Multiple Choice Answers

Q32: D

Multiple Choice Answers

Q40: D

3(a)(i)	**M1** Heat (solid **FA 5)** **AND** observe condensation, droplets, steam, water vapour **M2** Make an aqueous solution of **FA 5 /** dissolve in water to use for tests **M3** (To portion of the solution) add aqueous NH_3 **AND** white ppt **AND** insoluble in excess NH_3 **M4** (To portion of the solution) add aqueous barium chloride or barium nitrate **AND** white precipitate **M5** to distinguish sulfate / sulfite (white precipitate from **M4**) insoluble in hydrochloric **OR** nitric acid **OR** $KMnO_4$ is not decolourised / remains purple (added after **M4** or directly to **FA 5** (aq))
3(a)(ii)	Zn^{2+} : X SO_4^{2-} : ✓ H_2O : ✓
3(b)(i)	• (**FA 6**) starting colour purple • solid jumps / moves around • black residue • test with glowing splint • splint relights / glows more brightly
3(b)(ii)	(dark) Green

3(c)(i)

'No change' 2 correct = *, 3 correct = **

2* = 1 mark

Max mark = 4

test	*observations*		
	FA 7	**FA 8**	**FA 9**
Test 1 Add hydrogen peroxide	Bubbles/ effervescence * Purple / **FA 7** (solution) to colourless (solution) * (Gas / oxygen) relights glowing splint *	No change	Bubbles / effervescence * (Gas/ oxygen) relights glowing splint *
Test 2 Add sodium hydroxide, then		Off-white ppt*	No change
leave to stand		brown ppt on standing*	
Test 3 Add aqueous iron(II) sulfate	Turns colourless / yellow **OR** colourless / yellow solution formed*	No change	

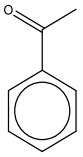
3(c)(ii) manganese / Mn

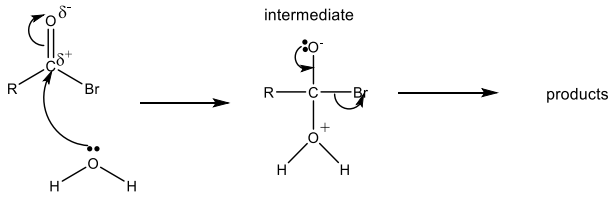
3(c)(iii)

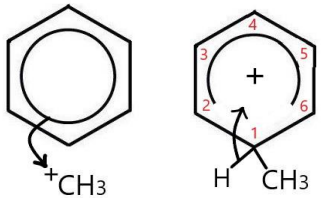
	FA 6 / FA 7	**FA 8**
oxidation state	(+)7	(+)2

1(a)(i)	$Sr(HCO_3)_2 \rightarrow SrCO_3 + CO_2 + H_2O$
1(a)(ii)	**M1**: radius of cation / M^{2+} increases **OR** charge density of cation / M^{2+} decreases **M2**: less polarisation / less distortion of the anion / carbonate ion
1(b)	**M1**: least soluble $CaF_2 < SrF_2 < BaF_2$ most soluble **M2**: ΔH_{latt} and ΔH_{hyd} both become less exothermic / less negative **M3**: ΔH_{hyd} changes less / becomes less exothermic by a smaller extent **OR** ΔH_{latt} changes more / becomes less exothermic by a larger extent **M4**: ΔH_{sol} becomes more exothermic / more negative
1(c)(i)	enthalpy change when one mole of gaseous ions dissolve in water to form a solution
1(c)(ii)	**M1**: ionic radii **AND** ionic charge **M2**: (ionic) radii increase / charge density decreases **AND** ΔH_{hyd} decreases/less exothermic **AND** less attraction between water molecules and (gaseous) ions **OR** as ionic charge increases / charge density increases **AND** ΔH_{hyd} increases/more exothermic **AND** more attraction between water molecules and (gaseous) ions
1(d)	**M1**: use of –2957 / –1926 / –505 **AND** 2 × (–505) **M2**: correct signs and evaluation ΔH_{sol} of $MgF_2(s) = -1926 + (2 \times -505) - (-2957) = (+)21$ kJ mol^{-1}
1(e)(i)	**M1:** $K_{sp} = [Hg_2^{2+}][F^-]^2$ **M2:** units = mol^3 dm^{-9}
1(e)(ii)	$K_{sp} = 2^2 \times (9.20 \times 10^{-3})^3$ = **3.11 × 10^{-6}** min 2sf
2(a)	the (3)d and (4)s sub-shells / orbitals / electrons are close / similar in energy
2(b)	species or ion formed by a central metal atom/ion **AND** surrounded by/bonded to (one or more) ligands
2(c)(i)	NaOH / OH^-(aq) **AND** precipitation / ligand exchange / deprotonation / acid–base
2(c)(ii)	**M1**: $Fe(H_2O)_4(OH)_2$ is oxidised (from + 2 to + 3 on standing) **M2**: $E^\ominus$ of $Fe(H_2O)_3(OH)_3$ is more negative than $E^\ominus$ of O_2 **OR** $E^\ominus_{cell} = 0.40 - (-0.56) = (+)0.96$ V **M3**: $4Fe(H_2O)_4(OH)_2 + O_2 \rightarrow 4Fe(H_2O)_3(OH)_3 + 2H_2O$
2(d)	$\Delta G^\ominus = -2 \times 1.67 \times 96\,500 = -322\,310$ J mol^{-1} **M1:** $\Delta G^\ominus = -nE^\ominus_{cell}F$ **AND** n = 2 **OR** $-2 \times 1.67 \times 96\,500$ **M2:** $\Delta G^\ominus = -322.3$ kJ mol^{-1}

3(a)	heterogeneous **AND** MnO_2 is in a different state / phase to the reactants / H_2O_2
3(b)(i)	**M1:** (expt 2 and 3) $[I^-] \times 2$ initial rate × 2 so 1st order wrt $[I^-]$ **M2:** (expt 1 and 2) $[I^-] \times 2$, $[H_2O_2] \times 0.5$ initial rate × 1 so 1st order wrt $[H_2O_2]$ **OR** (expt 1 and 4) $[I^-] \times 4$ initial rate × 4 **AND** $[H^+] \times 4$ so zero order wrt $[H^+]$ **OR** (expt 1 and 3) $[I^-] \times 4$, $[H_2O_2] \times 0.5$ initial rate × 2 so 1st order wrt $[H_2O_2]$ **M3:** (expt 1 and 4) $[I^-]$ x 4 , $[H^+] \times 4$ initial rate × 4 so zero order wrt $[H^+]$ **OR** (expt 3 and 4) $[H_2O_2] \times 2$ initial rate × 2**AND** $[H^+]$ x 4 so zero order wrt $[H^+]$ **OR** (expt 3 and 4) $[H_2O_2] \times 2$, $[H^+] \times 4$ initial rate × 2 so 1st order wrt $[H_2O_2]$ **M4:** rate = $k[H_2O_2][I^-]$ **OR** rate = $k[H_2O_2][I^-][H^+]^0$
3(b)(ii)	**M1:** $k = 2.42 \times 10^{-3} \div (0.045 \times 0.030) = 1.79$ min 2sf **M2:** units = dm^3 mol^{-1} s^{-1}
3(c)(i)	**M1:** calculation of one $t_{1/2} = 60$ s ± 5 s **M2:** two $t_{1/2}$ calculated that are constant
3(c)(ii)	$k = \ln 2 \div 60 = 0.0116$ **OR** $k = 0.693 \div 60 = 0.0116$ min 2sf
3(d)	increases k and increases the rate of reaction

8(a)(i)	NO_2 group directs to 3 (and 5) / meta position **AND** due to being an electron-withdrawing / electronegative group
8(a)(ii)	$HNO_3 + H_2SO_4 \rightarrow NO_2^+ + HSO_4^- + H_2O$ **OR** $HNO_3 + 2H_2SO_4 \rightarrow NO_2^+ + 2HSO_4^- + H_3O^+$
8(b)(i)	
8(b)(ii)	**M1:** (reaction 1) ethanoyl chloride / CH_3COCl **AND** $AlCl_3$ **M2:** (reaction 2) 2-bromopropane / $(CH_3)_2CHBr$ **AND** $FeBr_3$
8(c)	**M1:** with C_6H_5Br no change / no precipitate **AND** with $C_6H_5CH_2Br$ cream precipitate in C_6H_5Br **M2:** lone pair / p-orbital on Br delocalised / overlaps with ring / π system **M3:** C–Br bond stronger / has partially double bond character

8(d)(i)	(nucleophilic) addition–elimination
8(d)(ii)	 **M1 M2:** • lone pair on O • curly arrow from (lone pair) O (in H_2O) to C (of C=O) • correct dipole on C=O • curly arrow from the C=O bond to O atom any two [1], all four [2] **M3:** correct intermediate **M4:** curly arrow from (lone pair on) $O^{(-)}$ to C–O bond **AND** curly arrow from C–Br to Br

9(a)	• all C atoms are sp^2 hybridised • bonds between C atoms are σ and π • C–C σ bonds are formed by overlap of sp^2 hybrid orbitals • C–C π bonds are formed by overlap of p orbitals • bonds between C and H atoms are σ • C–H bonds are formed by overlap of sp^2 hybrid orbitals and s orbitals Any two [1], any four [2], all six [3]
9(b)	CH_3Cl and $AlCl_3$
9(c)	 **M1:** curly arrow from within hexagon towards ^+C **M2:** intermediate, usual rules for horseshoe and + charge **M3:** curly arrow from C–H bond into ring **AND** H^+ product
9(d)	**M1:** HNO_3 **AND** H_2SO_4 **M2:** concentrated **AND** 25 °C ⩽ T ⩽ 60 °C
9(e)	alkaline $KMnO_4$
9(f)	4-nitrobenzoic acid
9(g)	(hot) concentrated HCl and Sn
9(h)	**M1:** perform step 3 before step 2 **OR** perform step 2 before step 1 **M2:** COOH is 3-directing **OR** NO_2 is 3-directing