

Using equations to find masses and yields

Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Worksheet answers

Each answer shows the formula, the substitution and the result with its unit. Compare your method as well as your final value: a correct method with a slip in arithmetic still earns most of the marks in an exam.

Level: Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** HS-PS1-7, GCSE C3

Problem 1 Reading mole ratios

1. The coefficients give the ratio **1 : 3 : 2**.
2. $n(\text{H}_2) = 4 \times 3 = \mathbf{12 \text{ mol}}$.
3. $n(\text{NH}_3) = 4 \times 2 = \mathbf{8 \text{ mol}}$.

Problem 2 Relative formula masses

1. $40 + 12 + 3 \times 16 = \mathbf{100}$.
2. $2 \times 23 + 32 + 4 \times 16 = 46 + 32 + 64 = \mathbf{142}$.
3. $2 \times 27 + 3 \times 16 = 54 + 48 = \mathbf{102}$.

Problem 3 Units of concentration

1. $250 \div 1000 = \mathbf{0.250 \text{ dm}^3}$.
2. $c = n \div V = 0.50 \div 2.0 = \mathbf{0.25 \text{ mol/dm}^3}$.
3. $n = c \times V = 0.80 \times 0.250 = \mathbf{0.20 \text{ mol}}$.

Problem 4 A simple yield

1. It is the **theoretical yield**.
2. $3.6 \div 4.5 \times 100 = \mathbf{80\%}$.
3. $0.65 \times 8.0 = \mathbf{5.2 \text{ g}}$.

Problem 5 Hydrogen from magnesium

1. $n = 2.4 \div 24 = \mathbf{0.10 \text{ mol}}$.
2. The ratio Mg : H₂ is 1 : 1, so **0.10 mol**.
3. $m = 0.10 \times 2 = \mathbf{0.20 \text{ g}}$.

Problem 6 Mass of iron(III) oxide

1. $2 \times 56 + 3 \times 16 = 112 + 48 = \mathbf{160 \text{ g/mol}}$.

2. $m = 0.25 \times 160 = \mathbf{40\text{ g}}$.
3. $n = 80 \div 160 = \mathbf{0.50\text{ mol}}$.

Problem 7 Oxygen from potassium chlorate

1. $39 + 35.5 + 3 \times 16 = \mathbf{122.5\text{ g/mol}}$.
2. $n = 12.25 \div 122.5 = \mathbf{0.100\text{ mol}}$.
3. $n(\text{O}_2) = 0.100 \times 3/2 = 0.150\text{ mol}$, so $m = 0.150 \times 32 = \mathbf{4.8\text{ g}}$.

Problem 8 Which gas runs out?

1. Hydrogen would need $6 \div 2 = 3\text{ mol}$ of O_2 , and 4 mol is available, so **hydrogen is limiting**.
2. $n(\text{H}_2\text{O}) = n(\text{H}_2) = \mathbf{6\text{ mol}}$.
3. O_2 used = 3 mol , so **1 mol** of oxygen is left.

Problem 9 Burning methane

1. $n = 8.0 \div 16 = \mathbf{0.50\text{ mol}}$.
2. $n(\text{CO}_2) = 0.50\text{ mol}$; $M = 44\text{ g/mol}$; $m = \mathbf{22\text{ g}}$.
3. $n(\text{H}_2\text{O}) = 1.0\text{ mol}$; $M = 18\text{ g/mol}$; $m = \mathbf{18\text{ g}}$.

Problem 10 Salt water for an aquarium

1. $M = 58.5\text{ g/mol}$, so $n = 5.85 \div 58.5 = \mathbf{0.100\text{ mol}}$.
2. $c = 0.100 \div 0.500 = \mathbf{0.200\text{ mol/dm}^3}$.
3. $5.85 \div 0.500 = \mathbf{11.7\text{ g/dm}^3}$ (or 0.200×58.5).

Problem 11 Weighing copper sulfate

1. $n = 0.100 \times 0.250 = \mathbf{0.0250\text{ mol}}$.
2. $63.5 + 32 + 64 = \mathbf{159.5\text{ g/mol}}$.
3. $m = 0.0250 \times 159.5 = \mathbf{3.99\text{ g}}$.

Problem 12 Silver chloride precipitate

1. $M(\text{AgNO}_3) = 108 + 14 + 48 = 170$, so $n = 3.40 \div 170 = \mathbf{0.0200\text{ mol}}$.
2. $n(\text{AgCl}) = 0.0200\text{ mol}$; $M = 143.5$; $m = \mathbf{2.87\text{ g}}$.
3. $2.58 \div 2.87 \times 100 = \mathbf{89.9\%}$.

Problem 13 Why is the yield low?

1. $0.72 \times 15.0 = \mathbf{10.8\text{ g}}$.
2. Product is lost when transferring, filtering or evaporating; some reactant forms side products; the reaction may not go to completion because it is reversible.

3. More product than the equation allows means the solid is probably **wet or impure**, because mass cannot be created.

Problem 14 Which solution is strongest?

1. A: $0.04 \text{ mol} \div 0.100 \text{ dm}^3 = \mathbf{0.40 \text{ mol/dm}^3}$. B: $0.04 \div 0.050 = \mathbf{0.80 \text{ mol/dm}^3}$. C: $0.06 \div 0.200 = \mathbf{0.30 \text{ mol/dm}^3}$.

2. **B > A > C**.

3. B must reach the concentration of A (0.40 mol/dm^3), so its 0.04 mol needs 0.100 dm^3 in total: add **50 cm³** of water.

Problem 15 Three trials, one mean

1. $3.85 \div 5.00 = \mathbf{77.0\%}$; $4.10 \div 5.00 = \mathbf{82.0\%}$; $3.95 \div 5.00 = \mathbf{79.0\%}$.

2. $(77.0 + 82.0 + 79.0) \div 3 = \mathbf{79.3\%}$.

3. Different losses when transferring and drying the solid, and small differences in the amounts weighed.

Problem 16 Precipitating chalk

1. $n(\text{Na}_2\text{CO}_3) = 0.40 \times 0.0250 = \mathbf{0.010 \text{ mol}}$; $n(\text{CaCl}_2) = 0.30 \times 0.0500 = \mathbf{0.015 \text{ mol}}$.

2. The ratio is 1 : 1, so sodium carbonate (0.010 mol) is **limiting**.

3. $n(\text{CaCO}_3) = 0.010 \text{ mol}$; $M = 100$; $m = \mathbf{1.0 \text{ g}}$. $\text{CaCl}_2 \text{ left} = 0.015 - 0.010 = \mathbf{0.005 \text{ mol}}$.

Problem 17 Spot the error

1. He ignored the coefficient 2: each mole of CaCO_3 needs **2 mol of HCl**.

2. $n(\text{HCl}) = 1.0 \times 0.100 = 0.10 \text{ mol}$, which is the limiting amount. $n(\text{CO}_2) = 0.10 \div 2 = \mathbf{0.050 \text{ mol}}$.

3. $m(\text{CO}_2) = 0.050 \times 44 = \mathbf{2.2 \text{ g}}$. Marble used = $0.050 \text{ mol} \times 100 = 5.0 \text{ g}$, so **5.0 g** is left.

Problem 18 Roasting zinc ore

1. $M(\text{ZnS}) = 97$, $n = 4.85 \div 97 = 0.0500 \text{ mol}$; $n(\text{ZnO}) = 0.0500 \text{ mol}$; $M(\text{ZnO}) = 81$; theoretical = **4.05 g**.

2. $3.24 \div 4.05 \times 100 = \mathbf{80.0\%}$.

3. $n(\text{O}_2) = 0.0500 \times 3/2 = 0.0750 \text{ mol}$, $m = \mathbf{2.40 \text{ g}}$. $n(\text{SO}_2) = 0.0500 \text{ mol}$; $M = 64$; $m = \mathbf{3.20 \text{ g}}$. (Check: $4.85 + 2.40 = 7.25 = 4.05 + 3.20$.)

Problem 19 Yield through three steps

1. Multiply the fractions: $0.90 \times 0.80 \times 0.75 = 0.540$, so the overall yield is **54.0%**.

2. $n(\text{D}) = 0.500 \times 0.540 = \mathbf{0.270 \text{ mol}}$.

3. $n(\text{A}) = 0.270 \div 0.540 = \mathbf{0.500 \text{ mol}}$.

Problem 20 Lead iodide precipitate

1. $n(\text{Pb}(\text{NO}_3)_2) = 0.00500 \text{ mol}$; $n(\text{KI}) = 0.00750 \text{ mol}$. KI would need to be $2 \times 0.00500 = 0.0100 \text{ mol}$, so **KI is limiting**.

2. $n(\text{PbI}_2) = 0.00750 \div 2 = 0.00375 \text{ mol}$; $M = 461$; theoretical = $0.00375 \times 461 = \mathbf{1.73 \text{ g}}$.

3. $1.40 \div 1.729 \times 100 = \mathbf{81.0\%}$. Lead nitrate left = $0.00500 - 0.00375 = 0.00125 \text{ mol}$ in 0.100 dm^3 , so **0.0125 mol/dm³**.