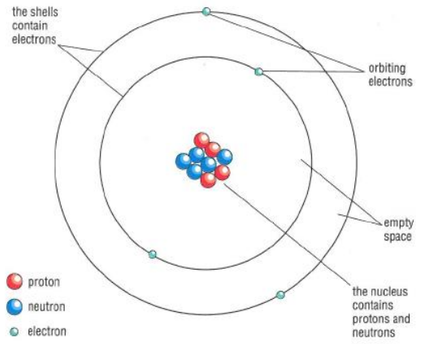
GCSE Science – Chemistry 2

2.1 – Structure of the ato



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

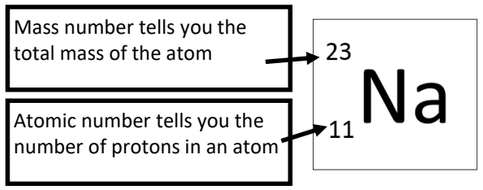
Atomic number = number of protons = number of electrons
Mass number = number of protons + number of neutrons
Example – sodium
Atomic number = 11
Number of protons = 11, number of electrons = 11
Mass number = 23
Number of neutrons = 23 – 11 = 12

2.2 – Atomic and mass numbers

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.

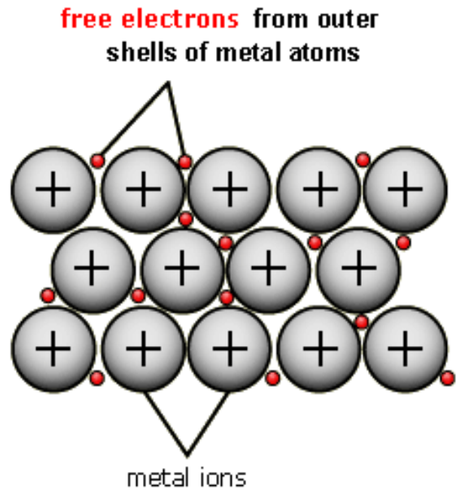


The relative atomic mass (Ar) of an atom is equal to its mass number.
The relative molecular mass (Mr) is the total mass of a molecule.
Example
The Mr of CO_2 would be;
Ar of Carbon —> 12
2 x Ar of Oxygen —> 2 x 16 = 32
32 + 12 = 44

2.3 - Properties of metals

Strong, high melting points, electrical conductivity, good conductors of heat, malleable ect.
Metallic bonding- layers of atoms, sea of electrons.
Metal crystals are made up of positive metal ions surrounded by a sea of negative electrons.

The sea of electrons in a metal crystal is mobile.
If a **potential difference** is applied across a piece of metal, the electrons will move, carrying an electrical current.
Strong **electrostatic attraction** between positive ions and negative electrons means that a lot of **energy** is needed to separate these particles from the crystal lattice.



2.4 – Nanoscale particles

Nano-sized silver particles are antibacterial, antiviral and antifungal and that they are used in plasters, antiseptic sprays, refrigerator linings, socks, deodorant sprays and so on.

Nano-sized titanium dioxide particles are used in some sun screens as they absorb and reflect UV light but are also transparent so more appealing to consumers.

Self-cleaning glass is coated with nano-scale titanium dioxide particles. These catalyse the breakdown of dirt in the presence of UV light and also cause water to spread out in a thin film, rather than forming droplets on the surface. The combined effort of sunshine and rainwater cleans the windows!

Risks of Nano-scale Particle

Nanomaterials currently used have been tested to ensure that they cause no damage to individuals or the environment, but that their long-term effects are as yet unknown. Some people have expressed concern that nano-scale silver (deodorants) and titanium dioxide (sun screens) are applied to the skin and can therefore be easily absorbed into the body. While it has been shown that these uses are safe in the short term, there is no certainty that exposure over many years will not result in problems.

2.5 - Acids & Bases

Acid – a substance that produces H^+ ions in water
Base – a substance that neutralises an acid, but does not dissolve in water
Alkali – a base dissolved in water

Acids & alkalis are classified using the pH scale.
The pH scale is a measure of the hydrogen ions (H^+) in the substance.

Acids contain hydrogen ions (H^+)s in water – the higher the concentration of H^+ (measured in mol/dm^3), the lower the pH and the stronger the acid.

Alkalis contain hydroxide ions (OH^-) in water – the higher the concentration of OH^+ (measured in mol/dm^3), the higher the pH and the stronger the alkali.

Acids – pH lower than 7
Neutral solution – pH 7
Alkalis – pH higher than 7

2.6 – Neutralisation

Acids react with metal oxides, hydroxide (both bases) and carbonates to form a salt and neutral water molecules.
These reactions are exothermic – they give out heat.

General chemical reaction in terms if ions
hydrogen ions + hydroxide ions → water
$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$

Neutralisation reaction
acid + base → salt + water

examples
sulphuric acid + magnesium oxide → magnesium sulphate + water
$H_2SO_{4(aq)} + MgO_{(s)} \rightarrow MgSO_{4(aq)} + H_2O_{(l)}$

hydrochloric acid + sodium hydroxide → sodium chloride + water
$HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$

Acids also react with metal carbonates to form a salt and water, but also produce carbon dioxide. These reactions effervesce – they produce bubbles of gas, carbon dioxide.

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2.7 – Reactivity of metals

Reactive metals such as aluminium are extracted by electrolysis, while a less-reactive metal such as iron may be extracted by reduction with carbon. Gold, because it is so unreactive, is found as the native metal and not as a compound, so it does not need to be chemically separated.

Metal Ores
Ores are naturally occurring rocks that contain metal or metal compounds in sufficient amounts to make it worthwhile extracting them.

Alloys
An alloy is a mixture of two or more elements, where at least one element is a metal. Many alloys are mixtures of two or more metals.
Steel
Carbon is removed from molten iron by blowing oxygen into it. The oxygen reacts with the carbon, producing carbon monoxide and carbon dioxide, which escape from the molten metal. Enough oxygen is used to achieve steel with the desired carbon content.

2.8 - Transition Metals

The transition metals are placed in the centre of the periodic table, between groups 2 and 3.

The transition metals have the following properties in common:
- form coloured compounds.
- good conductors of heat and electricity.
- can be hammered or bent into shape easily.
- less reactive than alkali metals such as sodium.
- have high melting points - but mercury is a liquid at room
- temperature.
- usually hard and tough.
- high densities.

Many transition metals are useful catalysts (e.g. iron in the manufacture of ammonia, platinum in catalytic converters).
They can form more than one type of ion e.g. Fe^{2+}/Fe^{3+} and their compounds are often coloured.

2.9 – Chemical reactions and energy

Exothermic reactions are reactions that give out energy in the form of heat.

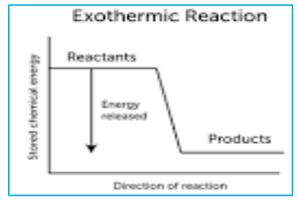
With exothermic reactions this means a chemical bond is being made.

In an exothermic reaction, the energy of the products is less than the energy of the reactants, because energy, in the form of heat, has been given to the surroundings.

Endothermic reactions are reactions that take in energy in the form of heat.

With endothermic reactions this means that a chemical bond is being broken.

In an endothermic reaction, the energy of the products is greater than that of the reactants, because energy has been taken in from the surroundings.



2.10 - Transition Metals

Calculating energy changes

The energy changes in a chemical reaction can be calculated in terms of the energy needed to break bonds and that is produced in forming bonds.

Combustion is a reaction that involves burning a fuel in oxygen. The combustion reaction involves breaking bonds in the reactants and forming bonds in the products.
Consider methane as an example:

$CH_4 + 2O_2 \qquad CO_2 + 2H_2O$

The breaking the bond is **ENDOTHERMIC**. This means it requires energy to be put in. In this example, 4 C-H bonds and 2 O = O bonds are broken.

The formation of a bond is **EXOTHERMIC**. This means it gives out energy. In this example, 2 C = O bonds and 4 O – H bonds are formed.

The **difference** between the total energy needed to break all the bonds and the total energy given out when new bonds are formed tells us if the overall reaction is endothermic or exothermic.

2.11 – Crude oil

Crude oil is a complex mixture of hydrocarbons that was formed over millions of years from the remains of simple marine organisms.

Fractional distillation of crude oil separates out fractions which can be used in a variety of ways.

The fractions contain mixtures of hydrocarbons (alkanes) with similar boiling points.

The compounds in the fractions have decreasing chain lengths and lower boiling points as you go up the fractionating column.

The fractions with low boiling points and low viscosity are the most useful as fuels.

The oil industry has global economic and political importance and social and environmental impacts.

2.12 – Combustion

Hydrocarbons and other fuels undergo combustion with oxygen.

The combustion reaction of hydrogen produces no carbon dioxide.

Hydrogen has advantages and disadvantages as a fuel. For example, it only produces water when it burns, however it is very flammable and can explode so is potentially more dangerous than oil based fuels.

The fire triangle indicates the components required for fire and is used in fire fighting and fire prevention.