3 Quantitative

When mass changes (but it doesn't!)

When reactions appear to involve a change in mass it's because a reactant or product is a gas and its mass has not been taken into account.

e.g. A metal reacts with oxygen the mass of the oxide produced is **greater** than the mass of the metal.

In thermal decompositions of metal carbonates **carbon dioxide** is produced and escapes into the atmosphere leaving the metal oxide as the only solid product.

Moles (mol)(HT)

- The mass of one mole of a substance in grams is the same (in numbers) as its relative formula mass.
- One mole of a substance contains the same number of atoms, molecules or ions as one mole of any other substance.
- The number of atoms, molecules or ions in a mole of a given substance is the Avogadro constant. The value of the Avogadro constant is $\mathbf{6.02 \times 10^{23}}$ per mole.
- The big numbers in balanced equations show the number of moles.

Formula mass

To calculate formula mass look at the MASS number on the periodic table for the atom. Then multiply this by the number of that type of atom. Do this for each type of atom and add them together.

Definitions

The law of conservation of mass - no atoms are lost or made during a chemical reaction so the mass of the products equals the mass of the reactants.

The relative formula mass (M_r) of a compound is the sum of the relative atomic masses of the atoms in the numbers shown in the formula.

Limiting reactant (HT)

- In a chemical reaction involving two reactants, it is common to use an excess of one of the reactants to ensure that all of the other reactant is used.
- The reactant that is completely used up is called the **limiting reactant** because it limits the amount of products.

Solid

Number of moles = mass/molecular mass

Liquid

Number of moles = volume (dm^3) x concentration (mol/dm^3)

Conctration (g/dm^3) = mass/volume (dm^3)

Gas (triple only)

Number of moles = volume /24 dm^3

To convert cm^3 to dm^3 /by 1000

Yield and atom economy

Even though no atoms are gained or lost in a chemical reaction, it isn't always possible to obtain the calculated amount of a product because:

- the reaction may not go to completion because it is **reversible**
- some of the product may be **lost** when it is separated from the reaction mixture
- some of the reactants may **react** in ways different to the expected reaction.

The amount of a product obtained is known as the **yield**. When compared with the maximum theoretical amount as a percentage, it is called the percentage yield.

Percentage yield = (actual yield / theoretical yield) x 100

The **atom economy** is a measure of the amount of starting materials that end up as useful products. It is important for sustainable development and for economic reasons to use reactions with high atom economy.

The percentage atom economy of a reaction is calculated using the balanced equation for the reaction as follows:

% atom economy = molecular mass of desired product /sum of molecular masses of all reactants x100

Reacting mass calculations

1) Calculate the number of moles by dividing the mass by the Mr.
2) Using the balancing numbers in the equation, calculate the number of moles of the substance asked for in the question.
3) Calculate the mass by x by Mr

Titrations

- Rinse equipment with deionised water then the solution you will be filling it with.
- Use a **pipette** to measure 25cm^3 of your solution of known concentration.
- Place the solution into a **conical flask**.
- Place a **white tile** underneath.
- Add 2-3 drops of **indicator**.
- Add your other solution of unknown concentration to the **burette**.
- Add the solution to the conical flask 1 cm^3 at a time with swirling.
- Record volume at which the colour changed. This is your rough results.
- Repeat but add drop wise towards the end point until you have 3 readings within **0.10**cm^3 of each other. These are called **concordant results**.
- Use your concordant results to calculate an average.