AP CHEMISTRY • EXERCISE SHEET

4.5 Stoichiometry

Name: _____ Class: _____ Date: _____ **Total: 14 marks**

KEY WORDS limiting reactant 限制反应物 • mole ratio 摩尔比 • stoichiometry 化学计量

Objective

Build the skills to answer exam questions on **stoichiometry** — mole ratios in a balanced equation.

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

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

The mole map

Mass → moles (÷ molar mass) → moles of other species (× **mole ratio**) → mass (× molar mass). The balanced equation supplies the ratio.

A worked mass-to-mass

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

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.

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.

2 Practice

Now apply the methods above.

2.1 How many moles are in 8.0 g of CH_4 ($M = 16$ g/mol)? [2]

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

2.3 State what "limiting reactant" means. [1]

3 Exam-style questions

3.1 The mole ratio in a reaction comes from [1]

- **A** the molar masses
- **B** the balanced-equation coefficients
- **C** the masses given
- **D** Avogadro's number

3.2 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. [2]

(b) Find the moles of Cl_2 consumed. [2]

3.3 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. [2]

(b) Find the moles of NH_3 produced. [2]

Solutions

2.1 $8.0 \div 16 = 0.50$ mol.

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

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

3.1 B — the balanced-equation coefficients.

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

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