

Box 1: Keywords

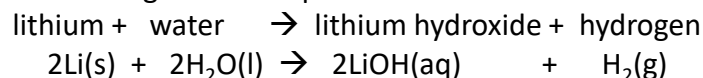
Relative atomic mass (A_r)	The average mass of the atoms of an element compared to carbon-12. (The average mass takes into account the abundance of the naturally occurring isotopes.)
Relative formula mass (M_r)	The relative formula mass (M_r) of a compound is the sum of the relative atomic masses of the atoms in the numbers shown in the formula.
Concentration	The concentration of a solution can be measured in mass per given volume of solution, e.g. grams per dm^3 (g/dm^3).
Mole	One mole of a substance contains the same number of the stated particles, atoms, molecules or ions as one mole of any other substance. This number is 6.023×10^{23} and is known as the Avogadro's constant.
Excess	a substance is in excess if there is more than enough of it to react with another reactant.
Limiting reactant	A limiting reagent is the reagent that got completely used up.

Box 2: Conservation of mass

The **law of conservation of mass** states that atoms cannot be created or destroyed in a chemical reaction. The atoms are just rearranged into new substances.

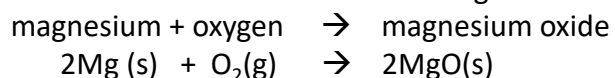
Decrease in mass

Sometimes, it may seem that the mass at the end of a reaction has decreased, this is just because a gas has been formed and those atoms are not measured in the mass at the end of the reaction. The gas has escaped to the room.



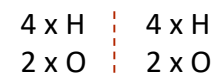
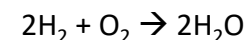
Increase in mass

In other reactions, it may seem that the mass has increased, this is because a reactant was a gas and was not measured in the starting mass



Box 3: Balancing equations

Symbol equations must be balanced because of the law of conservation of mass. This means that the number of each type of atom has to be the same on both sides of the equation.



When balancing equations, you must not change the small numbers in the chemical formulae. Changing the small number changes the chemical that is reacting. You are only allowed to change the big numbers in front of the chemical formulae.

Box 4: Relative formula mass (M_r)

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.

Example: Calculate the M_r of CaCO_3 . The relative atomic masses (A_r) are:

Ca = 40, C = 12, O = 16

$$\begin{aligned} M_r \text{ CaCO}_3 &= 1 \times \text{Ca} + 1 \times \text{C} + 3 \times \text{O} \\ &= 1 \times 40 + 1 \times 12 + 3 \times 16 \\ &= 100 \end{aligned}$$

Example: Calculate the M_r of CuSO_4 . The relative atomic masses (A_r) are:

Cu = 63.5, S = 32, O = 16

$$\begin{aligned} M_r \text{ CuSO}_4 &= 1 \times \text{Cu} + 1 \times \text{S} + 4 \times \text{O} \\ &= 1 \times 63.5 + 1 \times 32 + 4 \times 16 \\ &= 159.5 \end{aligned}$$



Box 5: Avogadro's constant (higher)

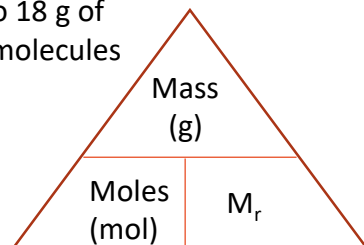
One mole of a substance contains 6.02×10^{23} atoms, ions or molecules. This is Avogadro's constant.

One mole of a substance has the same mass as the M_r of the substance.

For example, the M_r (H_2O) = 18, so 18 g of water contains 6.02×10^{23} water molecules and is called one mole of water.

This can be written as:

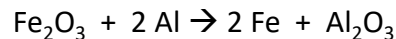
$$\text{moles} = \frac{\text{mass}}{M_r}$$



Box 6: Moles and reacting masses (higher)

A balanced symbol equation can be used to find the mass of another substance in the equation.

Example: What mass of aluminium is needed to react with 640 g of iron oxide?



1. Write ✓ ? on balanced equation: $Fe_2O_3 + 2 Al \rightarrow 2 Fe + Al_2O_3$

2. Find moles of ✓ moles $Fe_2O_3 = \frac{\text{mass}}{M_r} = \frac{640}{160} = 4 \text{ mol}$

3. Use ratio from balanced equation to find moles of ? Moles Al = 8 mol

4. Find mass ? mass = moles $\times M_r = 8 \times 27 = \underline{216 \text{ g}}$

Box 7: Moles to balance equations (higher)

If you are asked to balance an equation using the masses of all of the substances in an equation then:

1. Work out the M_r of all substances
2. Calculate the number of moles of each substance
3. Divide the number of moles by the smallest number of moles to give a whole number ratio
4. Use the ratio to balance the equation

Box 10: Pathway

Previous knowledge: KS3 chemical reactions, KS4 atomic structure

Future links: KS4 chemical changes, energy changes, rates

Careers: pollutant controllers, forensic scientists, environmental health officers, art restorers, pharmacists

Box 11: Cross curricular links

Maths – calculating percentages

- converting units
- changing the subject of equations

Box 8: Excess and limiting (higher)

The limiting reactant is the reactant that gets used up first in a reaction. This is the reactant that is **NOT** in excess. Therefore, the quantities of products formed in a chemical reaction are determined by the limiting reactant.

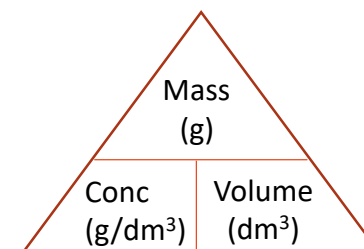
Box 9: Concentration

The concentration of a solution is the mass of a solute dissolved in a given volume. The unit of concentration is g/dm^3 . Concentration can be calculated using:

$$\text{Concentration (g/dm}^3\text{)} = \frac{\text{mass (g)}}{\text{volume (dm}^3\text{)}}$$

Volume measured in cm^3 needs to be converted to dm^3

$$\text{Volume (dm}^3\text{)} = \frac{\text{volume (cm}^3\text{)}}{1000}$$



Box 12: Key skills

- Use the relative formula mass of a substance to calculate the number of moles in a given mass of that substance and vice versa.
- Calculate the masses of reactants and products from the balanced symbol equation and the mass of a given reactant or product.