4.5 Stoichiometry

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

KEY WORDS limiting reactant • mole ratio • stoichiometry

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** from a balanced equation
- find the mass of a product and identify the **limiting reactant**

1 Key knowledge and 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

Each answer shows the steps, then the **result**.

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