

Exercise walk-through

1.1.1

Concentrations, gas equations and limiting amounts

Pearson Edexcel · International A-Level · Chemistry

Compare fuels using their whole pathway

- 1** Cracking makes smaller hydrocarbons including alkenes; balance atoms in proposed products.
- 2** CO reduces oxygen transport; nitrogen/sulfur oxides can contribute to acid pollution.
- 3** Bioethanol growth can absorb CO₂, but processing and transport still emit. Hydrogen production also matters.

Choose reagents and conditions

- 1 **1** H_2/Ni adds hydrogen; steam/acid catalyst adds water; Br_2 adds bromine across $\text{C}=\text{C}$.
- 2 **2** Cold dilute acidified manganate(VII) gives a diol. Bromine decolourisation supports unsaturation, not a unique identity.
- 3 **3** Addition polymerisation opens $\text{C}=\text{C}$, retains side groups and loses no small molecule.

Final transfer: a biased measurement

Your turn

A 0.480 g sample produces 0.240 dm³ of gas in a 1:1 reaction. Use $V_m = 24.0 \text{ dm}^3 \text{ mol}^{-1}$. A leak makes gas volume too low. What happens to inferred sample molar mass?

- ☐ A. It is too high
- ☐ B. It is too low
- ☐ C. It stays correct
- ☐ D. It becomes negative

Exercises 2.1·2.3

2.1 Define relative formula mass and molar mass. Explain why sodium chloride has a formula mass rather than a molecular mass. [3]

2.2 Dissolve 4.00 g NaOH and make the solution up to 250 cm³. Use $M = 40.0 \text{ g mol}^{-1}$. Calculate both amount concentration and mass concentration. [4]

2.3 Air contains 0.0420% carbon dioxide by volume. Calculate its concentration in ppm by volume. [2]

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2.1 Relative formula mass is the sum of relative atomic masses in the formula, a dimensionless ratio. Molar mass is mass per mole, with units such as g mol^{-1} . Sodium chloride has a giant ionic lattice rather than discrete NaCl molecules.

2.2 Dissolve 4.00 g NaOH and make the solution up to 250 cm^3 . Use $M = 40.0 \text{ g mol}^{-1}$. Calculate both amount concentration and mass concentration. [4]

2.2 $V = 250/1000 = 0.250 \text{ dm}^3$; $n = m/M = 4.00/40.0 = 0.100 \text{ mol}$.

$$c = n/V = 0.100/0.250 = 0.400 \text{ mol dm}^{-3}$$

Mass concentration = $m/V = 4.00/0.250 = 16.0 \text{ g dm}^{-3}$.

2.3 Air contains 0.0420% carbon dioxide by volume. Calculate its concentration in ppm by volume. [2]

2.3 Fraction = $0.0420/100 = 0.000420$. ppm = $0.000420 \times 10^6 = 420$. Do not multiply

Exercises 3.1·3.2

3.1 A volatile liquid of mass 0.230 g becomes 100 cm³ of vapour at 373 K and 1.00×10^5 Pa. Use $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$. Calculate its molar mass, assuming ideal behaviour. [4]

3.2 A mixture contains 0.0600 mol aluminium and 0.0600 mol chlorine. Use $2\text{Al} + 3\text{Cl}_2 \rightarrow 2\text{AlCl}_3$. Identify the limiting reactant, calculate the amount of product, and calculate the amount of aluminium left. [4]

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3.1 $V = 100 \times 10^{-6} = 1.00 \times 10^{-4} \text{ m}^3$.

$$n = \frac{pV}{RT} = \frac{1.00 \times 10^5 \times 1.00 \times 10^{-4}}{8.31 \times 373} = 0.00323 \text{ mol}$$

$M = m/n = 0.230/0.00323 = 71.3 \text{ g mol}^{-1}$. The gas equation requires the absolute temperature already supplied in K.

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3.2 Available amount/coefficient is $0.0600/2 = 0.0300$ for aluminium and $0.0600/3 = 0.0200$ for chlorine. Chlorine limits. Product amount = $0.0600 \times 2/3 = 0.0400 \text{ mol}$; aluminium left = $0.0600 - 0.0400 = 0.0200 \text{ mol}$.

Exercises 3.3-3.4

3.3 A student adds aqueous sodium carbonate to aqueous calcium chloride. A white solid forms. Write a balanced full equation and the net ionic equation with state symbols, and identify the spectator ions. [4]

3.4 A process has theoretical product mass 4.00 g but gives 3.20 g isolated dry product. Calculate percentage yield. Explain why a 100% atom-economy reaction can still give this yield. [3]

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3.3 $\text{Na}_2\text{CO}_3(\text{aq}) + \text{CaCl}_2(\text{aq}) \rightarrow \text{CaCO}_3(\text{s}) + 2\text{NaCl}(\text{aq})$. $\text{Ca}^{2+}(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{CaCO}_3(\text{s})$. Na^+ and Cl^- are spectator ions; the white solid is calcium carbonate.

3.4 A process has theoretical product mass 4.00 g but gives 3.20 g isolated dry product. Calculate percentage yield. Explain why a 100% atom-economy reaction can still give this yield. [3]

3.4 $\text{Yield} = 3.20/4.00 \times 100 = 80.0\%$. Atom economy concerns the balanced reaction products, while incomplete reaction or isolation losses can lower actual yield even if no by-product is formed.