Exercise walk-through

Stoichiometry ▪ 4.5

eXercise

You must be able to

- convert mass to **moles** using molar mass
- use the **mole ratio 摩尔比** from a balanced equation
- find the mass of a product and identify the **limiting reactant 限制反应物**

Method — The mole map

Mass $\rightarrow$ moles ($\div$ molar mass) $\rightarrow$ moles of other species ($\times$ **mole ratio**) $\rightarrow$ mass ($\times$ molar mass). The balanced equation supplies the ratio.

Method — A worked mass-to-mass

For $2H_2 + O_2 \rightarrow 2H_2O$, find the mass of water from 4.0 g H_2:
4.0 g $\div\, 2.0 = 2.0$ mol H_2; ratio $H_2 : H_2O = 2 : 2$, so 2.0 mol H_2O; mass $= 2.0 \times 18 = 36$ g.

Method — Limiting reactant

The **limiting reactant** runs out first and sets the amount of product. Compare the moles of each reactant divided by its coefficient; the **smallest** value limits.

Method — A worked limiting-reactant check

For $N_2 + 3H_2 \rightarrow 2NH_3$ with 1 mol N_2 and 2 mol H_2: H_2 needs 3 mol per N_2 but only 2 are present, so H_2 is limiting.

Practice 2.1 ▪ 2 marks

How many moles are in 8.0 g of CH_4 ($M = 16$ g/mol)?

Solution 2.1

Worked steps

$8.0 \div 16 = 0.50$ mol **M1** **A1**.

Practice 2.2 ▪ 2 marks

For $N_2 + 3H_2 \rightarrow 2NH_3$, how many moles of NH_3 form from 2 mol N_2 (excess H_2)?

Solution 2.2

Worked steps

ratio $N_2 : NH_3 = 1 : 2$, so $2 \times 2 = 4$ mol NH_3 M1 A1.

Practice 2.3 ▪ 1 mark

State what “limiting reactant” means.

Solution 2.3

Worked steps

The reactant that runs out first, limiting how much product forms **B1**.

Exam-style 3.1 ▪ 1 mark

The mole ratio in a reaction comes from

A the molar masses

B the balanced-equation coefficients

C the masses given

D Avogadro's number

Solution 3.1

Method: The mole map

A the molar masses

B the balanced-equation coefficients ✓

C the masses given

D Avogadro's number

Worked steps

B — the balanced-equation coefficients.

Exam-style 3.2 ▪ 2 marks

For $2Al + 3Cl_2 \rightarrow 2AlCl_3$, start with 4.0 mol Al and excess Cl_2.

(a) Find the moles of $AlCl_3$ produced.

(b) Find the moles of Cl_2 consumed.

Solution 3.2

Worked steps

(a) ratio Al : $AlCl_3 = 2 : 2$, so 4.0 mol $AlCl_3$ **M1** **A1**. (b) ratio Al : $Cl_2 = 2 : 3$, so $4.0 \times \frac{3}{2} = 6.0$ mol Cl_2 **M1** **A1**.

Exam-style 3.3 ▪ 2 marks

For $N_2 + 3H_2 \rightarrow 2NH_3$, you have 3.0 mol N_2 and 6.0 mol H_2.
(a) Identify the limiting reactant.
(b) Find the moles of NH_3 produced.

Solution 3.3

Method: A worked limiting-reactant check

Worked steps

(a) H_2 needs $3 \times 3.0 = 9.0$ mol but only 6.0 present, so H_2 is limiting **M1** **A1**. (b) 6.0 mol $H_2 \times \frac{2}{3} = 4.0$ mol NH_3 **M1** **A1**.