Formula

n = m/M

n is the amount of substance, in moles, mol.

m is the mass of the substance, in grams, g.

M is the molar mass of the substance (the mass of one mole of the substance) in g mol^{-1}.

Molar masses: *These will be given in questions*

M(C) = 12.0 g mol^{-1}

M(H) = 1.00 g mol^{-1}

M(O) = 16.0 g mol^{-1}

M(Na) = 23.0 g mol^{-1}

M(Mg) = 24.3 g mol^{-1}

M(S) = 32.1 g mol^{-1}

% composition

What is the % composition of magnesium carbonate, $MgCO_3$?

- Calculate the molar mass of the compound
- Calculate the mass of each in one mole of the compound
- Divide this mass by the molar mass and x 100

$M(MgCO_3)$ = 24.3 + 12.0 + (16.0 x 3) = 84.3 g mol^{-1}
%Mg = 24.3/84.3 x 100 = 28.8%
%C = 12.0/84.3 x 100 = 14.2%
%O = 48.0/84.3 x 100 = 56.9%
(Answers to 3 s.f.)

Empirical and molecular formulae

What is the empirical formula of a molecule containing 65.5% carbon, 5.50% hydrogen, and 29.0% oxygen?

- Assume 100 g of the compound, so 65.5 g C, 5.50 g of H, 29.0 g of O
- Calculate the mol of each (m/M)
- Divide through by smallest mol to get simplest whole number ratio *(Answers to 3 s.f.)*

C: 65.5 g 65.5/12.0 = 5.46 mol
H: 5.50 g 5.50/1.00 = 5.50 mol
O: 29.0 g 29.0 / 16.0 = 1.81 mol
Divide all 3 by 1.81 to get a ratio of C:H:O is 3:3:1 so empirical formula is C_3H_3O

If the molar mass of the compound is 110 g mol^{-1} what is the molecular formula?

- Divide molar mass of compound by molar mass of empirical formula to find "how many" of the empirical formula are in the molecular formula.

Molar mass of "C_3H_3O" is (12.0 x 3) + (1.00 x 3) + 16.0 = 55.0 g mol^{-1}. 110 / 55 = 2, so 2 x C_3H_3O gives a molecular formula of $C_6H_6O_2$

Achievement Standard Chemistry 91161

Carry out quantitative analysis

SURVIVAL SHEET

Calculations from equations

What mass of sodium hydroxide reacts with sulfuric acid to produce 10.0 g of sodium sulfate?

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

- *Identify the chemicals of interest in the equation – sodium hydroxide & sodium sulfate*
- *Write the amount (mol) below these*
- *Calculate the mass, in g*

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$
$$2\ mol \quad 1\ mol$$
$$2 \times 40.0\ g \quad 142.1\ g$$

- *Use proportion to calculate the mass of sodium hydroxide*

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$
$$2\ mol \quad 1\ mol$$
$$80.0\ g \quad 142.1\ g$$
$$10.0 / 142.1 \times 80.0\ g \quad 10.0\ g$$
$$= 5.63\ g$$

Or…….using n=m/M and m=nM

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$
$$2\ mol \quad 1\ mol$$

- *$M(Na_2SO_4)$ = 142.1 g mol^{-1}*
- *M(NaOH) = 40.0 g mol^{-1}*

- *$n(Na_2SO_4)$ = m/M = 10.0/142.1 = 0.0704 mol*
- *$n(NaOH) : n(Na_2SO_4)$ is 2 : 1*
- *n(NaOH) = 2 x 0.0704 = 0.141 mol*
- *m(NaOH) = n x M = 0.141 x 40.0 = 5.63 g*