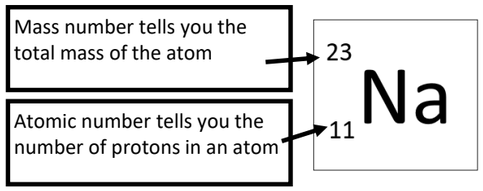
GCSE Science – Chemistry 1

1.1 - The nature of substances

Element – A substance that cannot be broken down into a simpler substance by chemical means. A basic building block of all substances, made up of only one type of atom.

Compound – A substance made of two or more different atoms, chemically bonded together. Can have completely different properties to the elements making it up.

Mixtures – A substance made of to or more elements or compounds mixed together and not chemically bonded.



The relative atomic mass (Ar) of an atom is equal to its mass number.
The relative molecular mass (Mr) is the total mass of a molecule.
Example
The Mr of CO_2 would be;
Ar of Carbon —> 12
2 x Ar of Oxygen —> 2 x 16 = 32
32 + 12 = 44

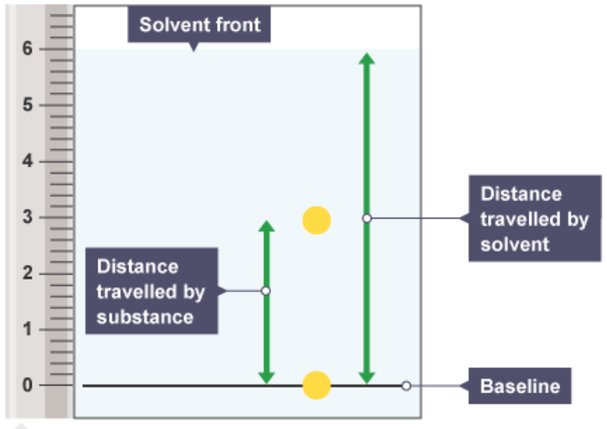
1.2 - Chromatography

R_f values

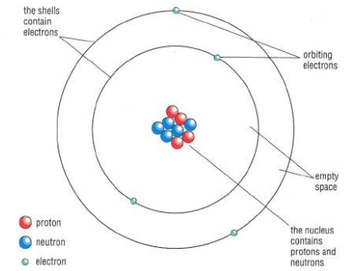
Different **chromatograms** and the separated components of the mixtures can be identified by calculating the **retardation factor** (R_f).
The R_f value is worked out by using this equation:

R_f = distance moved by the compound ÷ distance moved by the solvent

The R_f value of a particular compound is always the same *if* the chromatography has been carried out in the same way. This allows industry to use chromatography to identify compounds in mixtures.



1.3 – Structure of the atom



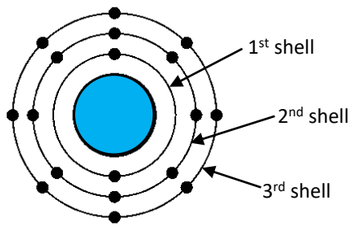
	charge	mass	position
proton	positive (+)	1	in nucleus
neutron	neutral	1	in nucleus
electron	negative (-)	0	in shells

Atomic number = number of protons = number of electrons
Mass number = number of protons + number of neutrons
Example – sodium
Atomic number = 11
Number of protons = 11, number of electrons = 11
Mass number = 23
Number of neutrons = 23 – 11 = 12

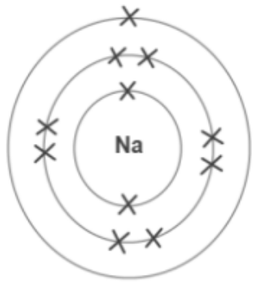
1.4 – Electron shells

Electrons occupy energy levels, shells or orbits. The lowest energy level (innermost shells) fills with electrons first.

1st shell holds up to 2 electrons
2nd shell holds up to 8 electrons
3rd shell holds up to 8 electrons



Example



Sodium has 11 electrons
2 in the 1st shell
8 in the 2nd shell
1 in the 3rd shell

The electron arrangement for sodium can be written **2, 8, 1**

1.5 - What's in natural water?

Water is a fantastic solvent; it dissolves two main types of solutes:
- Ions – As water flows over the ground, it picks up various ions from minerals. e.g Sodium, Calcium and Magnesium
- Gases– As water falls as rain, oxygen (essential for marine life) and carbon dioxide (essential for plant life) dissolve in the water.

Other things that water picks up on its travels contain microorganisms, which are natural pollutants and include bacteria and viruses, and man-made pollutants including fertilisers, pesticides and household and industrial waste.

Treatment of the water supply

1. **Water in** – groundwater/rivers provide water to reservoir
2. **Coarse filter** – removes larger particles
3. **Sedimentation** – in reservoirs/tanks, larger solid particles settle under gravity.
4. **Fine filtration** – through layers of sand and gravel, removes smaller insoluble particles.
5. **Chlorination** – chlorine added to kill bacteria, prevents disease/makes it safe to drink.

1.6 - Hard and soft water

Water can be hard or soft depending on where you live. In Cardiff we have soft water.
Hard water is water which contains calcium and Magnesium ions.
Hard water can be temporary or permanent, or a mixture of the two. Temporary hard water contains calcium hydrogencarbonate and/or magnesium hydrogencarbonate. When this is boiled the hardness is removed and calcium carbonate is formed.
Permanent hard water contains chlorides and/or sulphates. Boiling does not soften this water.
You can tell the difference between hard and soft water as soft water lathers (makes bubbles) easily with soap but hard water does not.
The three ways of softening hard water

1. Boiling. Cheap and easy but can only be used for small amounts of water
2. Adding sodium carbonate. This softens temporary and permanent hard water.
3. Ion exchange columns is a tube filled with resin. Water is passed through the tube and sodium ions on the resin are exchanged for calcium and magnesium ions.

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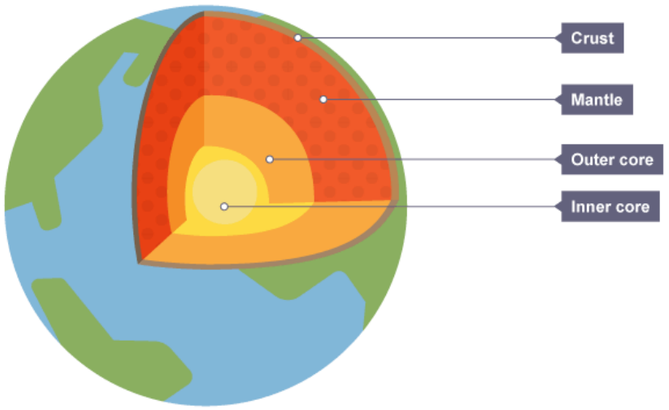
1.7 – Structure of the earth

The Earth is almost a sphere. These are its main layers, starting with the outermost:

- **Crust** - relatively thin and rocky
- **Mantle** - has the properties of a solid, but can flow very slowly
- **Outer core** - made from liquid nickel and iron
- **Inner core** - made from solid nickel and iron

The Earth's **lithosphere** is the rigid outer layer that is made up of the **crust** and the part of the **mantle** just below it.



1.8 - Pollution

Global warming

Caused by increased amounts of carbon dioxide in the atmosphere.
Global warming could cause;

- Climate change e.g. hotter summers (causing droughts) and increased rainfall (causing flooding).
- Higher rate of melting of icecaps, polar sea ice and glaciers.
- Rising sea levels

Acid rain

Caused by burning fuels that contain sulphur impurities. When burnt sulphur dioxide is produced which forms sulphuric acid when it comes in contact with water vapour in the atmosphere.

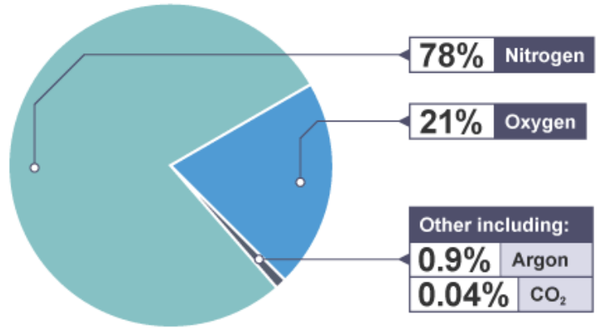
Rain is usually weakly acid (pH~5.5) however acid rain is much more acidic (pH 2-4). Acid rain lowers the pH in lakes, damaging aquatic life and damages forests and vegetation. It can also damage limestone buildings and increase corrosion in metal objects.

How do we stop it?

There are no simple solutions to the environmental problems associated with burning fossil fuels. We can make a difference by;

- Being a responsible consumers of energy.
- Getting electricity from renewable sources e.g. wind power, solar etc.

1.9 – Our atmosphere



The original atmosphere would have been mostly carbon dioxide, water vapour and ammonia, as these are the main gases released from volcanoes.

- As the surface of **the earth cooled**, the water vapour in the atmosphere condensed **forming the oceans**.
- As **green plants evolved** the carbon dioxide in the atmosphere decreased due to **more photosynthesis** taking place. This also increased the amount of oxygen in the atmosphere.
- Lots of **carbon dioxide was locked away in fossil fuels** made millions of years ago from the remains of marine organisms (Crude oil and gas) and large land plants (coal).
- **Ammonia decomposed** with oxygen to form large quantities of **Nitrogen**, which is now the most abundant gas in our atmosphere.

1.10 – Particle/Collision Theory

Particles must collide with enough energy in order to react – these are called successful collisions.

Rates of reaction means the speed of a reaction. There are 4 ways to increase the rate of the reaction.

1. **Temperature** When temperature is increased particles all move quicker i.e. they have more kinetic energy. If they are moving quicker they will cause more successful collisions.

2. **Concentration (pressure)** If a solution is made more concentrated, that means there are more reactant particles in between the water molecules which makes successful collision more likely.

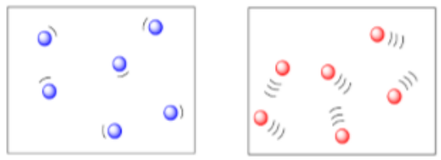
3. **Surface area (size)** Breaking a solid into smaller pieces will increase the total surface area. This means particles in the solution will have more area to react with and therefore more successful collisions.

4. **Catalyst** A catalyst is a substance which increases the speed of reaction without being chemically changed or used up in the reaction.

1.11 – Rates of reaction

Temperature-

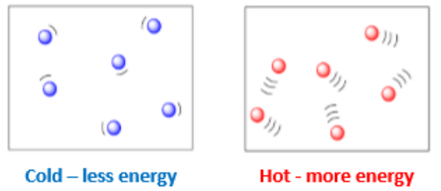
When temperature is increased particles all move quicker i.e. they have more kinetic energy. If they are moving quicker they will cause more successful collisions.



Concentration (Pressure)-

If a solution is made more concentrated, that means there are more reactant particles in between the water molecules which makes successful collision more likely.

In a gas, increasing the pressure means the particles are closer together and then successful collision will be more likely



1.12 - Catalysts

Catalysts-

A catalyst is a substance which increases the speed of reaction without being chemically changed or used up in the reaction.

- A catalyst works by giving the reactants surface to stick to where they can "bump" into each other. The overall number of collisions isn't increased but the number of successful collisions is.
- Development of better catalysts is extremely important in industry as it can lead to new ways of making materials that may use less energy, use renewable raw materials or use fewer steps.
- Catalysts allow reactions to work at a much lower temperature, which reduces energy consumption.
- Different reactions require different catalysts.
- Catalysts can be expensive, need to be removed from the reaction and can be "poisoned" by impurities.
- Enzymes are biological catalysts.