Mixed moles and stoichiometry

AQA 7404 and 7405 · AS and A level

Answer on your own paper. Show your working where needed.

1. Mass from a balanced equation

$2Al + 3Cl_2 \rightarrow 2AlCl_3$. A sample of 5.40 g of aluminium reacts with excess chlorine. Calculate the mass of aluminium chloride formed.

A_r: Al = 27.0, Cl = 35.5. Give your answer to three significant figures.

2. Ammonia in a closed vessel

$N_2 + 3H_2 \rightarrow 2NH_3$. A vessel initially contains 0.420 mol of N_2 and 0.900 mol of H_2.

For this calculation assume the reaction goes to completion. Identify the limiting reactant and calculate the amounts of NH_3 and unreacted gas at the end.

3. Empirical and molecular formula

A compound contains 54.5% carbon, 9.1% hydrogen and 36.4% oxygen by mass. Its M_r is 88.0.

Find its empirical and molecular formulae. A_r: C = 12.0, H = 1.00, O = 16.0.

4. Dilution and a measured portion

A student dilutes 15.0 cm^3 of 0.400 mol dm^{-3} KCl solution to 250.0 cm^3. Calculate the new concentration and the amount of KCl in a 25.0 cm^3 portion of the diluted solution.

5. Percentage yield

$CaCO_3 \rightarrow CaO + CO_2$. Heating 12.5 g of pure $CaCO_3$ gives 5.32 g of pure CaO. Calculate the percentage yield.

M_r: $CaCO_3$ = 100.0, CaO = 56.0.

6. Mass from a precipitate

A 0.850 g solid contains Na_2SO_4 and a soluble inert impurity. Its solution gives 1.165 g of dry $BaSO_4$ with excess barium ions.

$Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$. Calculate the mass percentage of Na_2SO_4. M_r: $BaSO_4$ = 233.0, Na_2SO_4 = 142.0.

7. Oxygen from decomposition

$2KClO_3 \rightarrow 2KCl + 3O_2$. A learner collects 1.28 g of oxygen from a 3.00 g sample of pure potassium chlorate.

Could the reaction have produced this much oxygen from that sample? Use a calculation to justify your decision. M_r: $KClO_3$ = 122.6, O_2 = 32.0.

8. Analysis of a powder

A 0.900 g powder contains Na_2CO_3 and a soluble inert impurity. It is dissolved and made up to 250.0 cm^3. A 25.0 cm^3 portion contains 6.40×10^{-4} mol of Na_2CO_3.

Calculate the mass percentage of Na_2CO_3 in the powder. $M_r(Na_2CO_3)$ = 106.0.

9. Extra challenge · Find both components of a powder

A 1.900 g mixture contains only sodium carbonate, Na_2CO_3, and sodium hydrogencarbonate, $NaHCO_3$. It reacts with exactly 0.0300 mol of HCl. Their M_r values are 106.0 and 84.0 respectively. Both give CO_2, water and sodium chloride.

Write the balanced equations and calculate the mass percentage of Na_2CO_3. Calculate the total volume of CO_2 at room conditions, using a molar gas volume of 24.0 dm^3 mol^{-1}.

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