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Chemistry

For the IB Diploma

> Chapter 4

Counting particles by mass: The mole

> Definitions

Relative atomic mass (A_r): the average mass of the naturally occurring isotopes of an element relative to the mass of $1/12$ of an atom of carbon-12.

Relative molecular mass (M_r): the average mass of a molecule of a compound relative to the mass of $1/12$ of an atom of carbon-12; M_r is the sum of the relative atomic masses for the individual atoms making up a molecule.

Relative formula mass: if a compound contains ions, the relative formula mass is the average mass of the formula unit relative to the mass of $1/12$ of an atom of carbon-12.

The **mole** is the unit of the amount of substance. The amount of substance that contains the Avogadro constant (6.02×10^{23}) of particles (atoms, ions, molecules, etc.).

How many C atoms are there in 12 g of ^{12}C , if the mass of each C atom is 1.992×10^{-23} g

$$6.02 \times 10^{23}$$



Avogadro constant

> The relationship between the number of moles and the number of particles

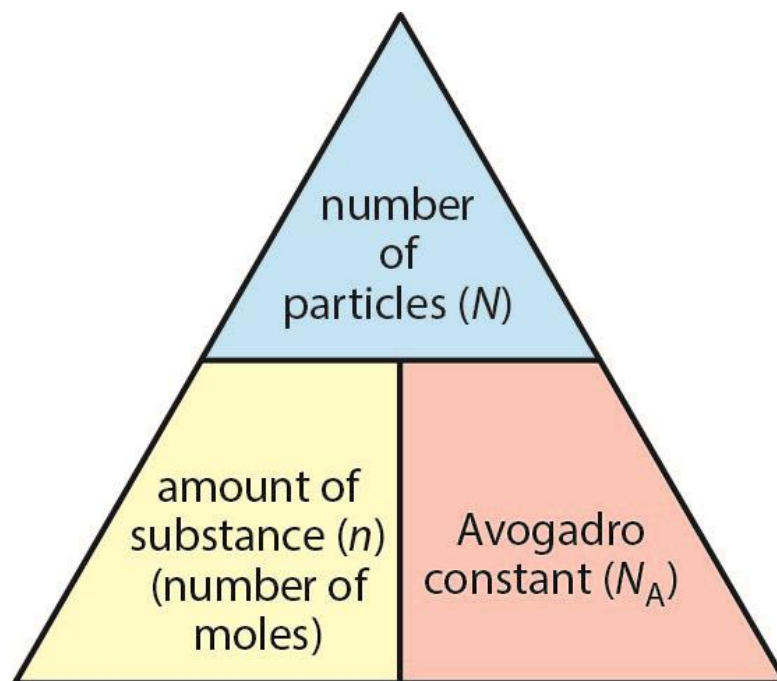


Figure 4.1: The relationship between the number of moles and the number of particles.

➤ The relationship between the mass of a substance, the amount in mol and molar mass

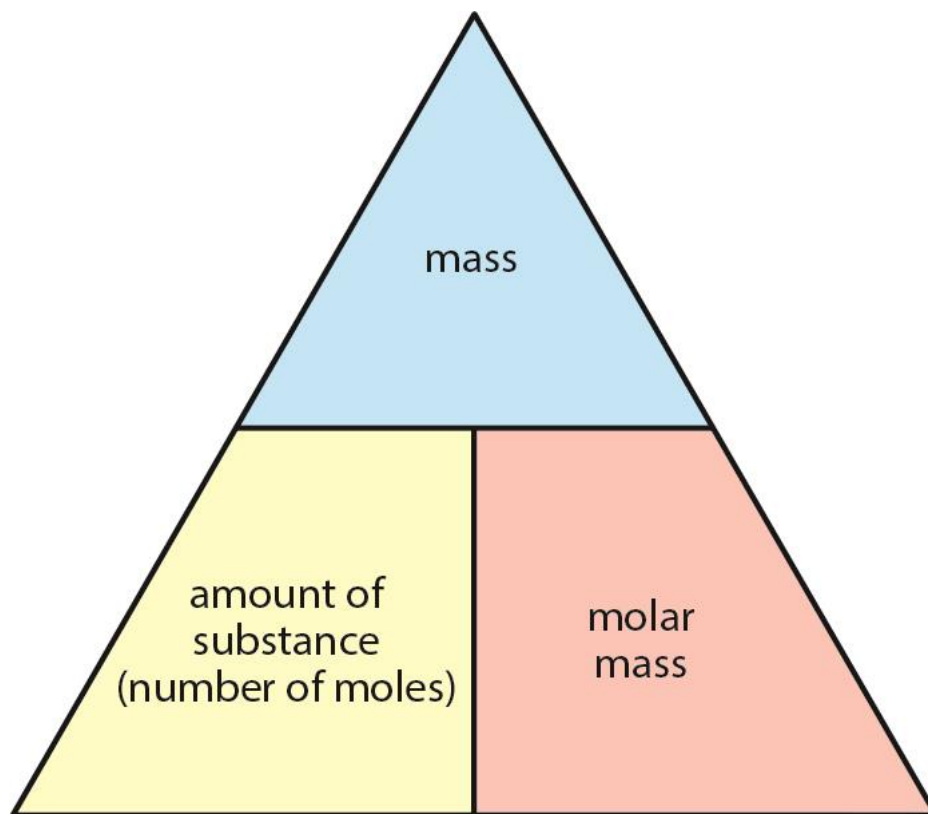


Figure 4.2: The relationship between the mass of a substance, the amount in mol and the molar mass.

> Percentage composition of a compound

$$\% \text{ by mass of an element} = \frac{\text{number of atoms of the element} \times \text{relative atomic mass}}{\text{relative molecular mass}} \times 100$$

> Definitions

Empirical formula: the simplest whole number ratio of the elements present in a compound.

Molecular formula: the total number of atoms of each element present in a molecule of the compound; the molecular formula is a multiple of the empirical formula.

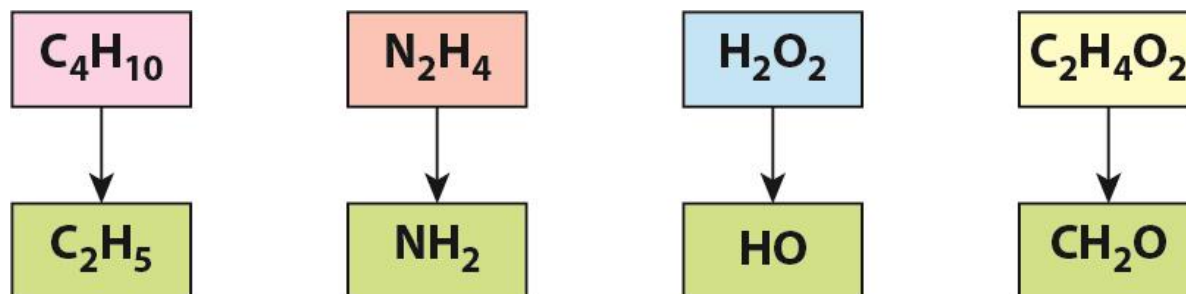


Figure 4.3: Examples of empirical and molecular formulas.

> Calculating the empirical formula from the mass of the elements present in a compound

Element			
Mass / g			
$\div A_r$			
Number of moles			
\div smallest number of moles			
Ratio			

➤ The relationship between the concentration of the solute, the number of moles of the solute and the volume of the solution

Solute: a substance that is dissolved in another (the solvent) to form a solution.

Solvent: a substance that dissolves another substance (the solute); the solvent should be present in excess of the solute.

Solution: a mixture that is formed when a solute dissolves in a solvent.

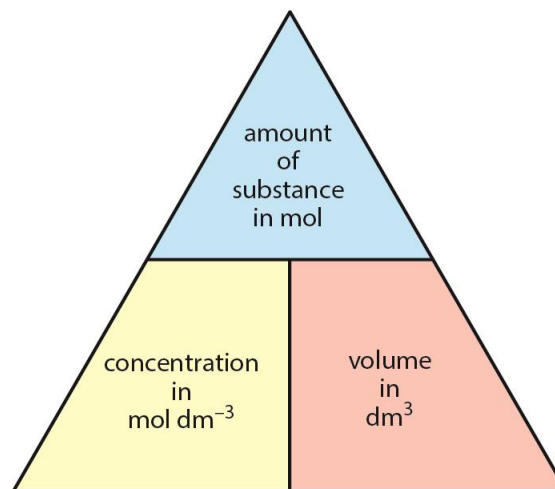


Figure 4.4: The relationship between concentration, number of moles and volume of solution.

> Make a serial dilution

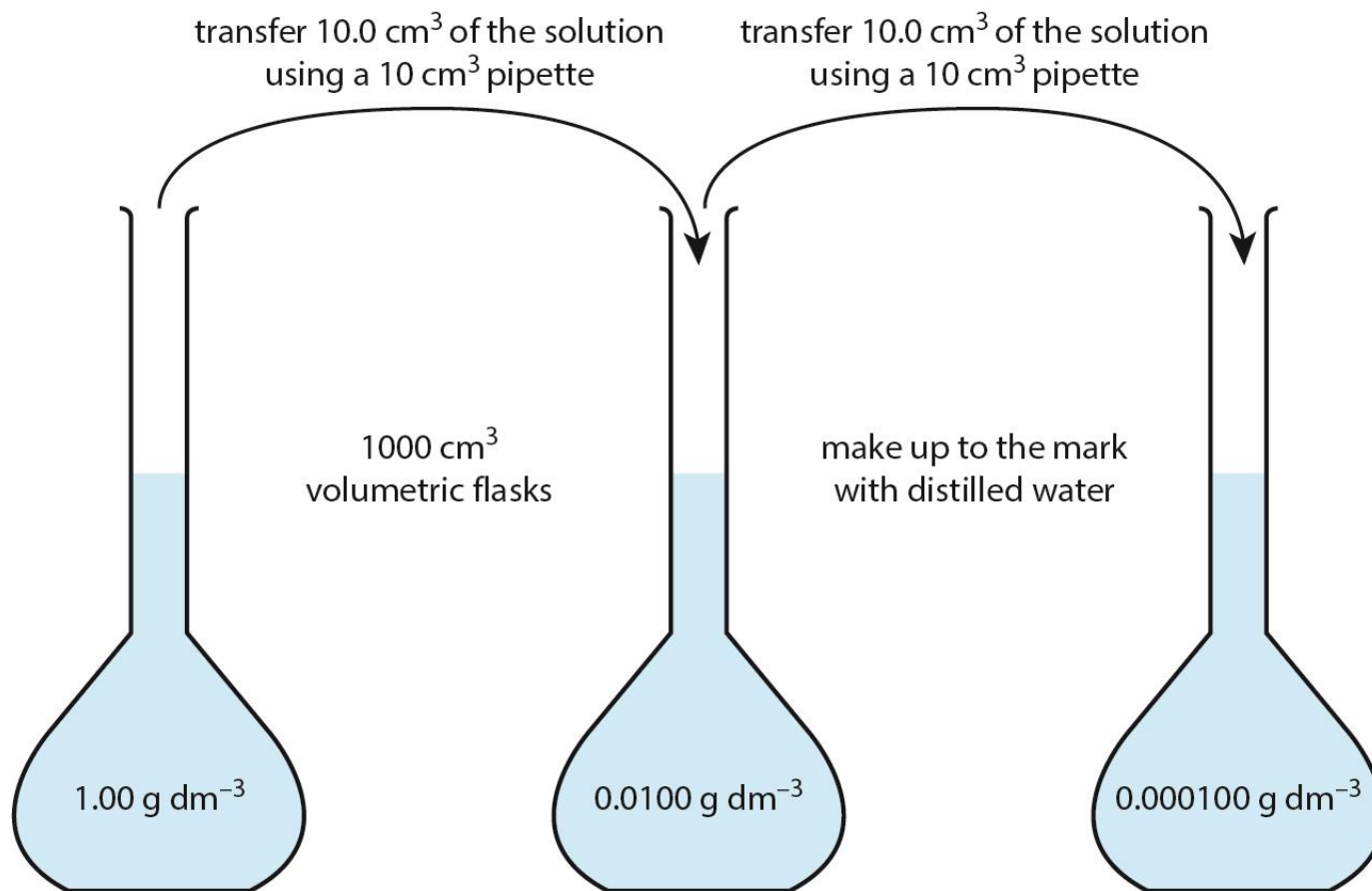


Figure 4.5: Serial dilutions.

> Room temperature and pressure

Avogadro's law: equal volumes of gases measured at the same temperature and pressure contain the same number of molecules.



Figure 4.6: Portrait of Amedeo Carlo Avogadro.

N_2 1 mole 24 dm³	H_2 1 mole 24 dm³	Ne 1 mole 24 dm³
CO_2 1 mole 24 dm³	O_2 1 mole 24 dm³	Ar 1 mole 24 dm³