

Oxidation numbers and balancing redox equations

Chemistry grades 11-12 (A Level · IB · Class 11-12) · Lab answers

Model answers follow the sample burette readings. Your own titres will differ a little. Judge your lab by the agreement of your concordant results, the correct mole ratio 2 : 5 and a sensible percentage strength.

Level: Chemistry grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** IB R3.2

Question 1 Mean titre

The three results 17.65, 17.70 and 17.60 are within 0.10 cm³ of each other (the rough titre is excluded). Mean = $(17.65 + 17.70 + 17.60) \div 3 = \mathbf{17.65 \text{ cm}^3}$.

Question 2 Why no indicator

Manganate(VII) is intensely purple and its reduced form Mn²⁺ is almost colourless, so it acts as its own indicator. The end point is the **first permanent pale pink** (excess MnO₄⁻ no longer reacts).

Question 3 Choice of acid

Sulfuric acid supplies the H⁺ without adding a reactive anion. **Hydrochloric acid** contains Cl⁻, which MnO₄⁻ oxidises to Cl₂, giving a falsely high titre. **Nitric acid** is itself an oxidising agent and could oxidise the sample.

Question 4 Moles of manganate(VII)

$n(\text{MnO}_4^-) = 0.01765 \text{ dm}^3 \times 0.0200 \text{ mol/dm}^3 = \mathbf{3.53 \times 10^{-4} \text{ mol}}$.

Question 5 Hydrogen peroxide concentration

Ratio MnO₄⁻ : H₂O₂ = 2 : 5, so $n(\text{H}_2\text{O}_2) = 3.53 \times 10^{-4} \times 2.5 = \mathbf{8.83 \times 10^{-4} \text{ mol}}$ in 25.0 cm³.
In 250 cm³: $8.83 \times 10^{-3} \text{ mol}$, all from 5.00 cm³, so $c = 8.83 \times 10^{-3} \div 0.00500 = \mathbf{1.77 \text{ mol/dm}^3}$.
Mass = $1.765 \times 34.0 = 60.0 \text{ g per dm}^3 = \mathbf{6.0 \text{ g per 100 cm}^3 (6.0 \%)}$.

Question 6 Uncertainty

Two readings are subtracted, so the uncertainties add to $\pm 0.10 \text{ cm}^3$. Percentage = $0.10 \div 17.65 \times 100 = \mathbf{0.57 \%}$.

Question 7 Improving the method

Read the burette at eye level to avoid parallax, repeat the titration until three results agree within 0.05 cm^3 , and standardise the manganate(VII) solution against a primary standard before use. The purple fades very slowly for the first drops and then quickly because **Mn²⁺ formed acts as a catalyst**.