

Solutions

Original authored guidance; these tasks are not official past-paper questions.

2.1 $n(\text{Al}) = 1.08/27.0 = 0.0400 \text{ mol}$ and $n(\text{O}) = 0.960/16.0 = 0.0600 \text{ mol}$. Ratio = 1:1.5 = 2:3, giving Al_2O_3 .

2.2 $n(\text{Mg}) = 0.120/24.0 = 0.00500 \text{ mol}$; the 1:1 ratio gives the same hydrogen amount. $V = 0.118 \text{ dm}^3$.

$$V_m = V/n = 0.118/0.00500 = 23.6 \text{ dm}^3 \text{ mol}^{-1}$$

This value belongs to the actual measurement conditions, not every temperature and pressure.

2.3 A leak lowers recorded gas volume, so V/n and calculated molar volume are too low when n is fixed by the known magnesium amount. If instead gas volume determines n for an unknown substance, inferred n is too low and $M = m/n$ is too high.

3.1 Oxygen removed = 0.160 g. $n(\text{O}) = 0.160/16.0 = 0.0100 \text{ mol}$ and $n(\text{Cu}) = 0.635/63.5 = 0.0100 \text{ mol}$. Ratio 1:1 gives CuO . Incomplete reduction leaves oxygen in the residue, so recorded oxygen loss is too low; treating the heavier residue as all copper also overestimates copper amount, further lowering the inferred O:Cu ratio.

3.2 $n(\text{Ca}) = 0.200/40.0 = 0.00500 \text{ mol}$. The proposed equation predicts $n(\text{H}_2) = 0.00500 \text{ mol}$ and $V = nV_m = 0.00500 \times 24.0 = 0.120 \text{ dm}^3 = 120 \text{ cm}^3$. The measured value agrees, but one volume cannot establish every product identity or exclude compensating measurement errors. Agreement supports the proposed ratio rather than proving the complete equation alone.

3.3 Incomplete oxidation leaves a smaller oxygen mass gain, so oxygen amount is underestimated and Mg:O is too high; repeat heat-cool-weigh until constant mass with oxygen access. Escaping oxide lowers final mass and the inferred oxygen gain while the initial magnesium mass is still used; use a lid slightly open for oxygen and control heating to retain smoke.

3.4 $n(\text{C}) = 3.60/12.0 = 0.300 \text{ mol}$ and $n(\text{H}) = 0.600/1.00 = 0.600 \text{ mol}$. C:H = 1:2 gives CH_2 . Empirical-formula mass = 14.0; factor = $56.0/14.0 = 4$. Multiply every subscript by four to obtain C_4H_8 . This formula does not alone identify connectivity.