A Level AQA Chemistry

Chapter 5 – answers

Question	Answers	Extra information	Mark	AO Spec reference
01.1	$Cl_2\ (g) + 2I^-\ (aq) \rightarrow 2\ Cl^-\ (aq) + I_2\ (aq)$	1 mark for equation 1 mark state symbols	1 1	3.1.7 3.1.2.5 AO1
01.2	Oxidising agent		1	3.1.7 AO1
01.3	$\frac{0.1 \times 26.0}{1000} = 0.0026$ *moles thiosulfate* Moles $I_2 = \frac{0.0026}{2} = 0.0013$ moles in 25 cm^3 0.013 moles in 250 cm^3 0.013 moles Cl_2	Correct answer scores 4 marks	1 1 1 1	3.1.2.5 AO2 MS 0.2
01.4	$V = \frac{nRT}{P}$ $V = \frac{0.013 \times 8.31 \times 298}{101\,000}$ $= 3.19 \times 10^{-4}\ m^3$	Recall of equation scores 1 mark	1 1 1	3.1.2.3 AO2 MS 2.2, 2.3, 2.4
01.5	$\left(\frac{3.19 \times 10^{-4}}{0.060}\right) \times 100 = 0.532\%$	5.32×10^{-4} % score 1 mark	2	3.1.2.5 AO2 MS 0.2
01.6	$0.013 \times 71 = 0.923$ g Cl_2 in 0.06 m^3 Which is much higher than safety limits		1 1	3.1.2.5 AO3
02.1	$Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$		1	3.1.2.5 MS 0.2

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02.2	HNO_3 (+) 5 NO_2 (+) 4		1 1	3.1.7 AO1
02.3	$HNO_3 + H^+ + e^- \rightarrow NO_2 + H_2O$ or $NO_3^- + 2H^+ + e^- \rightarrow NO_2 + H_2O$/		1	3.1.7 AO1
02.4	Concentration(s) (of reactants and products) remain(s) constant / stay(s) the same / remain(s) the same / do(es) not change Forward rate = Reverse / backward rate	For M1 accept [ ] for concentration NOT "equal concentrations" and NOT "concentration(s) is/are the same" NOT "amount" Ignore "dynamic" and ignore "speed" Ignore "closed system" It is possible to score both marks under the heading of a single feature	1 1	3.1.6.1 AO3
02.5	The (forward) reaction / to the right is endothermic or takes in / absorbs heat The equilibrium shifts / moves left to right to oppose the increase in temperature	Allow converse 2nd mark dependent on 1st mark and must involve temperature	1 1	3.1.6.1 AO3
02.6	Amount of NO_2 decreases Equilibrium shifts to the left to reduce the pressure	Allow concentration/partial pressure M3 dependent on M2 and must involve pressure	1 1 1	3.1.6.1 AO3

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02.7	Moles at equilibrium NO_2 = 3.0 Mole fractions $NO_2 = \frac{3}{4} = 0.75$. $N_2O_4 = \frac{1}{4} = 0.25$ Partial pressure NO_2 = 0.75 × 200 = 150 kPa Partial pressure of N_2O_4 = 0.25 × 200 = 50 kPa $K_p = \frac{(pNO_2)^2}{(pN_2O_4)} = \frac{150^2}{50} = 450$	Allow e.c.f. Correct workings scores both marks for K_p equation	1 1 1 1 2	3.1.10 AO2 MS 2.2 2.3
03.1	Methanoic acid		1	3.3.9.1 AO1
03.2	$C_3H_7OH + HCOOH \rightarrow HCOOC_3H_7 + H_2O$	Allow any correct formula Must have reversible arrow	1	3.3.9.1 AO1
03.3	Reflux To prevent reactants or products evaporating		1 1	3.3.9.1 AO1
03.4	Moles of propanol at equilibrium = 0.95 Moles of methanoic acid at equilibrium = 0.45 $K_c = \frac{[HCOOC_3H_7]\ [H_2O]}{[HCOOH]\ [C_3H_7OH]}$ or workings $K_c = \frac{\left(\frac{1.05}{2}\right)^2}{\left(\frac{0.95}{2}\right) \times \left(\frac{0.45}{2}\right)}$ = 2.58 NO UNITS	Allow completed table or can be Found in K_c equation	1 1 1 1 1	3.1.6.2 AO2

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04.1	(+)5/ V/ five		1	3.1.7 AO1
04.2	Reducing agent		1	3.1.7 AO1
04.3	Enthalpy/Energy change when 1 mole of substance is formed from its elements, under standard conditions with all species in their standard states		1 1 1	3.1.4.1 AO1
04.4	$\Delta H = \Sigma\Delta_f H$ (**products**) − $\Sigma\Delta_f H$ (**reactants**) = 5(−635) − (−1560) = − 3175 + 1560 = −1615 (kJ mol^{-1})	Or correct cycle. can be shown in calculation	1 1 1	3.1.4.3 AO”
04.5	$VCl_2 + H_2 \rightarrow V + 2HCl$	Ignore state symbols	1	3.1.2.5 AO1
04.6	HCl is a gas so will escape into the atmosphere	Allow removed/lost/separated	1	3.1.2.5 AO3
05.1	Propanol + sulfuric acid in (round bottom) flask Anti-bumping granules Reflux condenser attached Heat gently Add potassium dichromate dropwise	Allow heart shaped/ quick fit Allow gently/slowly etc.	1 1 1 1 1	3.3.5.2 AO1

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Question	Answers	Extra information	Mark	AO Spec reference
05.2	$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$	Allow multiples	1	3.1.7 AO1
05.3	Orange to green colour change	Allow it would turn green	1	3.3.5.2 AO1
05.4	Marks awarded for this answer will be determined by the quality of written communication as well as the standard of the scientific response. Examiners should apply a 'best-fit' approach to the marking. **Additional tests limits to lower mark within a level.** This would include, for example, adding silver nitrate to the already identified propanoic acid.	**Indicative Chemistry Content** **Identification of Acid** 1a add named carbonate 1b effervescence/bubbles/ fizzing **Identification of aldehyde** 2a add Tollens reagent/ Fehlings A + B 2b warm/ water bath 2c silver mirror/brick red precipitate **Identification of alcohol** 3a add acidified potassium dichromate 3b heat 3c orange to green colour change	6	3.3.5.2 3.3.9.1 3.3.8 AO3
	Level 3 (5–6 marks) All stages are covered and each stage is generally correct and virtually complete. Answer is communicated coherently and shows a logical progression from Stage 1 to Stages 2 and 3 to identify all three compounds in a logical sequence with results and equations for all compounds stated. **Covers 2 tests with matching observations, conclusions and equations**			
	Level 2 (3–4 marks) All stages are covered but stage(s) may be incomplete or may contain inaccuracies OR two stages are covered and are generally correct and virtually complete. Answer is communicated mainly coherently and shows a logical progression from Stage 1 to Stages 2 and 3. **Covers 2 compounds** Isolated tests on named compounds – max LEVEL 2			
	Level 1 (1–2 marks) Two stages are covered but stage(s) may be incomplete or may contain inaccuracies OR only one stage is covered but is generally correct and virtually complete. Answer includes isolated statements but these are not presented in a logical order.			

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Question	Answers	Extra information	Mark	AO Spec reference
06.1	Iodine has more electrons So stronger van der Waals So more energy needed to separate the molecules	Do not accept break bonds unqualified	1 1 1	3.1.3.7
06.2	The (forward) reaction / to the right is endothermic or takes in / absorbs heat The equilibrium shifts / moves left to right to oppose the increase in temperature	Allow converse M2 dependent on M1 and must involve temperature	1 1	3.1.6.1 AO3
06.3	No effect Equal number of gaseous moles both sides		1 1	3.1.6.1 AO1
06.4	$\Delta G = \Delta H - T\Delta S$ $= -11 - (300 \times 2.0 \times 10^{-2})$ $= -17\ \text{kJ mol}^{-1}$ Yes, it is feasible as less than 0		1 1 1 1	3.1.8.2 AO2 MS 2.2, 2.3, 2.4
06.5	Oxidising agent		1	3.1.7 AO1
06.6	$\text{HI(g)} \rightarrow \text{H}^+\text{(aq)} + \text{I}^-\text{(aq)}$	Allow multiples	1	3.1.2.5 AO1
06.7	$\text{pH} = -\log[\text{H}^+] = -\log(0.015)$ $= 1.82$	Must be 2 d.p.	1 1	3.1.12.2 AO1 AO2 MS 0.4, 2.5

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Question	Answers	Extra information	Mark	AO Spec reference
06.8	Brown solution Purple fumes/solution $2I^-(aq) \rightarrow I_2(g) + 2e^-$ $Cl_2 + 2e^- \rightarrow 2Cl^-$ $2I^- + Cl_2 \rightarrow I_2 + 2Cl^-$	Ignore state symbols	1 1 1 1 1	3.1.7 3.1.2.5 3.2.3.1
07.1	No effect		1	3.1.6.1 AO1
07.2	Concentration of B would increase (Forward reaction is endothermic) equilibrium would shift to the left To oppose the change/to heat the solution		1 1 1	3.1.6.1 AO1
07.3	Moles of B = 0.66 × 0.1 = 0.066 Change in B = 0.066 − 0.048 = 0.018 Moles of A = $1.8\times10^2 - \left(\frac{0.018}{2}\right) = 9\times10^{-3}$ Moles C = 9×10^{-3} Moles D = $(9\times10^{-3}) \times 3 + 3.5\times10^{-2} = 0.062$	Can be credited in correct working	1 1 1 1 1	3.1.2.5 AO2 MS 2.2, 2.3
07.4	$K_c = \frac{[C][D]^3}{[A][B]^2}$ $\frac{9\times10^{-3} \times (0.062)^3}{9\times10^{-3} \times (4.8\times10^{-2})^2} \div (0.1^{4-3})$ = 1.03 mol dm^{-3}	Allow e.c.f. from **07.3** M3 for calculating concentrations	1 1 1 1 1	3.1.6.2 AO2 MS 2.2, 2.3

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08.1	7/VII/seven		1	3.1.7 AO1
08.2	$16H^+ + 2MnO_4^- + 10Cl^- \rightarrow 2Mn^{2+} + 8H_2O + 5Cl_2$	Allow multiples 1 mark for reversing chlorine half equation	2	3.1.7 AO1
08.3	$Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$		1	3.1.2.5 AO1
08.4	Chlorine		1	3.1.7 AO1
08.5	Gains electrons/removes electrons	Allow specific references to this example to illustrate and half equation	1	3.1.7 AO1
08.6	Bromine had more electrons So stronger van der Waals forces More energy needed to overcome the forces	 Ignore break bonds unless specifically van der Waals bonds	1 1 1	3.1.3.7 AO1

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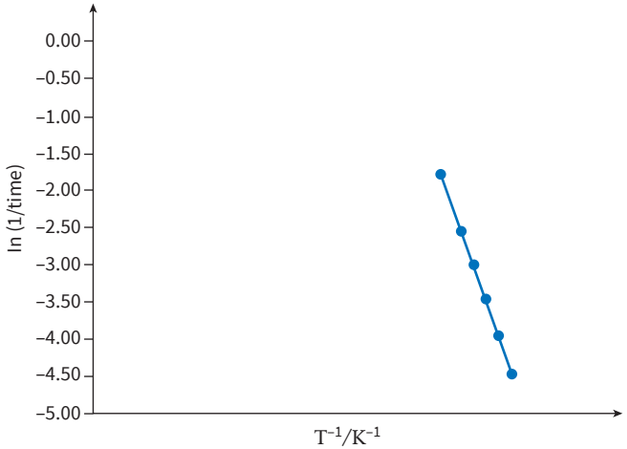
Skills box answers

1.

Temp / °C	Time / s	Temp / K	T^{-1} / K^{-1}	$\ln\left(\frac{1}{\text{time}}\right)$
20	88	293	3.41×10^{-3}	–4.48
30	52	303	3.30×10^{-3}	–3.95
40	32	313	3.19×10^{-3}	–3.47
50	20	323	3.10×10^{-3}	–3.00
60	13	333	3.00×10^{-3}	–2.56

2.



3. Gradient = –4640 K allow −4180 to −5100

gradient = $-\frac{E_a}{R}$ ∴ $E_a = -R \times$ gradient = $-8.31 \times 4640 = 38560$ J mol^{-1}

∴ E_a = 38.6 kJ mol^{-1}

(If ±5% is allowed in the gradient, then E_a is between 36.6 to 40.4 kJ mol^{-1}.)