1.2 Formulae equations and moles

Name: _____ Class: _____ Date: _____ **Total: 30 marks**

Objective

Build the skills to answer exam questions on **chemical formulae, equations and calculations** 、 : balanced equations with state symbols, relative formula mass, moles, reacting masses, percentage yield, empirical formulae and solution concentration.

You must be able to:

- balance equations and add state symbols
- calculate M_r, moles and reacting masses
- calculate empirical formulae and percentage yield
- calculate the concentration of a solution

1 Key knowledge and worked examples

Mole calculations

idea	formula
moles	mass (g) $\div M_r$
mass	moles $\times M_r$
concentration (mol/dm^3)	moles $\div$ volume (dm^3); 1000 cm^3 = 1 dm^3
percentage yield	actual mass $\div$ theoretical mass $\times 100$
empirical formula	moles of each element (mass $\div A_r$), then the simplest whole-number ratio

Worked example 1: moles. Find the moles in 8.0 g of sodium hydroxide, NaOH ($M_r = 40$).

1. Known: 8.0 g; $M_r = 40$.
2. Rule: mass $\div M_r$.
3. Numbers: $8.0 \div 40$.
4. Result: 0.20 **mol**.

Worked example 2: empirical formula. A compound contains 2.4 g of carbon and 0.6 g of hydrogen. Find its empirical formula.

1. Known: C 2.4 g (A_r 12); H 0.6 g (A_r 1).
2. Rule: moles of each, then simplest ratio.
3. Numbers: C 0.2; H 0.6; ratio 1 : 3.
4. Result: $\mathbf{CH_3}$.

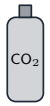
Answer shapes: write the equation first, then use the mole ratio from it.

2 Practice

2.1 Calculate the relative formula mass of calcium carbonate, $CaCO_3$ (A_r: Ca 40, C 12, O 16). [2]



2.2 Calculate the number of moles in 4.4 g of carbon dioxide, CO_2 ($M_r = 44$). [2]



2.3 Balance the equation and add state symbols: $Mg + O_2 \rightarrow MgO$. [2]

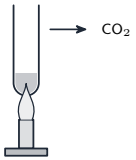


2.4 0.25 mol of a salt is dissolved to make 500 cm^3 of solution. Calculate the concentration in mol/dm^3. [2]



3 Exam-style questions

3.1 Calcium carbonate decomposes: $CaCO_3 \rightarrow CaO + CO_2$. Calculate the mass of calcium oxide ($M_r = 56$) made from 25 g of calcium carbonate ($M_r = 100$). [3]



3.2 A compound contains 1.4 g of nitrogen and 3.2 g of oxygen. Calculate its empirical formula (A_r: N 14, O 16). [3]



3.3 A student heats magnesium ribbon in a crucible to make magnesium oxide. The results are shown in the table. (A_r: Mg 24, O 16)

(a) Calculate the mass of magnesium used and the mass of oxygen that reacted. [3]

	mass / g
empty crucible and lid	20.00
crucible, lid and magnesium	20.48
crucible, lid and product	20.80

(b) Use your answers to show that the empirical formula of magnesium oxide is MgO. [4]

(c) Another student starts with 0.48 g of magnesium but collects only 0.68 g of magnesium oxide ($M_r = 40$). Calculate the percentage yield. [3]

(d) Explain why the second student's yield is less than 100%, and describe how the method could be improved. [6]