Quantitative chemistry knowledge organiser

The **relative atomic mass** (ram or Ar) is the average mass of the atoms of an element compared to carbon-12. (The average mass takes into account the abundance of the naturally occurring isotopes.)

The **relative formula mass** (rfm or Mr) of a molecule is the total of the relative atomic masses added up as shown in the formula of the substance.

The law of **Conservation of mass** states that no atoms are destroyed or created during a chemical reaction hence the mass of the products is equal to the mass of the reactants.
$2Na + Cl_2 \rightarrow 2NaCl$ There are 2 sodium atoms and 2 chorine atoms on either side of the equation.
Sum of rfm on LHS of equation
2 x Mr Na + 2 x Mr Cl_2 = (2 x 23) + (2 x 71) = 117
Sum of rfm on RHS of equation
2 x Mr NaCl = (2 x 58.5) = 117
So the total Mr on the LHS is equal to the Mr on the RHS hence mass is conserved.

Some reactions may appear to show that there has been a loss in mass, but this can because one of the products was a **gas** and escaped into the surroundings.
e.g., $Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$

In a balanced chemical equation, the sum of the rfm of the reactants is equal to the sum of the rfm of the products. Mass is conserved.

The **mole** is the name given to an amount of substance. The symbol for the unit mole is **mol**.

One **mole** of a substance contains the same number of particles/atoms/molecules/ions as one mole of any other substance. This number is 6.023 x 10^{23} and is known as the **Avagadro** constant.
1 mole of carbon atoms will contain 6.023 x 10^{23} atoms
1 mole of iron atoms will contain 6.023 x 10^{23} atoms
1 mole of carbon dioxide molecules will contain 6.023 x 10^{23} molecules
1 mole of potassium ions will contain 6.023 x 10^{23} ions.

Chemical equations can be interpreted in terms of moles
$2Na + Cl_2 \rightarrow 2NaCl$
2 moles of sodium react with one mole of chlorine to produce one mole of sodium chloride.

Reactions stop when one reactant has been used up.

The reagent that is **in excess** is a chemical that has not been used up at the end of a chemical reaction.

A **limiting reagent** is the reagent that got completely used up (hence it limits the amount of product that can be made.)

One of the reagents is always added **in excess** to ensure that the other reactant is completely used up.

The concentration of a solution is the amount of a particular substance dissolved within a particular volume of solution. It's measured in g/dm^3 or mol/dm^3

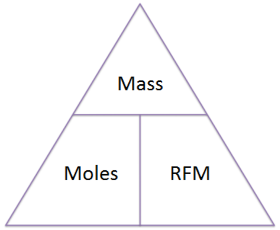
Volumes are often given in cm^3 but the units of concentration require conversion of cm^3 to dm^3. To **convert cm^3 to dm^3 we divide by 1000**.

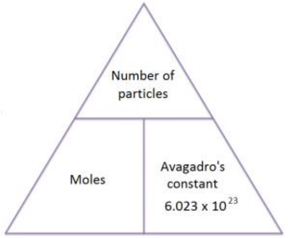
To convert **g/dm^3 into mol/dm^3** we **divide by rfm**.

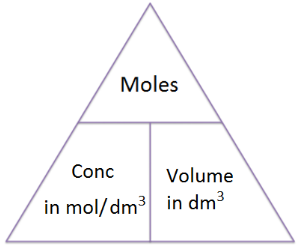
Titrations are experiments where you measure accurately the volumes of two solutions that react together completely. If you know the concentration of one of the solutions, you can then calculate the concentration of the other solution.

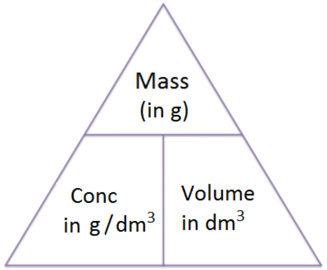
Volumetric flasks are used to make up solutions of **known concentration**. Water is added to a solute until it's dissolved. The flask has a graduation mark and the water is then filled up to this mark by looking at the bottom of the meniscus.

As you know the mass of solute and then volume of water added, you can work our its concentration









A **more concentrated** solution has more solute in the same volume of solution than a less concentrated solution.

A pipette is used to measure out a precise volume of solution.

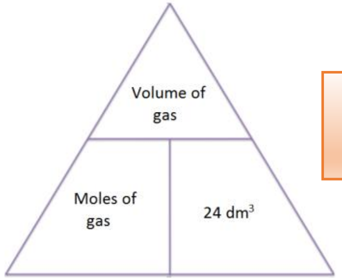
The burette is used to measure the volume of solution added. It is more accurate than a measuring cylinder but less accurate than a pipette.

Steps required to complete an acid alkali titration:

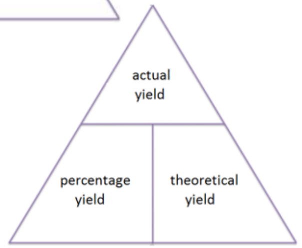
- Measure a known volume of alkali into a conical flask using a pipette.
- add an indicator, phenolphthalein to sodium hydroxide in a conical flask.
- add the acid from the burette and swirl.
- add acid dropwise towards the end point until the indicator just changes colour.
- the indicator changes colour from pink to colourless.
- Repeat the process at least three times until you get two results within 0.1cm^3 of each other.

A certain volume of gas **always** contains the **same number** of gas particles under the same conditions.

The volume of a 1 mole of any gas occupies 24 dm^3 (or 24000 cm^3) at RTP (room temp and pressure.)



To convert **dm^3 to cm^3 we multiply by 1000**.

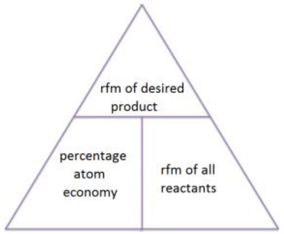


Pipette Burette

Titrations are usually used to measure accurately the exact volume of acid and alkali that will react together .

The **end point** is the point at which the acid and alkali have reacted completely. This is judged by a **change in colour of the indicator**.

Atom economy is a measure of the amount of starting materials that end up as **useful products.**



Maximising atom economy in Industry will conserve the world's resources and reduce pollution.

In reality reactions do not go to completion, this is because:
Not all the reactants reacted.
Some of the product was lost during purification
Some by-products might have formed.

The amount of product that can form in theory is known as the **theoretical yield**.
The amount of product formed is known as the **actual yield**.

The percentage yield of a chemical tells us how much product was made compared with the maximum amount that could have been made.