



Premium IB tuition — Physics, Chemistry, Maths

IB Chemistry: Uncertainties and Errors

Mark Scheme / Answer Key

Answers to the 30 Practice Questions (Q1–Q30)

Easy Answers (Q1–Q10)

Mark Scheme

- Q1. ± 0.05 cm (half of 0.1 cm)
- Q2. ± 0.01 g (last significant digit)
- Q3. $(0.5/250.0) \times 100\% = 0.20\%$
- Q4. $\Delta T = 65.0 - 21.0 = 44.0^\circ\text{C}$; $\Delta(\Delta T) = 0.5 + 0.5 = 1.0^\circ\text{C} \rightarrow 44.0 \pm 1.0^\circ\text{C}$
- Q5. Mean = $(5.23 + 5.25 + 5.22)/3 = 5.233$ g $\rightarrow 5.23$ g (3 s.f.)
- Q6. $(0.0005/0.0500) \times 100\% = 1.0\%$
- Q7. $0.05 + 0.05 = \pm 0.10$ cm³
- Q8. $(0.3/15.0) \times 100\% = 2.0\%$
- Q9. $4\% = (\Delta x/2.50) \times 100\% \Rightarrow \Delta x = 0.10$ cm
- Q10. Area = $4.0 \times 3.0 = 12.0$ cm²; $\%\Delta L = 2.5\%$, $\%\Delta W = 3.33\%$; $\%\Delta A = 5.83\%$;
 $\Delta A = 0.70$ cm² $\rightarrow 12.0 \pm 0.7$ cm²

Medium Answers (Q11–Q20)

Mark Scheme

- Q11. $C = 0.0250/0.500 = 0.0500$ mol dm³; $\%\Delta n = 2\%$, $\%\Delta V = 1\%$, $\%\Delta C = 3\%$;
 $\Delta C = 0.0015$ mol dm³ $\rightarrow 0.0500 \pm 0.0015$ mol dm³
- Q12. $C_2 = 2.00 \times 25.00/500.0 = 0.100$ mol dm³; $\%\Delta C_1 = 1\%$, $\%\Delta V_1 = 0.2\%$,
 $\%\Delta V_2 = 0.1\%$; $\%\Delta C_2 = 1.3\%$; $\Delta C_2 = 0.0013$ mol dm³ $\rightarrow 0.1000 \pm 0.0013$ mol dm³
- Q13. Mass lost = $3.45 - 2.12 = 1.33$ g; $\Delta = 0.01 + 0.01 = 0.02$ g $\rightarrow 1.33 \pm 0.02$ g

Q14. $M(\text{H}_2\text{O}) = 2(1.01) + 16.00 = 18.02 \text{ g mol}^{-1}$; $\Delta M = 0.01 + 0.01 + 0.01 = 0.03 \text{ g mol}^{-1}$; $\% \Delta = (0.03/18.02) \times 100\% = 0.17\%$

Q15. $\Delta \text{titre} = 0.05 + 0.05 = 0.10 \text{ cm}^3$; $\% \Delta = (0.10/25.00) \times 100\% = 0.40\%$

Q16. Mean = $(24.2 + 24.4 + 24.3 + 24.5)/4 = 24.35^\circ\text{C}$; Range = 0.3°C ; Uncertainty = $\pm 0.15^\circ\text{C} \rightarrow 24.35 \pm 0.15^\circ\text{C}$

Q17. $\Delta m = (0.2/100) \times 0.500 = 0.001 \text{ g}$

Q18. Density = $25.00/10.0 = 2.50 \text{ g cm}^3$; $\% \Delta m = 0.04\%$, $\% \Delta V = 1\%$; $\% \Delta \rho = 1.04\%$; $\Delta \rho = 0.026 \text{ g cm}^3 \rightarrow 2.50 \pm 0.03 \text{ g cm}^3$

Q19. $\% \Delta n = \% \Delta C + \% \Delta V = 1\% + 2\% = 3\%$

Q20. $\% \Delta k = (0.001/0.050) \times 100\% = 2\%$; $\% \Delta [A] = (0.005/0.200) \times 100\% = 2.5\%$; $\% \Delta \text{rate} = 4.5\%$

Hard Answers (Q21–Q30)

Mark Scheme

Q21. $V = \frac{4}{3}\pi(2.00)^3 = 33.51 \text{ cm}^3$; $\% \Delta r = 1\%$; $\% \Delta V = 3 \times 1\% = 3\%$; $\Delta V = 1.01 \text{ cm}^3 \rightarrow 33.5 \pm 1.0 \text{ cm}^3$

Q22. $A = 6(1.50)^2 = 13.5 \text{ cm}^2$; $\% \Delta s = 0.667\%$; $\% \Delta A = 2 \times 0.667\% = 1.33\%$; $\Delta A = 0.18 \text{ cm}^2 \rightarrow 13.50 \pm 0.18 \text{ cm}^2$

Q23. $q = 50.0 \times 4.18 \times 10.0 = 2090 \text{ J}$; $\% \Delta m = 1\%$, $\% \Delta c = 0.239\%$, $\% \Delta T = 5\%$; $\% \Delta q = 6.239\%$; $\Delta q = 130 \text{ J} \rightarrow 2090 \pm 130 \text{ J}$

Q24. $E = 0.5 \times 0.500 \times (2.00)^2 = 1.00 \text{ J}$; $\% \Delta m = 0.2\%$, $\% \Delta v = 2.5\%$; $\% \Delta (v^2) = 5\%$; $\% \Delta E = 5.2\%$; $\Delta E = 0.052 \text{ J} \rightarrow 1.00 \pm 0.05 \text{ J}$

Q25. $n = 0.1240/158.11 = 7.843 \times 10^{-4} \text{ mol}$; $C = n/V = 7.843 \times 10^{-4} \text{ mol dm}^3$; $\% \Delta m = 0.0806\%$, $\% \Delta M_r = 0.0063\%$, $\% \Delta V = 0.04\%$; $\% \Delta C = 0.127\%$

Q26. $\text{HCl reacted} = 0.0200 - 0.0080 = 0.0120 \text{ mol}$; $\Delta = 0.0004 + 0.0002 = 0.0006 \text{ mol}$; $\text{CaCO} = 0.00600 \text{ mol}$; $\% \Delta = (0.0006/0.0120) \times 100\% = 5\%$; $\Delta \text{CaCO} = 0.00030 \text{ mol} \rightarrow 0.00600 \pm 0.00030 \text{ mol}$

Q27. $\text{pH} = -\log(2.5 \times 10^{-5}) = 4.602$; $\Delta[H^+]/[H^+] = 0.1/2.5 = 0.04$; $\Delta \text{pH} = 0.434 \times 0.04 = 0.017 \rightarrow 4.602 \pm 0.017$

Q28. $\text{rate} = 0.025 \times (0.300)^2 = 0.00225 \text{ mol dm}^3 \text{ s}^{-1}$; $\% \Delta k = 4\%$, $\% \Delta [A] = 1.67\%$; $\% \Delta ([A]^2) = 3.33\%$; $\% \Delta \text{rate} = 7.33\%$; $\Delta \text{rate} = 0.000165 \rightarrow (2.25 \pm 0.17) \times 10^{-3} \text{ mol dm}^3 \text{ s}^{-1}$

Q29. $c = 0.750/(1500 \times 1.00) = 5.00 \times 10^{-4} \text{ mol dm}^3$; $\% \Delta A = 0.667\%$, $\% \Delta \varepsilon = 1.33\%$, $\% \Delta l = 1\%$; $\% \Delta c = 3.00\%$; $\Delta c = 1.50 \times 10^{-5} \rightarrow (5.00 \pm 0.15) \times 10^{-4} \text{ mol dm}^3$

Q30. $M = 0.150 / (0.100 \times 0.01850) = 81.08 \text{ g mol}^{-1}$; $\% \Delta m = 0.667\%$, $\% \Delta C = 1\%$,
 $\% \Delta V = 0.270\%$; $\% \Delta M = 1.937\%$; $\Delta M = 1.57 \text{ g mol}^{-1} \rightarrow 81.1 \pm 1.6 \text{ g mol}^{-1}$

This mark scheme is provided free for IB Chemistry students.

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