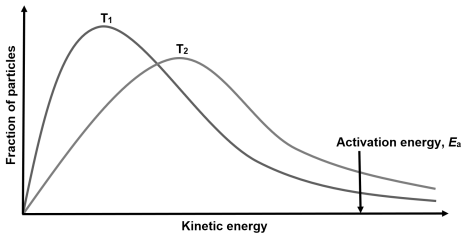
Chemistry

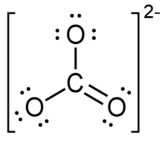
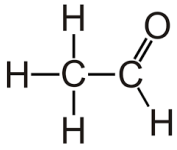
Higher level

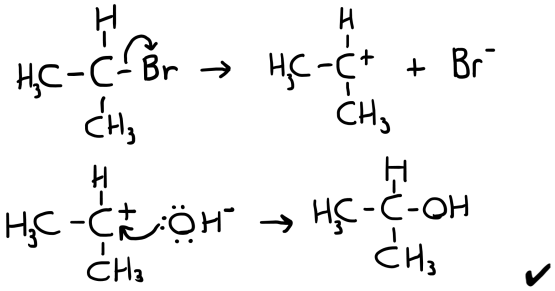
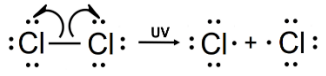
Paper 2

Markscheme

Question	Answers	Total
1 (a)	C: 40.00 / 12.01 = 3.33 H: 6.70 / 1.01 = 6.63 O: 63.31 / 16.00 = 3.33 CH_2O ✔	3
1 (b)	60 / 30 = 2 $C_2H_4O_2$ ✔	2
2 (a)	$Zn(s) + 2HNO_3(aq) \rightarrow Zn(NO_3)_2(aq) + H_2(g)$	1
2 (b)	Zn: 3.00 / 65.38 = 0.0459 mol HNO_3: 1.00 × (50.0 / 1000) = 0.0500 mol HNO_3 is limiting reactant ✔	2
2 (c)	(0.0500 / 2) × 22.7 = 0.568 dm^3	2
2 (d)	Particles must collide with: Correct orientation ✔ $E \geq E_a$ ✔	2
2 (e)	Rate of reaction increases ✔ Frequency of collisions between reactant particles increases ✔	2
2 (f)		1

3 (a)	H_2 Second-order ✔ I_2 First-order ✔	2
3 (b)	Rate = $k[H_2]^2[I_2]$ ✔	2
3 (c)	$k = 5 \times 10^3$ mol^{-2} dm^6 s^{-1} ✔	1
4 (a)	Group number determines the number of valence electrons / electrons in outer shell ✔	1
4 (b)	$1s^2\ 2s^2\ 2p^6\ 3s^2$ ✔ s block ✔	2
4 (c)	Chlorine has higher nuclear charge ✔ And smaller atomic radius ✔	2
4 (d)	s orbital ✔ p orbital ✔ 	2
4 (e) (i)	0 / zero ✔	1
4 (e) (ii)	Coordination bond ✔ Between lone pairs on ligand and central metal ion ✔	2
4 (e) (iii)	Cu^{2+} is magnetic due to unpaired electron in 3d sublevel ✔	1
4 (e) (iv)	4s and 3d sublevels are close in energy ✔ Gradual increase in successive ionisation energies ✔	2
5 (a)	$K = \frac{[SO_3]^2}{[SO_2]^2[O_2]}$ ✔	1
5 (b)	$[SO_3]_{eq} = 3.00$ mol dm^{-3} $[SO_2]_{eq} = 1.50$ mol dm^{-3} $[O_2]_{eq} = 0.75$ mol dm^{-3} $K = 0.188$ ✔	2
5 (c)	$\Delta G^\ominus = -8.31 \times 300 \times (\ln 0.188)$ $\Delta G^\ominus = 4.17$ kJ mol^{-1} ✔	2
5 (d)	Non-spontaneous **and** $\Delta G^\ominus$ positive ✔	1
5 (e)	Yield of SO_2 decreases ✔ More gaseous molecules on reactants side ✔	2
5 (f) (i)	$SO_3(g) + H_2O(l) \rightarrow H_2SO_4(aq)$ ✔	1

5 (f) (ii)	Strong acid ✔ Completely ionises in solution ✔	2
6 (a)	HCO_3^- ✔	1
6 (b)	 ✔	1
6 (c)	Trigonal planar ✔ Three electron domains around central atom ✔	2
6 (d)	$K_a = x^2 / [HA]_{initial}$ $4.5 \times 10^{-7} = x^2 / 0.0500$ $x = \sqrt{4.5 \times 10^{-7} \times 0.0500}$ $x = 1.5 \times 10^{-4}$ pH = -log (1.5×10^{-4}) = 3.8 ✔	2
7 (a)	Any two from: Same general formula Differ by CH_2 Same functional group Gradation in physical properties Similar chemical reactions	1
7 (b)	 ✔	1
7 (c)	Heat and distillation / excess of alcohol ✔	1
7 (d)	Ethanol has hydrogen bonding between its molecules / ethanal has dipole-dipoles forces between its molecules ✔ Hydrogen bonding is stronger than dipole-dipole forces ✔	2
7 (e)	Bonds broken: 3196 kJ Bonds formed: 3237 kJ ΔH = 3196 – 3237 = –41 kJ mol^{-1} ✔	2
7 (f) (i)	2-bromopropane ✔	1

7 (f) (ii)	Formation of 2-bromopropane results in the formation of secondary carbocation ✔ Secondary carbocation is more stable than primary carbocation ✔	2
7 (f) (iii)	 ✔	3
7 (g) (i)	Radical substitution ✔	1
7 (g) (ii)	 ✔	2
7 (h)	Diamond does not conduct electricity (no delocalised electrons) ✔ Graphite conducts electricity (has delocalised electrons) ✔	2
8 (a)	Cathode: $2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$ ✔ Anode: $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$ ✔	2
8 (b)	Electron flow in wires ✔ Ion flow in electrolyte ✔	2
8 (c)	Electrostatic attraction between oppositely charged ions ✔	1
8 (d)	Li^+ has smaller ionic radius than Na^+ ✔	1
8 (e)	$\Delta H_f = 159 + 520 + 121 + (-349) - 864$ $\Delta H_f = -413$ kJ mol^{-1}	3
9 (a)	$Zn(s) + Ni^{2+}(aq) \rightarrow Zn^{2+}(aq) + Ni(s)$ ✔	1
9 (b)	$E^{\ominus}_{cell} = -0.26 - (-0.76)$ $E^{\ominus}_{cell} = 0.50$ V ✔	1
9 (c)	$\Delta G^{\ominus} = -2 \times 96500 \times 0.50$ $\Delta G^{\ominus} = -193$ kJ mol^{-1} ✔	2
9 (d)	Spontaneous **and** $\Delta G^{\ominus}$ negative ✔	1
9 (e)	Any two from: $H_2(g)$ 100 kPa, 1 mol dm^{-3} $[H^+(aq)]$, Pt electrode	2
9 (f)	Anode: $Cr(s) \rightarrow Cr^{3+}(aq) + 3e^-$ ✔ Cathode: $Cr^{3+}(aq) + 3e^- \rightarrow Cr(s)$ ✔	2

10 (a)	$\Delta H = -366 - (2 \times -242 + 82)$ $\Delta H = 36$ kJ mol^{-1} ✔	1
10 (b)	$\Delta S^{\ominus} = 151 - (2 \times 189 + 220)$ $\Delta S^{\ominus} = -447$ J K^{-1} mol^{-1} ✔	1
10 (c)	$\Delta G^{\ominus} = 36 - 298 \times 0.447$ $\Delta G^{\ominus} = 169$ kJ mol^{-1} ✔	1
10 (d)	Endothermic with decrease in entropy ✔	1