3.2 Moles and reacting masses

Name: _____ Class: _____ Date: _____ **Total: 31 marks**

KEY WORDS mole • Avogadro constant • limiting reactant

Objective

Convert mass and moles, calculate reacting masses, balance from masses, use the limiting reactant and concentration. HT. Original questions for spec statements 4.3.2.1–4.3.2.5.

1 Key knowledge and worked examples

Moles = mass (g) ÷ Mr. Mass of one mole in grams = Mr. The **Avogadro constant** = 6.02×10^{23} particles per mole.

Equation → ratio → mass chain:

1. write the balanced equation;
2. convert the given mass to moles (÷ Mr);
3. multiply by the equation ratio;
4. convert back to mass (× Mr).

Balance from masses: each mass ÷ Mr → divide all by the smallest → clear fractions.

Limiting reactant: the one fully used up; moles of product are limited by it. The other is in **excess**.

Concentration: g/dm^3 = mass ÷ volume(dm^3); (HT) **mol/dm^3**: moles = C × V(dm^3).

Worked example (4 marks). What mass of magnesium oxide forms when 2.4 g of magnesium burns in excess oxygen? (Mg = 24, O = 16.)

$2\ Mg + O_2 \rightarrow 2\ MgO$; moles Mg = 2.4 ÷ 24 = 0.1; ratio 2:2, so moles MgO = 0.1; mass = 0.1 × 40 = 4.0 g.

2 Practice

2.1 How many moles are in 8.0 g of sodium hydroxide, NaOH (Na = 23, O = 16, H = 1)? [2]

2.2 What mass is 0.25 mol of $CaCO_3$ (Mr = 100)? [1]

2.3 0.2 mol of HCl is mixed with 0.2 mol of NaOH. Why does neither remain in excess? [1]

3 Exam-style questions

3.1 Calculate the mass of carbon dioxide produced when 10.0 g of calcium carbonate decomposes: $CaCO_3 \rightarrow CaO + CO_2$ (Ca = 40, C = 12, O = 16). [4]

3.2 6.0 g of magnesium reacts with 4.0 g of oxygen: $2\ Mg + O_2 \rightarrow 2\ MgO$. Identify the limiting reactant, if any, and calculate the mass of MgO formed (Mg = 24, O = 16). [5]

3.3 *(HT)* 250 cm^3 of sodium chloride solution contains 3.5 g of solute. Calculate the concentration in g/dm^3 and in mol/dm^3 (Na = 23, Cl = 35.5). [4]

3.4 A reaction uses 4.8 g Mg and 6.4 g O_2. Use $2Mg + O_2 \rightarrow 2MgO$, Mg = 24 and O = 16. Identify the limiting reactant, calculate the mass of MgO and the mass of oxygen remaining. [6]

3.5 11.2 g iron reacts with 4.8 g oxygen to make 16.0 g iron(III) oxide. Use Fe = 56 and O = 16; reactant formulae Fe and O_2, product Fe_2O_3. Convert all three masses to moles and deduce the balanced equation. [4]

3.6 A sample contains 0.25 mol O_2 molecules. Use 6.02×10^{23} particles per mole and O = 16. Calculate the number of O_2 molecules, the amount and number of oxygen atoms, and the sample mass. [4]