauxite. This valuable raw material is **mined** in tropical and subtropical countries. Australia, Jamaica, Brazil are among the biggest producers.

Gold

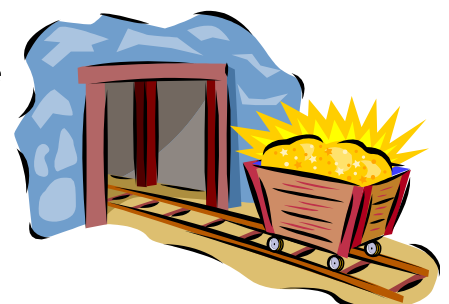
Gold is a shiny, yellow metal, probably one of the most expensive on Earth. It was one of the first metals discovered and people have been using gold for **jewellery** and coins for thousands of years.

Gold's chemical symbol is Au (Latin for "aurum"). It is a soft metal that can be pressed into many different **shapes**. One **ounce** of gold (about 30 grams) can be made into a thin **wire** that is 70 km long.

Gold does not **rust** when it gets into contact with water or air. Radios and TV sets have parts made of gold because electricity can pass through it well. Dentists use gold to make **crowns**, because it is easy to shape and gold crowns last a long time. **Artists** use thin **sheets** of gold to **decorate** objects.

Gold can be found in many rocks on Earth. In most cases, gold **ore** is mined deep under the surface. Sometimes gold is washed away by rain and wind. It gets into rivers where it sinks to the bottom because it is very heavy. In the middle of the 19th century a gold rush broke out all over the world. Gold was discovered in the rivers of Alaska, California and Australia.

Today, South Africa, the USA and Australia are the world's largest gold-producing countries.





Atoms and Elements

The Periodic Table of Elements

1 H 1.01																	18 He 4.00
3 Li 6.94	2 Be 9.01											13 B 10.81	14 C 12.01	15 N 14.01	16 O 15.99	17 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 25.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.41	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (270)	109 Mt (268)	110 Ds (281)	111 Rg (272)							

58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.97	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)