EMPIRICAL FORMULAE & MOLAR MASS CALCULATIONS

Empirical Formula

- expresses the elements in their simplest ratio - CH_2 or CHO
- can sometimes be the same as the molecular formula - H_2O and CH_4

	Molecular Formula	*Empirical Formula*
Sulphur dioxide	SO_2	SO_2
Hydrogen peroxide	H_2O_2	HO
Ethanoic acid	$C_2H_4O_2$	CH_2O
Glucose	$C_6H_{12}O_6$	CH_2O

Calculations You need • **percentage mass** and • **relative atomic mass**

Example *Calculate the empirical formula of a compound having C (69.8%), O (18.6%), H (11.6%)*

	C	**H**	**O**
1. Write out percentage by mass	*69.8*	*11.6*	*18.6*
2. Divide by relative atomic mass	*69.8 / 12*	*11.6 / 1*	*18.6 / 16*
- this gives the mole ratio	*5.81*	*11.6*	*1.16*
3. If not whole numbers then scale up - try dividing by smallest value (1.16)	*5*	*10*	*1*
4. Express as a formula	**$C_5H_{10}O$**		

Molecular Formula The exact number of atoms of each element in the formula - e.g. C_4H_8

Calculations

- Compare the empirical formula with the relative molecular mass.
- Relative molecular mass will be an exact multiple (x1, x2 etc.) of its relative empirical mass.

Ideal Gas Equation

$$\boxed{PV = nRT}$$

$$\boxed{PV = \frac{mRT}{M}}$$

where

P	pressure	Pa
V	volume	m^3
T	temperature	K
M	molar mass	$g\ mol^{-1}$
m	mass	g
n	moles of gas	
R	gas constant	$8.31\ J\ mol^{-1}\ K^{-1}$

EXAMPLE CALCULATION

A chemist collected 3.00g of a gas in a 400cm^3 flask. The temperature was 25°C and the pressure was 4.2 x 10^5 Pa. Calculate the molar mass of the gas.

- **Rearrange** the equation $M = \frac{mRT}{PV}$
- Convert values to **correct units** $400\ cm^3 = 0.0004\ m^3$ (there are 10^6 cm^3 in a m^3)

  25°C = 25 + 273 = 298K
- **Substitute** in the equation $M = \frac{3.00 \times 8.31 \times 298}{4.2 \times 10^5 \times 0.0004}$

ANSWER **$M = 44.22\ g\ mol^{-1}$**