

APOLLO

Chemistry

HL Answers

First assessment 2025

Whole questions arranged by syllabus topic.

Original question and scheme crops preserve source diagrams.

APOLLO

Measuring enthalpy changes

8 questions

Mark-scheme answers

Chemistry HL | Paper 1A | May 2025 TZ1 | Q22 | 1 marks

22. D

Chemistry HL | Paper 1A | May 2025 TZ1 | Q23 | 1 marks

23. C

Chemistry HL | Paper 1A | May 2025 TZ2 | Q18 | 1 marks

18. A

Chemistry HL | Paper 1A | May 2025 TZ3 | Q20 | 1 marks

20. D

Chemistry HL | Paper 1A | May 2025 TZ3 | Q21 | 1 marks

21. A

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q20 | 1 marks

20. A

2.	(a)		$\llcorner 26.77^{\circ}\text{C} - 25.00^{\circ}\text{C} = \gg 1.77^{\circ}\text{C/K} \gg \checkmark$ $\llcorner 5.65\text{ g} \times 4.18\text{ J g}^{-1}\text{K}^{-1} \times 1.77^{\circ}\text{C} = \gg 41.8 \llcorner \text{J} \gg \checkmark$	Award [2] for correct final answer.	2
2.	(b)		$\llcorner 26.77^{\circ}\text{C} - 100.00^{\circ}\text{C} = \gg -73.23^{\circ}\text{C/K} \gg \checkmark$ $\llcorner -41.8\text{ J}/1.28\text{ g} \times -73.23^{\circ}\text{C} = \gg 0.446 \llcorner \text{J g}^{-1}\text{K}^{-1} \gg \checkmark$	Award [2] for correct final answer. Award [2] if 40.5 J is used and answer is " $0.432^{\circ}\text{C/K}^{-1}$ ". Award [1] max for $-0.446 \llcorner \text{J g}^{-1}\text{K}^{-1} \gg$.	2

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8825 – 6208M

2.	(c)		iron $\checkmark$		1
2.	(d)		Any two of: loss of heat from metal during transfer $\checkmark$ loss of heat from/no insulation for beaker B/second calorimeter $\llcorner$ to surrounding $\gg \checkmark$ water evaporating from beaker B/second calorimeter during metal transfer $\checkmark$ not accounting for the heat absorbed by/heat capacity of beaker B/second calorimeter $\checkmark$	Accept "water mass very small". Accept "distilled/deionized/pure water not used". Do not penalize failing to identify beaker more than once. Do not accept "metal may have oxidized". Do not accept "water transferred with metal" as this would give opposite result. Do not accept "heat loss" alone.	2 max

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8825 – 6208M

2.	(e)		density OR electrical/thermal conductivity OR hardness $\checkmark$	Accept "magnetic" properties. Accept "strength" for hardness. Ignore any other physical property.	1
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Question	Answers	Notes	Total
	saturate chamber/chromatogram with solvent vapor $\checkmark$	Accept "affects/increases distance the solvent travels" for M1. Award [1] for descriptions of	

Mark-scheme answers

Chemistry HL | Paper 1A | Specimen 2025 | Q20 | 1 marks

20. A

APOLLO

Energy cycles in reactions

7 questions

Mark-scheme answers

Chemistry HL | Paper 1A | May 2025 TZ1 | Q24 | 1 marks

24. B

Chemistry HL | Paper 1A | May 2025 TZ3 | Q22 | 1 marks

22. C

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q21 | 1 marks

21. C

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q22 | 1 marks

22. C

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q20 | 1 marks

20. B

Chemistry HL | Paper 1A | Specimen 2025 | Q21 | 1 marks

21. D

Chemistry HL | Paper 1A | Specimen 2025 | Q23 | 1 marks

23. B

APOLLO

Energy from fuels

9 questions

Mark-scheme answers

Chemistry HL | Paper 1A | May 2025 TZ2 | Q19 | 1 marks

19. B

Chemistry HL | Paper 1A | May 2025 TZ2 | Q20 | 1 marks

20. C

9.	(a)		$6\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{l}) \rightarrow \text{C}_6\text{H}_{12}\text{O}_6(\text{aq}) + 6\text{O}_2(\text{g})$ ✓		1
9.	(b)	(i)	Any two: «ethanol is» renewable / sustainable resource ✓ «ethanol has» low/zero carbon footprint / produces less CO_2 ✓ less sulfur dioxide «than fossil fuels» OR less acid rain «than fossil fuels» ✓ less incomplete combustion «than fossil fuels» OR less carbon monoxide/soot «than fossil fuels» ✓	Accept "ethanol is biodegradable /less toxic than gasoline". Do not accept just "less harmful".	2 max
9.	(b)	(ii)	«bond breaking» $1 \text{ C-C} + 5 \text{ C-H} + 1 \text{ C-O} + 1 \text{ O-H} + 3 \text{ O=O}$ OR $346 + 5(414) + 358 + 463 + 3(498)$ OR 4731 «kJ» ✓ «bond forming» $4 \text{ C=O} + 6 \text{ O-H}$ OR $4(804) + 6(463)$ OR 5994 «kJ» ✓ «$\Delta H = 4731 - 5994 =$» $-1263 \text{ «kJ mol}^{-1}\text{»}$ ✓	Award [3] for correct final answer.	3
9.	(c)		«$Q = (4.00 / 46.08) \times 1367 =$» $119 \text{ kJ} / 119000 \text{ J}$ ✓ «$\Delta T = Q / mc = 119000 / (500.0 \times 4.18) =$» 56.9 «K» ✓	Accept 56.8 «K». Allow use of ΔH_c calculated in (b)(ii) without penalty. Answer is $\Delta T = 52.5 / 52.6 \text{ «K»}$.	2

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2225 – 6221M

Question	Answers	Notes	Total
9.	(d)	hydrogen has one shell only ✓ O has greater «effective» nuclear charge / more protons than C ✓ O and C have the same shielding effect/occupied energy levels ✓	3

Mark-scheme answers

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q23 | 1 marks

23. D

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q19 | 1 marks

19. C

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q21 | 1 marks

21. A

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q22 | 1 marks

22. D

Chemistry HL | Paper 1A | Specimen 2025 | Q22 | 1 marks

22. D

5.	(a)		$C_{17}H_{36}(l) + 26O_2(g) \rightarrow 17CO_2(g) + 18H_2O(l)$ ✓		1
5.	(b)	(i)	$n_{C_{17}H_{36}} = \frac{2.00 \text{ g}}{[(17 \times 12.01 \text{ g mol}^{-1}) + (36 \times 1.01 \text{ g mol}^{-1})]} = \frac{2.00 \text{ g}}{240.53 \text{ g mol}^{-1}} = \text{«} \text{»}$ $0.008315/0.00831 \text{ «mol»}$ ✓ $\text{« energy = } 11350 \text{ kJ mol}^{-1} \times 0.008315 \text{ mol = » } 94.4 \text{ «kJ»}$ ✓		2
5.	(b)	(ii)	$94\,400 = 500.0 \text{ g} \times 4.18 \text{ J g}^{-1} \text{ K}^{-1} \times \Delta T$ ✓ $\Delta T = 45.2 \text{ «K»}$ ✓		2
5.	(b)	(iii)	Any two: water does not evaporate ✓ heat is not lost to the surroundings OR all heat is transferred to the water ✓ density of water is 1 g cm^{-3} ✓ water is pure ✓ complete combustion ✓		2 max

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Question			Answers	Notes	Total
5.	(c)		CO_2 consumed while plant is growing «and later released when biofuel is combusted» OR photosynthesis uses up CO_2 «later released when biofuel is combusted» ✓		1
5.	(d)	(i)	bonds broken: $4(C-C) / 4 \times 346$ ✓ bonds formed: $2(C=C) / 2 \times 614$ ✓ $\Delta H^\ominus = \text{«} 4 \times 346 \text{ kJ} - 2 \times 614 \text{ kJ} / 1384 \text{ kJ} - 1228 \text{ kJ} = \text{«} \text{»}$ $\Delta H^\ominus = \text{«+»} 156 \text{ «kJ»}$ ✓	Award [3] for correct final answer.	3
5.	(d)	(ii)	$\Delta H = \Sigma \Delta H_f(\text{products}) - \Sigma \Delta H_f(\text{reactants})$ $\Delta H = (-311.5 + 2(52.0)) - (-393.9)$ ✓ $\Delta H = \text{«+»} 186.4 \text{ «kJ mol}^{-1}\text{»}$ ✓		2
5.	(d)	(iii)	(d)(ii) more accurate than (d)(i) as bond energies are average values OR (d)(ii) more accurate than (d)(i) as not specific to bonds in the reaction ✓		1
5.	(d)	(iv)	positive AND increase in number of moles/molecules «of gas» ✓		1
5.	(d)	(v)	$\Delta H > 0$ «and $\Delta S > 0$ » AND reaction spontaneous if $\Delta G = \Delta H - T\Delta S < 0$ ✓ at high«er» T reaction «more» spontaneous/ ΔG «more» negative ✓		2

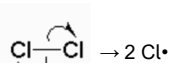
– 11 –

Question			Answers	Notes	Total
5.	(e)		$\text{C}_2\text{H}_4(\text{g}) + \text{H}_2\text{O}(\text{g}) \rightarrow \text{C}_2\text{H}_5\text{OH}(\text{g})$ ✓		1
5.	(f)	(i)	condensation/esterification AND H_2O / water ✓		1
5.	(f)	(ii)	$\frac{20(12.01) + 38(1.01) + 2(16.00)}{100 \times 310.58} =$ $\frac{(310.58 + 18.02)}{310.58} =$ 94.5 % ✓		1
5.	(f)	(iii)	<i>Any two of:</i> sustainable development ✓ more economical/efficient ✓ better use of natural resources ✓ reduces waste ✓		2 max
5.	(f)	(iv)	$K = \frac{[\text{C}_{17}\text{H}_{33}\text{COOCH}_2\text{CH}_3][\text{H}_2\text{O}]}{[\text{C}_{17}\text{H}_{33}\text{COOH}][\text{CH}_3\text{CH}_2\text{OH}]}$	Accept expressions with $[\text{X}(\text{l})]$ instead of $[\text{H}_2\text{O}]$.	1

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Question			Answers	Notes	Total
5.	(g)	(i)	K small AND $[\text{reactants}]_{\text{eqm}} = [\text{reactants}]_0 / 0.10$ ✓ $n_{\text{oleate}} = \ll (0.10 \times 0.10 \times 9.3 \times 10^{-5})^{1/2} = \gg 9.6 \times 10^{-4} \text{ «mol»}$ ✓		2
5.	(g)	(ii)	remove water OR add more oleic acid OR add more ethanol ✓		1

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Question				Answers	Notes	Total
						

APOLLO

Entropy and spontaneity (Additional higher level)

9 questions

Mark-scheme answers

Chemistry HL | Paper 1A | May 2025 TZ1 | Q25 | 1 marks

25. A

Chemistry HL | Paper 1A | May 2025 TZ2 | Q21 | 1 marks

21. D

Chemistry HL | Paper 1A | May 2025 TZ2 | Q22 | 1 marks

22. B

Chemistry HL | Paper 1A | May 2025 TZ3 | Q23 | 1 marks

23. B

Chemistry HL | Paper 1A | May 2025 TZ3 | Q24 | 1 marks

24. C

5.	(a)	(i)	«$\Delta H^\circ_{\text{c}}$ values: $\text{C}_2\text{H}_2 = -1301$, $\text{H}_2 = -286$, $\text{C}_2\text{H}_6 = -1561 \text{ kJ mol}^{-1}$» «$\sum (\Delta H^\circ_{\text{c}} \text{ reactants}) = \text{» } (-1301) + 2(-286) / -1873 \text{ «kJ mol}^{-1}\text{»}$» AND «$\sum (\Delta H^\circ_{\text{c}} \text{ products}) = \text{» } -1561 \text{ «kJ mol}^{-1}\text{»}$» ✓ «$\Delta H^\circ = \sum (\Delta H^\circ_{\text{c}} \text{ reactants}) - \sum (\Delta H^\circ_{\text{c}} \text{ products}) = -1873 - (-1561)$» $\Delta H^\circ = -312 \text{ «kJ mol}^{-1}\text{»}$ ✓	Award [2] for correct final answer.	2
5.	(a)	(ii)	$\Delta S^\circ = -233 \times 10^{-3} \text{ «kJ K}^{-1} \text{ mol}^{-1}\text{»}$ OR $\Delta H^\circ = -312000 \text{ «J mol}^{-1}\text{»}$ ✓ «$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$ » «$0 = (-312) - T(-233 \times 10^{-3})$» OR «$0 = (-312000) - T(-233)$» $T = 1340 \text{ «K or above»}$ ✓	Award [2] for correct final answer. If the alternative data is used the answer is 343 K. Do not award ECF for M2 if the answer is a negative Kelvin temperature.	2
5.	(b)		hydrogen is the limiting reactant OR $2\text{H}_2:1\text{C}_2\text{H}_6$ ✓ 80.0 cm^3 ✓	Award [2] for correct final answer. Accept answers expressed in dm^3.	2
5.	(c)	(i)	$\text{H} - \text{C} \equiv \text{C} - \text{H}$ ✓	Accept any combination of dots or crosses to represent electrons, or lines to represent electron pairs.	1

Mark-scheme answers

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q24 | 1 marks

24. C

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q28 | 1 marks

28. C

Chemistry HL | Paper 1A | Specimen 2025 | Q24 | 1 marks

24. D

APOLLO

How much? The amount of chemical change

11 questions

Mark-scheme answers

Chemistry HL | Paper 1A | May 2025 TZ1 | Q26 | 1 marks

26. C

Chemistry HL | Paper 1A | May 2025 TZ1 | Q27 | 1 marks

27. A

Chemistry HL | Paper 1A | May 2025 TZ2 | Q23 | 1 marks

23. D

Chemistry HL | Paper 1A | May 2025 TZ3 | Q25 | 1 marks

25. A

Chemistry HL | Paper 1A | May 2025 TZ3 | Q30 | 1 marks

30. D

Chemistry HL | Paper 1A | May 2025 TZ3 | Q33 | 1 marks

33. A

3.	(a)	reasonable line of best fit ✓ extrapolated past data given «extended beyond 0.08 AND 0.4 mol dm⁻³» ✓	Line can touch all data points. Accept range of extrapolation through origin to 0.02 mol dm⁻³ AND past data given for M2. Line can extend beyond graph range.	2
3.	(b)	«directly/positively» proportional OR positive linear ✓	Accept answers based on $y=mx+b$. Accept “«directly/positively» proportional OR positive linear” if extrapolation started from 0.02 mol dm⁻³. Do not accept “positive correlation” alone.	1

– 11 –

2225 – 6208M

Question		Answers	Notes	Total
3.	(c)	wavelength with maximum absorbance required OR absorbance varies with wavelength ✓	Accept “different substances absorb at different wavelength to determine concentration” OR “to quantify a substance more accurately” Do not accept “to improve accuracy/precision of the instrument” alone. Do not accept “CuSO₄ can only absorb complimentary color/certain wavelength of light” alone.	1
3.	(d)	gradient = 2.0 ✓ absorbance/A = 2.0 concentration/C OR $y = 2.0 \times$ ✓	Accept gradient/slope range of 1.9-2.3 for M1. Accept “$y=mx+b$” with range of -0.03-0 for b. Do not accept equation with +b values for M2.	2
3.	(e)	1.22 ✓	Accept answer in the range of 1.20-1.30. Do not ECF from calculation as error is contradiction to graph.	1

Question			Answers	Notes	Total
3.	(f)		no «significant» difference/they give the same value ✓		1
3.	(g)		635 «nm» ✓	Accept any value OR range of values from 585-647 «nm».	1

2.	(a)	«fully» dissolve in distilled/deionized/pure water ✓ use volumetric flask ✓ make up to line ✓ mix/invert/shake «the final solution» ✓	<i>Marking points can be in any order.</i>	3 max
2.	(b)	«dilute solution to» make several/multiple concentrations ✓ measure the absorbance/transmittance «of these solutions» ✓ plot graph of absorbance/transmittance vs/against concentration «with a straight line of best fit» ✓	<i>Do not accept "colour" for absorbance/transmittance for M2.</i>	3

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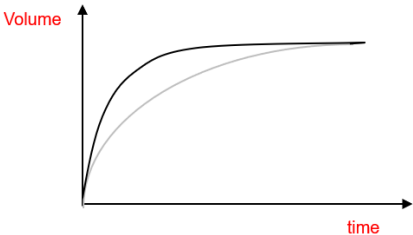
2225–6220M

Question		Answers	Notes	Total
2.	(c)	measure the absorbance/transmittance «of the unknown» AND use graph to determine concentration ✓	<i>Accept "Draw a line across from the absorbance/transmittance «on the y-axis» to the calibration curve and read off «intercept on» the concentration «axis».</i> <i>Accept use of the equation of the line.</i> <i>Do not accept "colour" instead of absorbance, unless applying ECF from 2(b).</i>	1

4.	(a)	(i)	does not contribute to global warming ✓ $\text{CaCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$ correct products AND state symbols ✓ correct balancing ✓	Do not accept $\text{H}_2\text{CO}_3(\text{aq})$ for M1. Accept ionic equation.	2
4.	(a)	(ii)	$n(\text{CaCO}_3) \llcorner \frac{3.162 \text{ g}}{100.09 \text{ g mol}^{-1}} \llcorner = 0.0316 \llcorner \text{mol} \llcorner$ AND $n(\text{HCl}) \llcorner 4.00 \text{ mol dm}^{-3} \times 20.0 \times 10^{-3} \text{ dm}^3 \llcorner = 0.0800 \llcorner \text{mol} \llcorner$ ✓ CaCO_3 is limiting ✓	Do not award M2 without working/answer seen for M1	2
4.	(a)	(iii)	$\llcorner V = 0.0316 \text{ mol} \times 22.7 \text{ dm}^3 \text{mol}^{-1} = \llcorner$ $0.717 \llcorner \text{dm}^3 \llcorner$ ✓		1

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2225 – 6209M

Question	Answers	Notes	Total
4. (b) (i)	Volume  time Greater gradient AND from origin AND same final volume ✓	Lines must not cross.	1
4. (b) (ii)	ethanoic acid weak / HCl strong OR ethanoic acid partially ionizes «in water» / HCl fully ionizes ✓	Accept lower $[\text{H}^+]$.	1

Question			Answers	Notes	Total
4.	(c)	(i)		<i>Do not accept ionization energy for Processes.</i> <i>Accept ionization energies for Processes.</i>	3
4.	(c)	(ii)	Ca²⁺ has larger ionic radius «than Mg²⁺» OR greater distance between ion centres «in CaCl₂» ✓	<i>Must be clear reference to ionic for M1</i>	1

Question	Answers	Notes	Total
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Mark-scheme answers

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q4 | 1 marks

4. A

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q24 | 1 marks

24. C

APOLLO

How fast? The rate of chemical change

24 questions

Mark-scheme answers

Chemistry HL | Paper 1A | May 2025 TZ1 | Q28 | 1 marks

28. A

Chemistry HL | Paper 1A | May 2025 TZ1 | Q30 | 1 marks

30. A

Chemistry HL | Paper 1A | May 2025 TZ1 | Q31 | 1 marks

31. B

Chemistry HL | Paper 1A | May 2025 TZ2 | Q24 | 1 marks

24. C

Chemistry HL | Paper 1A | May 2025 TZ2 | Q25 | 1 marks

25. A

Chemistry HL | Paper 1A | May 2025 TZ2 | Q26 | 1 marks

26. A

Chemistry HL | Paper 1A | May 2025 TZ2 | Q27 | 1 marks

27. D

Chemistry HL | Paper 1A | May 2025 TZ2 | Q28 | 1 marks

28. A

Chemistry HL | Paper 1A | May 2025 TZ3 | Q26 | 1 marks

26. A

Chemistry HL | Paper 1A | May 2025 TZ3 | Q27 | 1 marks

27. A

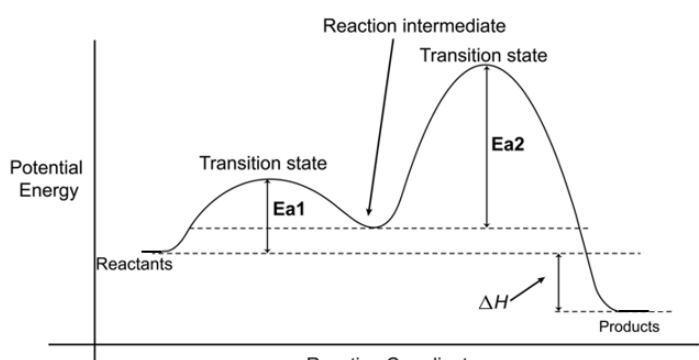
Chemistry HL | Paper 1A | May 2025 TZ3 | Q28 | 1 marks

28. C

8.	(a)	(i)	«since Si has higher melting point» ✓ C AND E ✓	1
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– 13 –

2225 – 6221M

Question	Answers	Notes	Total
8. (a) (ii)	 profile shows two transition states ✓ E_a of second step is larger AND products lower potential energy than reactants ✓ correct labels for reactants, products, both transition states and the intermediate ✓	E_a and ΔH labels are not required. Do not penalize if intermediate is at lower potential energy than the reactant.	3
8. (a) (iii)	A: first order AND B: second order ✓ «rate =» $k[A][B]^2$ ✓	Award [2] for correct rate equation.	2
8. (b)	Any 3 of the following: temperature increases kinetic energy/speed of molecules ✓ more frequent collisions ✓ more molecules have $E \geq E_a$ at higher temperature ✓ larger ratio/percentage of collisions are successful ✓	M2 requires time reference for probability, chance, or number of collisions.	3 max

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2225 – 6221M

Question	Answers	Notes	Total
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Mark-scheme answers

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q27 | 1 marks

27. A

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q28 | 1 marks

28. D

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q29 | 1 marks

29. B

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q25 | 1 marks

25. D

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q26 | 1 marks

26. B

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q27 | 1 marks

27. D

Chemistry HL | Paper 1A | Specimen 2025 | Q26 | 1 marks

26. B

Chemistry HL | Paper 1A | Specimen 2025 | Q27 | 1 marks

27. A

Chemistry HL | Paper 1A | Specimen 2025 | Q29 | 1 marks

29. C

Chemistry HL | Paper 1A | Specimen 2025 | Q31 | 1 marks

31. A

2.	(a)		Any two for [1 max] type of orange juice temperature light intensity «initial» surface area OR «initial» volume AND flask ✓		1 max
2.	(b)	i	Any one of: to perform multiple titrations ✓ too concentrated «so using too much iodine solution» ✓ end-point colour easier to see ✓		1 max
2.	(b)	ii	flask has to be opened to withdraw samples «so not 0 h» OR air was present in the flask at the start «so the ascorbic acid was exposed to air» ✓		1
2.	(b)	iii	titrate only once after two weeks OR fill flask with nitrogen/argon/inert gas OR withdraw samples with syringe «without opening flask» ✓		1
2.	(c)		$\frac{0.1 \text{ cm}^3}{15.0 \text{ cm}^3} \times 100 = 0.7 \text{ \%}$ ✓		1
2.	(d)	i	$\frac{(5.3 \times 10^{-3} \text{ mol dm}^{-3} - 1.1 \times 10^{-3} \text{ mol dm}^{-3})}{14 \text{ d}} = 3.0 \times 10^{-4}$ ✓ $\text{mol dm}^{-3} \text{ d}^{-1}$ ✓	Accept values in the range $2.9 \times 10^{-4} - 3.1 \times 10^{-4}$. Accept values converted to other units, such as $3.4 \times 10^{-9} - 3.6 \times 10^{-9} \text{ mol dm}^{-3} \text{ s}^{-1}$ or $0.29 - 0.31 \text{ mmol dm}^{-3} \text{ d}^{-1}$.	2

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2.	(d)	ii	«support» longer daily exposure leads to lower concentration of ascorbic acid OR 0 h decreases the least ✓ «doesn't support» no direct evidence of oxidation by oxygen ✓		2
2.	(d)	iii	should be stored in sealed container OR should be consumed in a few days after opening ✓		1
2.	(e)		Any one of: effect of temperature/light AND would show the value of refrigeration/darkness ✓ effect of preservative ✓ compare types of orange juice «e.g. fresh, from concentrate, etc.» ✓		1 max

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Question	Answers	Notes	Total
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3.	(a)	tangent drawn at $t = 0$ ✓ « $\frac{40.0 \text{ cm}^3}{35.0 \text{ s}} \Rightarrow 1.14 \text{ «cm}^3 \text{ s}^{-1}\text{»}$ ✓	Accept values in the range $1.04 - 1.24 \text{ cm}^3 \text{ s}^{-1}$.	2
3.	(b)	any value between 35 and 50 s ✓	Only a simple estimation is required.	1
3.	(c)	Any two: drink releases gas more slowly at higher pressure ✓ gas occupies lower volume at higher pressure ✓ gas is more soluble «in carbonated drink» at higher pressure ✓		2 max
3.	(d)	« $\frac{33.0 \text{ cm}^3 - 11.5 \text{ cm}^3}{33.0 \text{ cm}^3} \times \frac{100}{4} = 16.3 \text{ «% per 100 g»}$ ✓	Accept values in the range 15.8 – 16.7 «% per 100 g».	1
3.	(e)	horizontal line ✓ closed system ✓		2

APOLLO

How far? The extent of chemical change

14 questions

Mark-scheme answers

Chemistry HL | Paper 1A | May 2025 TZ1 | Q29 | 1 marks

29. D

Chemistry HL | Paper 1A | May 2025 TZ2 | Q29 | 1 marks

29. C

Chemistry HL | Paper 1A | May 2025 TZ2 | Q30 | 1 marks

30. A

Chemistry HL | Paper 1A | May 2025 TZ3 | Q29 | 1 marks

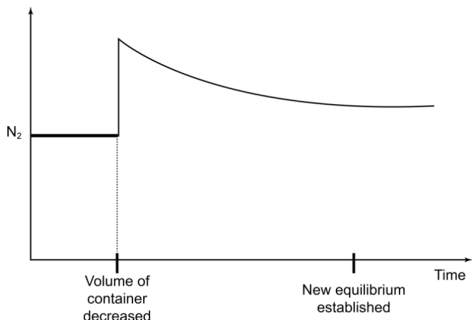
29. C

2.	(a)		$1s^2 2s^2 2p^6 3s^2 3p^6 3d^7$ / [Ar] $3d^7$ ✓		1
2.	(b)	(i)	no effect on K AND mixture has more $[\text{CoCl}_4]^{2-}$ /product OR no effect on K AND equilibrium shifts to the right ✓		1
2.	(b)	(ii)	endothermic AND equilibrium shifts to right OR endothermic AND forward reaction is favoured ✓	Accept endothermic as forward reaction removes heat Accept endothermic and more products formed	1

3.	(a)	(i)	$[N_2] = 0.545$ AND $[H_2] = 0.727$ AND $[NH_3] = 0.112$ «mol dm⁻³» ✓ $K = \frac{[NH_3]^2}{[N_2][H_2]^3}$ ✓. «$K = \frac{0.112^2}{0.545 \times 0.727^3} = 0.0599$» ✓.	Award [3] for correct final answer. Award [3] for $K_p = 1.66 \times 10^{-9}$.	3
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– 6 –

2225 – 6221M

Question	Answers	Notes	Total
3. (a) (ii)	 sharp increase at time volume of container decreased ✓ gradual decrease to second reference point ✓ final constant concentration above initial concentration ✓	Accept straight line or curve for M2.	3
3. (a) (iii)	«$\Delta G^\ominus = -RT \ln K$» «$\Delta G^\ominus = -8.31 \times 723 \times \ln(0.0599) = 16900$» ✓ J mol⁻¹ ✓	Award [2] for correct final answer. Accept J for M2. Accept 16.9 with the corresponding unit, kJ mol⁻¹/kJ. If $K=0.200$ used, answer is 9670 J mol⁻¹.	2
3. (b) (i)	it donates an electron/lone pair «to Cu ²⁺ » ✓	Accept diagram showing coordination bond from lone pair on N to Cu ²⁺ .	1

Question			Answers	Notes	Total
3.	(b)	(ii)	«NH₃ (aq) + H₂O (l) ⇌ NH₄⁺ (aq) + OH⁻ (aq)» ALTERNATIVE 1: $K_b = 10^{-4.75} = 1.8 \times 10^{-5}$ ✓ «$1.8 \times 10^{-5} = [\text{OH}^-]^2 / 0.350$» $[\text{OH}^-] = 0.0025$ «mol dm⁻³» ✓ pH «= $14.00 - (-\log 0.0025)$ »= 11.40 OR pH «= $-\log (1.00 \times 10^{-14} / 0.0025)$ »= 11.40 ✓ ALTERNATIVE 2: «$[\text{OH}^-]^2 = K_b \times [\text{NH}_3]$» pOH = $0.5 \text{ p}K_b - 0.5(\log [\text{NH}_3])$ OR pOH = $(0.5 \times 4.75) - (0.5 \times \log 0.350)$ ✓ pOH = 2.60 ✓ pH = $14.00 - 2.60 = 11.40$ ✓	Award [3] for correct final answer. Do not award ECF for M3 if pH < 7.	3
				Accept 2-bromo-3,3-dimethylbutane or	

Mark-scheme answers

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q30 | 1 marks

30. B

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q31 | 1 marks

31. D

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q23 | 1 marks

23. C

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q29 | 1 marks

29. C

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q30 | 1 marks

30. D

Chemistry HL | Paper 1A | Specimen 2025 | Q28 | 1 marks

28. A

Chemistry HL | Paper 1A | Specimen 2025 | Q30 | 1 marks

30. C

1.	(a)		Reactant: Cl_2 0 Products: HOCl +1 HCl -1 ✓ ✓	Award [2] for three correct. Award [1] for any two correct.	2
1.	(b)		equilibrium shifts to the right/product AND $\text{HCl}/\text{HOCl}/\text{H}^+$ removed/neutralized «by NaOH » ✓	Accept any suitable equation to illustrate the neutralization reaction.	1
1.	(c)	i	Any one of: pressure not given ✓ use of different units OR different ways of measuring ✓ different precisions/significant figures OR uncertainties not given ✓		1 max
1.	(c)	ii	$0.177 \text{ «dm}^3\text{»} \times 2.86 \text{ «g dm}^{-3}\text{»} / 0.506 \text{ «g»}$ OR $\frac{0.506 \text{ «g»}}{70.9 \text{ «g mol}^{-1}\text{»} \times 0.100 \text{ «dm}^3\text{»}}$ ✓ $0.0714 \text{ «mol dm}^{-3}\text{»}$ ✓	Award [2] for correct final answer. Accept use of $PV = nRT$ to calculate the solubility. Using $P = 100 \text{ kPa}$ gives a solubility of $0.0703 \text{ «mol dm}^{-3}\text{»}$.	2
1.	(c)	iii	«as temperature increases solubility decreases» dissolution is exothermic «hence equilibrium shifts to reactants side at higher temperatures» OR thermal energy overcomes intermolecular forces between chlorine and water OR negative entropy change «of dissolution» becomes more dominant at higher temperatures ✓	Accept “kinetic energy increases with temperature «so more gas molecules escape»”.	1

– 4 –

1.	(d)		Any one of: toxic ✓ gas ✓ difficult to handle/store ✓		1 max
1.	(e)	i	$0 - 6$ ✓	Accept any number or range below pH 6.5.	1
1.	(e)	ii	7.5 ✓ $[\text{OCl}^-] = [\text{HOCl}]$ OR $[\text{H}^+] = K_a$ ✓		2
1.	(f)	i	$\text{NH}_3(\text{aq}) + 2\text{HOCl}(\text{aq}) \rightarrow \text{NHCl}_2(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$ ✓		1
1.	(f)	ii	pH > 5/high ✓ low concentration of $\text{Cl}_2/\text{HOCl}/\text{NH}_3$ ✓	Do not accept general statements such as “less urination in the pool”.	2
1.	(g)		Any two of lower water evaporation ✓ reduce energy consumption/less energy needed to heat the water ✓ higher solubility of chlorine «so less chlorine lost» ✓	Accept “less chlorine needed AND fewer bacteria”.	2 max

– 5 –

Question	Answers	Notes	Total
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APOLLO

Proton transfer reactions

20 questions

Mark-scheme answers

Chemistry HL | Paper 1A | May 2025 TZ1 | Q3 | 1 marks

3. C

Chemistry HL | Paper 1A | May 2025 TZ1 | Q32 | 1 marks

32. B

Chemistry HL | Paper 1A | May 2025 TZ1 | Q33 | 1 marks

33. D

Chemistry HL | Paper 1A | May 2025 TZ1 | Q39 | 1 marks

39. D

Chemistry HL | Paper 1A | May 2025 TZ2 | Q31 | 1 marks

31. D

Chemistry HL | Paper 1A | May 2025 TZ2 | Q32 | 1 marks

32. D

Chemistry HL | Paper 1A | May 2025 TZ2 | Q33 | 1 marks

33. B

Chemistry HL | Paper 1A | May 2025 TZ2 | Q34 | 1 marks

34. A

Chemistry HL | Paper 1A | May 2025 TZ2 | Q35 | 1 marks

35. A

Chemistry HL | Paper 1A | May 2025 TZ3 | Q31 | 1 marks

31. C

Chemistry HL | Paper 1A | May 2025 TZ3 | Q32 | 1 marks

32. B

Chemistry HL | Paper 1A | May 2025 TZ3 | Q34 | 1 marks

34. D

Chemistry HL | Paper 1A | May 2025 TZ3 | Q35 | 1 marks

35. B

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q32 | 1 marks

32. B

Mark-scheme answers

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q33 | 1 marks

33. A

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q31 | 1 marks

31. A

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q32 | 1 marks

32. B

Chemistry HL | Paper 1A | Specimen 2025 | Q32 | 1 marks

32. C

Chemistry HL | Paper 1A | Specimen 2025 | Q33 | 1 marks

33. B

Chemistry HL | Paper 1A | Specimen 2025 | Q37 | 1 marks

37. A

APOLLO

Electron transfer reactions

25 questions

Mark-scheme answers

Chemistry HL | Paper 1A | May 2025 TZ1 | Q34 | 1 marks

34. D

Chemistry HL | Paper 1A | May 2025 TZ1 | Q35 | 1 marks

35. D

Chemistry HL | Paper 1A | May 2025 TZ2 | Q14 | 1 marks

14. D

Chemistry HL | Paper 1A | May 2025 TZ2 | Q36 | 1 marks

36. C

Chemistry HL | Paper 1A | May 2025 TZ2 | Q37 | 1 marks

37. D

Chemistry HL | Paper 1A | May 2025 TZ2 | Q38 | 1 marks

38. B

Chemistry HL | Paper 1A | May 2025 TZ2 | Q39 | 1 marks

39. B

Chemistry HL | Paper 1A | May 2025 TZ3 | Q15 | 1 marks

15. D

Chemistry HL | Paper 1A | May 2025 TZ3 | Q36 | 1 marks

36. C

Chemistry HL | Paper 1A | May 2025 TZ3 | Q37 | 1 marks

37. A

Chemistry HL | Paper 1A | May 2025 TZ3 | Q39 | 1 marks

39. A

6.	(a)	(i)	$\text{Li} \rightarrow \text{Li}^+ + \text{e}^-$ OR $\text{LiC}_6 \rightarrow \text{C}_6 + \text{Li}^+ + \text{e}^- \checkmark$	Do not accept 6C. Do not penalize equilibrium arrows.	1
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2225 – 6221M

Question			Answers	Notes	Total
6.	(a)	(ii)	negative sign AND large value $\checkmark$ oxidation/reverse reaction is «highly» spontaneous/favourable $\checkmark$	Accept Li is a good reductant/reducing agent for M2.	2
6.	(b)		arrow from cathode to anode in the external circuit $\checkmark$	Do not award mark if any arrows are in the electrolyte.	1
6.	(c)		«battery» stores «surplus» energy «from solar panel» $\checkmark$	Accept “stores charge/power for night use”. Accept “charges battery”.	1
6.	(d)		$\llbracket 1000.0 \text{ C} / 96500 \text{ C mol}^{-1} \rrbracket = 0.0104 \llbracket \text{mol of electrons/Li} \rrbracket \checkmark$ $\llbracket 1 \text{ mol electrons releases } 1 \text{ mol of Li}^+ \rrbracket$ $\llbracket 0.0104 \times 6.02 \times 10^{23} = 6.24 \times 10^{21} \llbracket \text{Li}^+ \text{ ions} \rrbracket \checkmark$	Award [2] for correct final answer.	2

Mark-scheme answers

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q14 | 1 marks

14. C

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q34 | 1 marks

34. A

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q36 | 1 marks

36. B

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q33 | 1 marks

33. D

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q34 | 1 marks

34. C

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q35 | 1 marks

35. C

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q36 | 1 marks

36. B

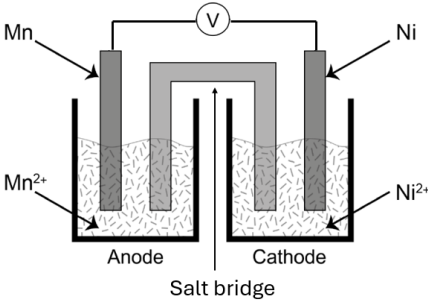
Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q37 | 1 marks

37. A

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q39 | 1 marks

39. D

4.	(a)	salt bridge «immersed in both half cells» ✓ «both electrodes connected to» voltmeter «by wires» ✓	<i>Accept specific examples of salt bridges.</i> <i>Award marks if these components are clearly shown in a diagram.</i>	2
4.	(b)	$E = 0.77 + \frac{8.31 \times 298}{9.65 \times 10^4} \ln \frac{3.25 \times 10^{-4}}{1.37 \times 10^{-2}}$ $E = 0.77 - 0.096 = 0.67 \text{ «V»}$ All values from data booklet correct AND T converted to K ✓ Correct substitution into equation ✓ Correct final answer ✓	<i>Award [3] for correct final answer.</i> <i>Award [2 Max] for 0.762 «V». (T=25)</i>	3

5.	(a)	(i)			1
5.	(a)	(ii)	 salt bridge✓ Voltmeter✓ ions «in solutions» AND electrodes correctly labelled ✓	Ignore any electron flow or standard conditions. Salt bridge must be in contact with the solutions for M1 Wires must be connected for M2	3
5.	(a)	(iii)	0.92 «V» ✓	.	1

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8825 – 6209M

5.	(b)	«$\Delta G^\theta = -nFE^\theta_{cell}$» $-570300 = -1 \times 96500 \times E^\theta_{cell}$ ✓ «$E^\theta_{cell} = 5.91$ «V» ✓ «half cells» $\frac{1}{2}F_2 + e^- \rightleftharpoons F^-$ AND $Li \rightleftharpoons Li^+ + e^-$ ✓	Award [3] if correct half cells identified and evidence of a calculation seen. M1 conversion to J and correct value of n. M2 5.91V. Accept named half cells for M3 Accept cell notation for M3	3																			
5.	(c)	<table border="1"> <thead> <tr> <th rowspan="2">Species</th><th colspan="2">Direction of movement</th><th colspan="2">Place of movement</th></tr> <tr> <th>Towards cathode</th><th>Towards anode</th><th>In the wires</th><th>Through the electrolytes</th></tr> </thead> <tbody> <tr> <td>electrons</td><td>✓</td><td></td><td>✓</td><td></td></tr> <tr> <td>Cr²⁺ ions</td><td>✓</td><td></td><td></td><td>✓</td></tr> </tbody> </table> ✓✓	Species	Direction of movement		Place of movement		Towards cathode	Towards anode	In the wires	Through the electrolytes	electrons	✓		✓		Cr ²⁺ ions	✓			✓	Any two correct ticks for [1].	2
Species	Direction of movement			Place of movement																			
	Towards cathode	Towards anode	In the wires	Through the electrolytes																			
electrons	✓		✓																				
Cr ²⁺ ions	✓			✓																			

Mark-scheme answers

Chemistry HL | Paper 1A | Specimen 2025 | Q34 | 1 marks

34. C

Chemistry HL | Paper 1A | Specimen 2025 | Q35 | 1 marks

35. B

APOLLO

Electron sharing reactions

3 questions

Mark-scheme answers

Chemistry HL | Paper 1A | May 2025 TZ2 | Q40 | 1 marks

40. A

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q37 | 1 marks

37. A

Chemistry HL | Paper 1A | Specimen 2025 | Q36 | 1 marks

36. D

APOLLO

Electron-pair sharing reactions

16 questions

Mark-scheme answers

Chemistry HL | Paper 1A | May 2025 TZ1 | Q36 | 1 marks

36. B

Chemistry HL | Paper 1A | May 2025 TZ1 | Q37 | 1 marks

37. C

Chemistry HL | Paper 1A | May 2025 TZ1 | Q38 | 1 marks

38. D

Chemistry HL | Paper 1A | May 2025 TZ1 | Q40 | 1 marks

40. C

Chemistry HL | Paper 1A | May 2025 TZ2 | Q11 | 1 marks

11. C

Chemistry HL | Paper 1A | May 2025 TZ3 | Q38 | 1 marks

38. A

Chemistry HL | Paper 1A | May 2025 TZ3 | Q40 | 1 marks

40. C

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q35 | 1 marks

35. B

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q38 | 1 marks

38. C

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q40 | 1 marks

40. A

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q38 | 1 marks

38. B

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q40 | 1 marks

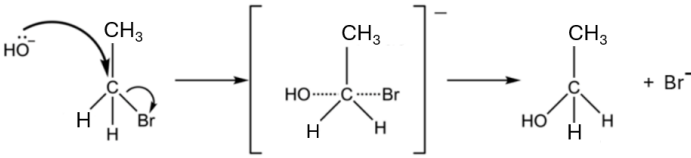
40. A

4.	(a)	(i)	electrophilic addition ✓		1
4.	(a)	(ii)	high electron density of C=C/pi bond ✓	<i>Do not accept only "presence of C=C".</i>	1

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8825 – 6221M

4.	(b)	(i)	ALTERNATIVE 1: «bonds broken» C=C + H–Br / 614 + 366 / 980 «kJ mol⁻¹» AND «bonds formed» C–C + C–H + C–Br / 346 + 414 + 285 / 1045 «kJ mol⁻¹» ✓ «ΔH = 980 – 1045 ⇒» –65 «kJ mol⁻¹» ✓ ALTERNATIVE 2: «bonds broken» 1C=C + 4C–H + 1H–Br / 614 + 4×414 + 366 / 2636 «kJ mol⁻¹» AND «bonds formed» 1C–C + 5C–H + 1C–Br / 346 + 5×414 + 285 / 2701 «kJ mol⁻¹» ✓ «ΔH = 2636 – 2701 ⇒» –65 «kJ mol⁻¹» ✓	<i>Award [2] for correct final answer.</i> <i>Award [1 max] for +65 «kJ mol⁻¹».</i>	2
4.	(b)	(ii)	Any two of: bond enthalpies are average values ✓ enthalpies of formation are specific to the compounds ✓ bond enthalpies apply to gases AND this reaction involves a liquid ✓ bond enthalpies do not account for the change of state ✓		2 max
4.	(b)	(iii)	two moles/molecules of reactants form one mole/molecule of product OR gaseous reactants form liquid product ✓		1

4.	(b)	(iv)	$\Delta S = 199 - 220 - 199 = -220 \text{ J K}^{-1} \text{ mol}^{-1}$ ✓ $\Delta G^\circ = -65\,000 \text{ J mol}^{-1} - (298 \text{ K} \times -220 \text{ J K}^{-1} \text{ mol}^{-1})$ $\Delta G^\circ = +560 \text{ J mol}^{-1} / +0.56 \text{ kJ mol}^{-1}$ AND non-spontaneous ✓	Award [2] for correct final answer (ΔG° value and spontaneity). If $\Delta H = -58 \text{ kJ mol}^{-1}$ used, answer is «+»7600 «J mol ⁻¹ » / «+»7.6 «kJ mol ⁻¹ ».	2
4.	(c)	(i)	nucleophilic substitution ✓	Accept S_N2 , but not S_N1 .	1
4.	(c)	(ii)	 curly arrow from lone pair/negative charge on O in HO^- to C ✓ curly arrow from C–Br bond to Br ✓ transition state showing negative charge AND partial bonds ✓	Award [2 max] for correct S_N1 mechanism if not stated in (i). Accept curly arrow going from C–Br bond to Br either in bromoethane or in the transition state for M2. Do not penalize if HO and Br are not at 180° , or the square bracket is missing, in M3. Do not award M3 if OH ---- C connection is seen.	3
4.	(c)	(iii)	primary halogenoalkane ✓	Accept reasons why, such as lack of steric hindrance or less stable carbocation.	1
4.	(c)	(iv)	2 / second ✓		1

4.	(c)	(v)	iodoethane AND «C–I» bond weaker/easier to break ✓	Accept "iodoethane AND I is a better leaving group".	1
4.	(c)	(vi)	quartet / quadruplet / 4 ✓		1
4.	(c)	(vii)	bromoethane AND absence of O–H «peak» AND in 3200–3600 «cm ⁻¹ range» OR bromoethane AND C–Br «peak» AND 500–600 «cm ⁻¹ » ✓	Accept specific value in 500 – 600 «cm ⁻¹ » range.	1

Question	Answers	Notes	Total
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Mark-scheme answers

Chemistry HL | Paper 1A | Specimen 2025 | Q38 | 1 marks

38. D

Chemistry HL | Paper 1A | Specimen 2025 | Q39 | 1 marks

39. C

Chemistry HL | Paper 1A | Specimen 2025 | Q40 | 1 marks

40. A

APOLLO

Introduction to the particulate nature of matter

4 questions

Mark-scheme answers

Chemistry HL | Paper 1A | May 2025 TZ2 | Q1 | 1 marks

1. A

Chemistry HL | Paper 1A | May 2025 TZ2 | Q8 | 1 marks

8. B

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q1 | 1 marks

1. D

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q1 | 1 marks

1. B

APOLLO

The nuclear atom

5 questions

Mark-scheme answers

Chemistry HL | Paper 1A | May 2025 TZ1 | Q1 | 1 marks

1. C

Chemistry HL | Paper 1A | May 2025 TZ2 | Q2 | 1 marks

2. B

Chemistry HL | Paper 1A | May 2025 TZ3 | Q4 | 1 marks

4. C

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q2 | 1 marks

2. A

Chemistry HL | Paper 1A | Specimen 2025 | Q2 | 1 marks

2. B

APOLLO

Electron configurations

14 questions

Mark-scheme answers

Chemistry HL | Paper 1A | May 2025 TZ1 | Q2 | 1 marks

2. D

Chemistry HL | Paper 1A | May 2025 TZ1 | Q4 | 1 marks

4. A

Chemistry HL | Paper 1A | May 2025 TZ1 | Q6 | 1 marks

6. D

Chemistry HL | Paper 1A | May 2025 TZ2 | Q3 | 1 marks

3. C

Chemistry HL | Paper 1A | May 2025 TZ2 | Q6 | 1 marks

6. A

Chemistry HL | Paper 1A | May 2025 TZ2 | Q16 | 1 marks

16. C

Chemistry HL | Paper 1A | May 2025 TZ3 | Q5 | 1 marks

5. C

Chemistry HL | Paper 1A | May 2025 TZ3 | Q13 | 1 marks

13. D

Chemistry HL | Paper 1A | May 2025 TZ3 | Q16 | 1 marks

16. D

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q3 | 1 marks

3. D

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q16 | 1 marks

16. A

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q2 | 1 marks

2. C

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q15 | 1 marks

15. B

2.	(a)	(i)	repelled by «hitting/close contact with» gold nucleus ✓		1
2.	(a)	(ii)	atom is mainly empty space/vacuum OR nucleus is very small «compared to the size of the atom» ✓		1
2.	(b)	(i)	discrete/series of lines of different frequency/wavelength ✓		1
2.	(b)	(ii)	energy of photon relates to a frequency «in the spectrum» ✓ energy of photon depends on difference in energy levels ✓		2
2.	(b)	(iii)	5250 «kJ mol ⁻¹ » ✓		1
2.	(b)	(iv)	H half/lower nuclear charge/number of protons ✓ H larger/double radius ✓		2
2.	(b)	(v)	electron-electron interactions «need to be taken in account» ✓		1
2.	(c)		Any one of: new evidence new technology developments in related models models incomplete/failed to account for all observations ✓		1

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Question			Answers	Notes	Total
			$\text{Li}(\text{CoO}_2)_2 + \text{Li}^+ + \text{e}^- \rightarrow 2\text{LiCoO}_2$ ✓		

APOLLO

Counting particles by mass: The mole

11 questions

Mark-scheme answers

Chemistry HL | Paper 1A | May 2025 TZ2 | Q5 | 1 marks

5. D

Chemistry HL | Paper 1A | May 2025 TZ3 | Q1 | 1 marks

1. D

Chemistry HL | Paper 1A | May 2025 TZ3 | Q2 | 1 marks

2. B

Chemistry HL | Paper 1A | May 2025 TZ3 | Q3 | 1 marks

3. B

7.	(a)	C = 2.59 «g» ✓ «$m(\text{O}) = 4.32 - (m(\text{C}) + m(\text{H}))$ $= 4.32 - (2.59 + 0.581) = 1.15 \text{ g}$ » $n(\text{O}) = \frac{1.15 \text{ g}}{16.00 \text{ g mol}^{-1}}$ / 0.0718 «mol» ✓ «$n(\text{C}):n(\text{H}):n(\text{O}) = 0.216 : 0.575 : 0.0718 = 3 : 8 : 1$ » $\text{C}_3\text{H}_8\text{O}$ ✓	M3 for finding empirical formula Award [3] for correct final answer.	3
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2225 – 6209M

Question			Answers	Notes	Total
7.	(b)	(i)	$T = 373 \text{ K}$ AND $V = 5.57 \times 10^{-5} \text{ m}^3$ OR $T = 373 \text{ K}$ AND 0.0557 dm^3 and $1 \times 10^2 \text{ kPa}$ ✓ «$n = \frac{PV}{RT} = \frac{1.00 \times 10^5 \text{ Pa} \times 5.57 \times 10^{-5} \text{ m}^3}{8.31 \text{ J K}^{-1} \text{ mol}^{-1} \times 373 \text{ K}}$» $n = 0.00180 \text{ «mol»}$ ✓	Award [2] for correct final answer.	2
7.	(b)	(ii)	«$M = \frac{0.108 \text{ g}}{0.00180 \text{ mol}}$ » $60.0 / 60.1 \text{ «g mol}^{-1}\text{»}$ ✓	If $n = 0.00220 \text{ mol}$ is used, $M = 49.1 \text{ «g mol}^{-1}\text{»}$ Accept mass of 60	1
			H. .CH₃	Accept only correct structural	

Mark-scheme answers

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q4 | 1 marks

4. D

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q25 | 1 marks

25. C

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q26 | 1 marks

26. D

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q3 | 1 marks

3. C

Chemistry HL | Paper 1A | Specimen 2025 | Q4 | 1 marks

4. A

Chemistry HL | Paper 1A | Specimen 2025 | Q25 | 1 marks

25. C

APOLLO

Ideal gases

6 questions

Mark-scheme answers

Chemistry HL | Paper 1A | May 2025 TZ1 | Q5 | 1 marks

5. A

Chemistry HL | Paper 1A | May 2025 TZ1 | Q17 | 1 marks

17. D

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q5 | 1 marks

5. C

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q5 | 1 marks

5. C

1.	(a)	Any one of: forms nitrous acid / HNO_2 / nitric acid / HNO_3 ✓ contributes to acid rain ✓ catalyses decomposition of ozone / contributes to ozone hole/depletion ✓ «respiratory» irritant/toxic ✓	Accept suitable equations showing acid rain formation or ozone depletion. Accept photochemical smog/forms NO_2 .	1 max
1.	(b)	$T = 200 + 273$ «K» ✓ « $n = PV/RT$ » « $n = \frac{(1.0 \times 10^5)(1.0 \times 10^{-3})}{8.31(200+273)}$ » « $n =$ » 0.025 «mol» ✓ «0.10% $\times$ 0.025 $\Rightarrow$ » 2.5×10^{-5} «mol» ✓	Award [3] for correct final answer.	3
1.	(c)	NO polar AND N_2 non-polar OR NO has dipole-dipole «and LDF» AND N_2 has London/dispersion «forces between molecules» ✓ stronger intermolecular forces in NO OR dipole-dipole «forces» are stronger «than LDF» ✓		2
1.	(d)	(i) Initial: +2 AND Final: 0 ✓	Accept II for initial oxidation state, but do not accept 2+ or 2.	1
1.	(d)	(ii) $2\text{NO}(\text{g}) + 2\text{CO}(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + \text{N}_2(\text{g})$ ✓		1

Question	Answers	Notes	Total
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Mark-scheme answers

Chemistry HL | Paper 1A | Specimen 2025 | Q5 | 1 marks

5. C

APOLLO

The ionic model

6 questions

Mark-scheme answers

Chemistry HL | Paper 1A | May 2025 TZ1 | Q7 | 1 marks

7. D

Chemistry HL | Paper 1A | May 2025 TZ3 | Q6 | 1 marks

6. D

Chemistry HL | Paper 1A | May 2025 TZ3 | Q7 | 1 marks

7. B

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q6 | 1 marks

6. D

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q13 | 1 marks

13. A

Chemistry HL | Paper 1A | Specimen 2025 | Q6 | 1 marks

6. B

APOLLO

The covalent model

28 questions

Mark-scheme answers

Chemistry HL | Paper 1A | May 2025 TZ1 | Q9 | 1 marks

9. B

Chemistry HL | Paper 1A | May 2025 TZ1 | Q10 | 1 marks

10. A

Chemistry HL | Paper 1A | May 2025 TZ1 | Q11 | 1 marks

11. C

Chemistry HL | Paper 1A | May 2025 TZ1 | Q13 | 1 marks

13. C

Chemistry HL | Paper 1A | May 2025 TZ2 | Q7 | 1 marks

7. C

Chemistry HL | Paper 1A | May 2025 TZ2 | Q9 | 1 marks

9. B

Chemistry HL | Paper 1A | May 2025 TZ2 | Q10 | 1 marks

10. B

Chemistry HL | Paper 1A | May 2025 TZ3 | Q8 | 1 marks

8. D

Chemistry HL | Paper 1A | May 2025 TZ3 | Q9 | 1 marks

9. C

Chemistry HL | Paper 1A | May 2025 TZ3 | Q10 | 1 marks

10. B

1.	(a)	elements contain only one type of atom / atoms with same atomic number/same number of protons OR cannot be chemically broken down «into simpler substances» ✓ compounds contain different types of atoms «chemically» bonded together OR consist of different elements «chemically» bonded together «in fixed ratios» ✓	Accept combined/joined for bonded in M2.	2
1.	(b)	<<electronegativity difference>> $\Delta X = 0.8$ AND average <<electronegativity >> $X = 2.2$ ✓		1
1.	(c)	Any one of: Fe is electrical/thermal conductor AND FeS is not ✓ Fe is malleable/ductile AND FeS is brittle/not malleable/ductile ✓ Fe is magnetic AND FeS is not ✓ Fe has higher melting point «than FeS» ✓ Fe is denser «than FeS» ✓	Do not accept atomic or molar mass. Do not accept any chemical properties. Accept colour or shininess Accept iron is sonorous	1
1.	(d)	«$IE(\text{Fe}) = 762 \text{ kJ mol}^{-1}$» E for 1 atom «$= \frac{762 \times 10^3 \text{ J mol}^{-1}}{6.02 \times 10^{23} \text{ mol}^{-1}}$» = 1.266×10^{-18} «J» ✓ f «$= \frac{E}{h} = \frac{1.266 \times 10^{-18} \text{ J}}{6.63 \times 10^{-34} \text{ J s}}$» = $1.91 \times 10^{15} \text{ s}^{-1}$ ✓ λ «$= \frac{c}{f} = \frac{3.0 \times 10^8 \text{ m s}^{-1}}{1.91 \times 10^{15} \text{ s}^{-1}}$» = $1.57 \times 10^{-7} \text{ m}$ ✓	Award [3] for correct final answer.	3

Question	Answers	Notes	Total
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7.	(a)		«$0.0104 \times 0.02 \times 10^{-3}$» «$0.24 \times 10^{-3}$» «$10^{-3}$» ✓ $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$ ✓ $\text{HOOC}(\text{CH}_2)_4\text{COOH}$ / $\text{ClOC}(\text{CH}_2)_4\text{COCl}$ ✓	Accept any type of structural or skeletal formula. Penalize clear incorrect bond connections only once in the paper.	2
7.	(b)	(i)	O of C=O with H of H-N on opposite chain ✓	Do not penalize multiple correct H-bonds.	1

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Question			Answers	Notes	Total
7.	(b)	(ii)	H that is «covalently» bonded to a «highly» electronegative atom ✓ is attracted to the electronegative atom of neighbouring molecule ✓	Accept a labelled diagram for both marks. Accept “F, O or N” for “electronegative atom”.	2
7.	(c)		covalent bonds between silicon atoms ✓ London/dispersion forces between poly(ethene) «chains/molecules» ✓ covalent bonds «much» stronger than London/dispersion/intermolecular forces «hence Si has higher melting points» ✓	M3: Do not accept “bonding in silicon is stronger than poly(ethene)” without named bonding/forces.	3

Mark-scheme answers

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q7 | 1 marks

7. A

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q8 | 1 marks

8. C

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q9 | 1 marks

9. B

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q10 | 1 marks

10. D

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q12 | 1 marks

12. B

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q39 | 1 marks

39. B

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q6 | 1 marks

6. B

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q7 | 1 marks

7. D

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q9 | 1 marks

9. D

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q11 | 1 marks

11. D

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q16 | 1 marks

16. B

Chemistry HL | Paper 1A | Specimen 2025 | Q7 | 1 marks

7. B

Chemistry HL | Paper 1A | Specimen 2025 | Q8 | 1 marks

8. D

Mark-scheme answers

Chemistry HL | Paper 1A | Specimen 2025 | Q9 | 1 marks

9. B

Chemistry HL | Paper 1A | Specimen 2025 | Q10 | 1 marks

10. D

Chemistry HL | Paper 1A | Specimen 2025 | Q17 | 1 marks

17. D

APOLLO

The metallic model

4 questions

Mark-scheme answers

Chemistry HL | Paper 1A | May 2025 TZ3 | Q11 | 1 marks

11. A

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q11 | 1 marks

11. C

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q10 | 1 marks

10. D

Chemistry HL | Paper 1A | Specimen 2025 | Q11 | 1 marks

11. D

APOLLO

From models to materials

2 questions

Mark-scheme answers

Chemistry HL | Paper 1A | May 2025 TZ1 | Q8 | 1 marks

8. A

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q8 | 1 marks

8. B

APOLLO

The periodic table: Classification of elements

18 questions

Mark-scheme answers

Chemistry HL | Paper 1A | May 2025 TZ1 | Q14 | 1 marks

14. A

Chemistry HL | Paper 1A | May 2025 TZ1 | Q15 | 1 marks

15. A

Chemistry HL | Paper 1A | May 2025 TZ1 | Q16 | 1 marks

16. B

Chemistry HL | Paper 1A | May 2025 TZ1 | Q18 | 1 marks

18. D

Chemistry HL | Paper 1A | May 2025 TZ2 | Q4 | 1 marks

4. A

Chemistry HL | Paper 1A | May 2025 TZ2 | Q12 | 1 marks

12. D

Chemistry HL | Paper 1A | May 2025 TZ2 | Q13 | 1 marks

13. C

Chemistry HL | Paper 1A | May 2025 TZ2 | Q15 | 1 marks

15. C

Chemistry HL | Paper 1A | May 2025 TZ3 | Q12 | 1 marks

12. B

Chemistry HL | Paper 1A | May 2025 TZ3 | Q14 | 1 marks

14. B

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q15 | 1 marks

15. B

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q12 | 1 marks

12. A

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q14 | 1 marks

14. A

1.	(a)			Accept x from 155–165 y from 500–700	1
1.	(b)		closer an electron is to the nucleus the greater the «electrostatic» attraction ✓	Accept smaller atomic radius for electron closer to the nucleus. Accept converse statement.	1
1.	(c)	(i)	inverse/negative «correlation» ✓	Do not accept inverse proportionality. Award [0] if linear relationship mentioned. Do not accept when AR increases IE decreases.	1

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1.	(c)	(ii)	similar trends / distribution of points ✓ as the period number increases the curve/distribution shifts down AND to the right OR as the period number increases the curve/distribution shifts to lower IE AND greater radius ✓	For M1 accept IE decreases as atomic radius increases .	2
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Question	Answers	Notes	Total
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Mark-scheme answers

Chemistry HL | Paper 1A | Specimen 2025 | Q3 | 1 marks

3. C

Chemistry HL | Paper 1A | Specimen 2025 | Q13 | 1 marks

13. A

Chemistry HL | Paper 1A | Specimen 2025 | Q15 | 1 marks

15. C

Chemistry HL | Paper 1A | Specimen 2025 | Q16 | 1 marks

16. B

APOLLO

Functional groups: Classification of organic compounds

20 questions

Mark-scheme answers

Chemistry HL | Paper 1A | May 2025 TZ1 | Q12 | 1 marks

12. C

Chemistry HL | Paper 1A | May 2025 TZ1 | Q19 | 1 marks

19. A

Chemistry HL | Paper 1A | May 2025 TZ1 | Q20 | 1 marks

20. B

Chemistry HL | Paper 1A | May 2025 TZ1 | Q21 | 1 marks

21. D

Chemistry HL | Paper 1A | May 2025 TZ2 | Q17 | 1 marks

17. B

Chemistry HL | Paper 1A | May 2025 TZ3 | Q17 | 1 marks

17. D

Chemistry HL | Paper 1A | May 2025 TZ3 | Q18 | 1 marks

18. C

Chemistry HL | Paper 1A | May 2025 TZ3 | Q19 | 1 marks

19. B

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q13 | 1 marks

13. C

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q17 | 1 marks

17. B

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q18 | 1 marks

18. A

Chemistry HL | Paper 1A | Nov 2025 TZ1 | Q19 | 1 marks

19. B

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q17 | 1 marks

17. C

Mark-scheme answers

Chemistry HL | Paper 1A | Nov 2025 TZ3 | Q18 | 1 marks

18. A

4.	(a)	(i)	<i>Peak 2 wavenumber: 1050 – 1410 «cm⁻¹»</i> AND <i>bond: C–O ✓</i>	<i>Accept any order.</i> <i>Accept any value in the given range.</i>	2
4.	(a)	(ii)	3200 – 3600 «cm ⁻¹ » AND 2500 – 3000 «cm ⁻¹ » AND «hydrogen bonded» O–H ✓		1
4.	(b)	(i)	70 / (102 – 32) ✓ the rest of the formula/ C ₅ H ₁₀ O ₂ ✓	<i>Any calculation that demonstrates 2 O atoms present for M1</i> <i>Award [2] for correct final formula, allow any representation of the structure.</i>	2
4.	(b)	(ii)	$\text{CH}_3\text{—CH}_2\text{—}\overset{\text{O}}{\parallel}\text{C—O—CH}_2\text{—CH}_3$ / ethyl propanoate / CH ₃ CH ₂ COOCH ₂ CH ₃ ✓	<i>Allow any correct structural representation of the ester.</i>	1

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Question	Answers	Notes	Total
	$2\text{NiO}(\text{OH})(\text{s}) + 2\text{H}_2\text{O}(\text{l}) + \text{Cd}(\text{s}) \rightarrow \text{Cd}(\text{OH})_2(\text{s}) + 2\text{Ni}(\text{OH})_2(\text{s})$ ✓	<i>Accept equilibrium arrows</i>	

Mark-scheme answers

Chemistry HL | Paper 1A | Specimen 2025 | Q1 | 1 marks

1. A

Chemistry HL | Paper 1A | Specimen 2025 | Q12 | 1 marks

12. A

Chemistry HL | Paper 1A | Specimen 2025 | Q14 | 1 marks

14. B

Chemistry HL | Paper 1A | Specimen 2025 | Q18 | 1 marks

18. A

Chemistry HL | Paper 1A | Specimen 2025 | Q19 | 1 marks

19. C