JABchem

Past Papers Advanced Higher Chemistry

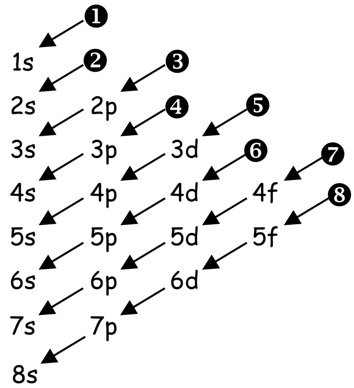
2010

Marking Scheme

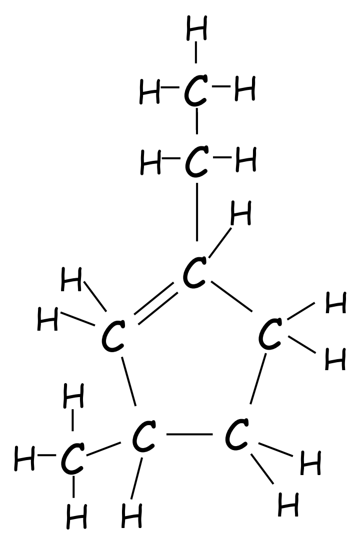
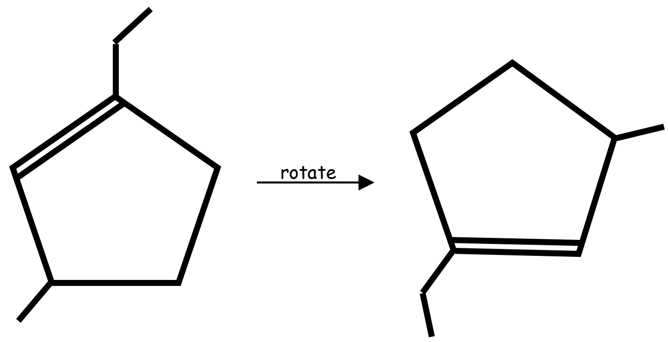
Grade Awarded	Mark Required		% candidates achieving grade
	(/125)	%	
A	85+	68%	27.6%
B	72+	58%	26.7%
C	60+	48%	22.3%
D	54+	43%	7.5%
No award	<54	<43%	15.9%

Section:	Multiple Choice	Extended Answer	Investigation
Average Mark:	27.2 /40	30.5 /60	15.3 /25

2010 Adv Higher Chemistry Marking Scheme

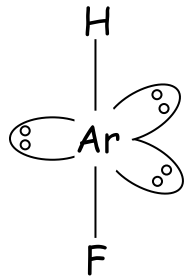
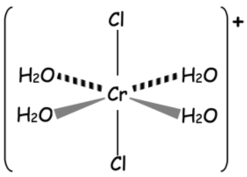
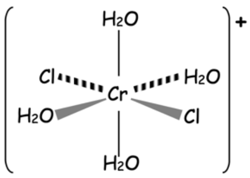
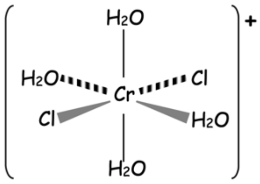
<table>
<tr><th>MC Qu</th><th>Answer</th><th>% Pupils Correct</th><th>Reasoning</th></tr>
<tr><td>1</td><td>D</td><td>86</td><td>☒A 4s fills before 3d and 3d fills singly before filling doubly
☒B 4s fills before 3d fills
☒C 4s fills doubly before 3d fills
☑D 4s fills doubly before 3d fills singly then doubly</td></tr>
<tr><td>2</td><td>C</td><td>61</td><td>$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$ is a group 3 element (Al) and forms a 3+ ion (Al^{3+}) to achieve an electron arrangement of $1s^2\ 2s^2\ 2p^6$</td></tr>
<tr><td>3</td><td>D</td><td>89</td><td>☒A 3d fills before 4p
☒B 4s fills before 3d
☒C 4s fills before 3d
☑D 3p then 4s then 3d then 4p

</td></tr>
<tr><td>4</td><td>B</td><td>77</td><td>
<table>
<tr><td>Ionisation Energy</td><td>1st</td><td>2nd</td><td>3rd</td><td>4th</td></tr>
<tr><td>Equation</td><td>$Mg_{(g)} \rightarrow Mg^{+}_{(g)} + e^-$
2,8,2 2,8,1</td><td>$Mg^{+}_{(g)} \rightarrow Mg^{2+}_{(g)} + e^-$
2,8,1 2,8</td><td>$Mg^{2+}_{(g)} \rightarrow Mg^{3+}_{(g)} + e^-$
2,8 2,7</td><td>$Mg^{3+}_{(g)} \rightarrow Mg^{4+}_{(g)} + e^-$
2,7 2,6</td></tr>
<tr><td>Value</td><td>738 kJ mol^{-1}</td><td>1451 kJ mol^{-1}</td><td>7733 kJ mol^{-1}</td><td>10543 kJ mol^{-1}</td></tr>
</table>
Group 2 elements have large increase between 2nd and 3rd ionisation energy as removing the 3rd electron breaks a full outer shell.</td></tr>
<tr><td>5</td><td>B</td><td>32</td><td>☒A Each element will give a characteristic spectrum with different coloured lines
☑B Energy is required to promote electrons, not just visible light
☒C Emission lines come from electron transitions from upper levels to lower levels
☒D The higher the intensity of the line, the higher the quantity of the element</td></tr>
<tr><td>6</td><td>D</td><td>53</td><td>$$\text{No. of electron pairs} = \frac{\text{no. of outer electrons in central atom + no. of bonds - charge}}{2}$$
$$= \frac{7+4-(-1)}{2} = \frac{12}{2} = \text{6 electron pairs (4 bonding + 2 lone pair)}$$</td></tr>
<tr><td>7</td><td>A</td><td>78</td><td>
<table>
<tr><th>Substance</th><th>Positive Ion Radii</th><th>Negative Ion Radii</th><th>Ratio</th></tr>
<tr><td>Cs^+Cl^-</td><td>Cs^+ = 174pm</td><td>Cl^- = 181 pm</td><td>$\frac{Cs^+}{Cl^-} = \frac{174}{181} = 0.961$</td></tr>
<tr><td>$Ba^{2+}O^{2-}$</td><td>Ba^{2+} = 135pm</td><td>O^{2-} = 136pm</td><td>$\frac{Ba^{2+}}{O^{2-}} = \frac{135}{140} = 0.964$</td></tr>
<tr><td>$Fe^{2+}O^{2-}$</td><td>Fe^{2+} = 61 pm</td><td>O^{2-} = 136pm</td><td>$\frac{Fe^{2+}}{O^{2-}} = \frac{61}{140} = 0.435$</td></tr>
<tr><td>Ag^+I^-</td><td>Ag^+ = 126 pm</td><td>I^- = 220pm</td><td>$\frac{Ag^+}{I^-} = \frac{115}{220} = 0.523$</td></tr>
<tr><td>$Ni^{2+}O^{2-}$</td><td>Ni^{2+} = 69 pm</td><td>O^{2-} = 136pm</td><td>$\frac{Ni^{2+}}{O^{2-}} = \frac{69}{140} = 0.493$</td></tr>
</table></td></tr>
<tr><td>8</td><td>B</td><td>75</td><td>☒A ionic hydrides produce alkaline solutions when added to water
☑B ionic hydrides produce hydrogen gas and alkaline solutions when added to water
☒C ionic hydrides produce alkaline solutions when added to water
☒D ionic hydrides produce hydrogen gas when added to water</td></tr>
</table>

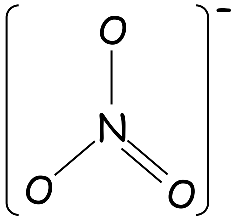
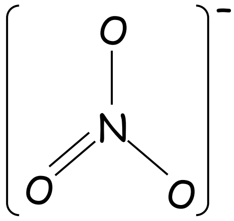
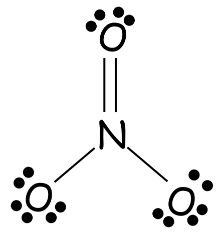
<table>
<tr><td>9</td><td>D</td><td>67</td><td>☒A Elements cannot have ionic bonding
☒B Metallic oxides will be solids at room temperature as they are ionic
☒C Elements are not polar covalent as there is no electronegativity difference
☑D Oxides which are gases at room temperature must be covalent (element is non-metal) and elements must non-polar covalent as there is no electronegativity difference</td></tr>
<tr><td>10</td><td>C</td><td>56</td><td>☒A SO_2 only partially dissociates when dissolved $\therefore$ few ions and lower conductivity
☒B CO_2 only partially dissociates when dissolved $\therefore$ few ions and lower conductivity
☑C Na_2O fully dissociates $\therefore$ many ions and higher conductivity
☒D Al_2O_3 is insoluble in water $\therefore$ no ions dissolved and no conductivity</td></tr>
<tr><td>11</td><td>C</td><td>75</td><td>☒A Forward reaction decreases temp $\therefore$ high temp favours forward reaction
☒B Forward reaction increases pressure $\therefore$ low pressure favours forward reaction
☑C The forward reaction is favoured by high temperature and low pressure
☒D Forward reaction increases pressure $\therefore$ low pressure favours forward reaction</td></tr>
<tr><td>12</td><td>A</td><td>85</td><td><table><tr><td>Quantity</td><td>$[I_2]_{water}$</td><td>$[I_2]_{cyclohexane}$</td><td>Partition Coefficient</td></tr><tr><td>Effect of adding more iodine</td><td>More iodine dissolves in water giving increase in concentration of iodine in water</td><td>More iodine dissolves in cyclohexane giving increase in concentration of iodine in cyclohexane</td><td>Partition coefficient remains constant as the proportion of iodine in each layer remains the same.</td></tr></table></td></tr>
<tr><td>13</td><td>B</td><td>89</td><td><table><tr><td rowspan="2">Bronsted-Lowry Definition</td><td>Acid</td><td>Donates a proton/H^+
(forms the conjugate base)</td></tr><tr><td>Base</td><td>Accepts a proton/H^+
(forms the conjugate acid)</td></tr></table></td></tr>
<tr><td>14</td><td>A</td><td>70</td><td>Titration of strong acid and weak alkali gives salt with pH below 7
• Methyl orange changes colour in the pH range 4.2-6.3</td></tr>
<tr><td>15</td><td>D</td><td>49</td><td>☒A Reactants are ions and not elements in their natural state
☒B Reactants are ions and not elements in their natural state
☒C Natural state of Bromine Br_2 is a liquid not a gas
☑D Formation of 1 mole of a substance from elements in their natural state</td></tr>
<tr><td>16</td><td>A</td><td>56</td><td><table><tr><td>Enthalpy</td><td>Definition</td><td>Equation</td></tr><tr><td>Combustion</td><td>Burning 1 mole of a substance completely</td><td>$\underset{1mol}{H_2(g)} + \frac{1}{2}O_2(g) \longrightarrow H_2O(l)$</td></tr><tr><td>Formation</td><td>Formation of 1 mole of a substance from elements in their natural state</td><td>$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow \underset{1mol}{H_2O(l)}$</td></tr></table></td></tr>
<tr><td>17</td><td>D</td><td>60</td><td>☒A Bond enthalpies cannot be directly measured by experiment
☒B Enthalpy of formations are measured using other enthalpies and Hess's Law
☒C The enthalpy for turning gaseous ions into a solid cannot be directly measured
☑D The enthalpy change for dissolving 1 mol of KCl an me measured using $\Delta H=cm\Delta T$</td></tr>
<tr><td>18</td><td>B</td><td>74</td><td>☒A Step involves: Breaking 2x O-H bonds and forming 1x H-H bond
☑B Step involves: Breaking 2x O-H bonds $\therefore$ 2X represents breaking 2x O-H bond
☒C Step involves: Breaking 2x O-H bonds and forming 1x H-H bond
☒D Step involves: Breaking 2x O-H bonds but X represents breaking 1x O-H bond</td></tr>
<tr><td>19</td><td>C</td><td>76</td><td>☒A Enthalpy of formation: $Li_{(s)} + \frac{1}{2}Br_{2(l)} \longrightarrow LiBr_{(s)}$
☒B Enthalpy of solution: $LiBr_{(s)} \longrightarrow Li^+_{(aq)} + Br^-_{(aq)}$
☑C Enthalpy of hydration: $Li^+_{(g)} \longrightarrow Li^+_{(aq)}$ and $Br^-_{(g)} \longrightarrow Br^-_{(aq)}$
☒D Ionisation Energy: $Li_{(g)} \longrightarrow Li^+_{(g)} + e^-$ Electron Affinity: $Br_{(g)} + e^- \longrightarrow Br^-_{(g)}$</td></tr>
<tr><td>20</td><td>D</td><td>58</td><td>☒A ΔH_2 is enthalpy of atomisation of potassium = +88kJ mol^{-1}
☒B ΔH_3 is breaking $\frac{1}{2}$mole of Cl-Cl bonds = $\frac{1}{2}$x243kJ mol^{-1} = +121.5kJ mol^{-1}
☒C ΔH_4 is enthalpy of electron affinity of chlorine = -349kJ mol^{-1}
☑D ΔH_5 is enthalpy of 1^{st} ionisation of potassium = +419kJ mol^{-1}</td></tr>
<tr><td>21</td><td>D</td><td>76</td><td>☒A ΔH_3 is breaking $\frac{1}{2}$mole of Cl-Cl bonds and is always endothermic
☒B ΔH_4 is enthalpy of electron affinity of chlorine and usually exothermic
☒C ΔH_5 is enthalpy of 1^{st} ionisation of potassium and is always endothermic
☑D ΔH_6 is enthalpy of lattice formation and is always very exothermic</td></tr>
</table>

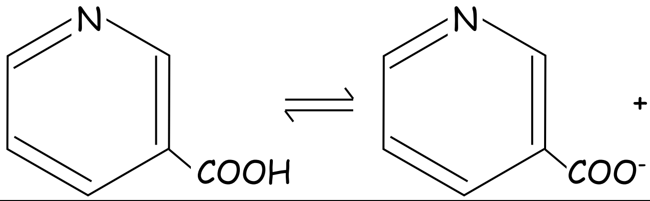
22	C	79	☒A ΔG^o must be negative for a reaction to be feasible ☒B ΔG^o must be negative for a reaction to be feasible ☑C ΔG^o must be negative and E^o must be positive for a reaction to be feasible ☒D E^o must be positive for a reaction to be feasible
23	C	83	☒A $Ni_{(s)}$ is oxidised: $Ni_{(s)} \longrightarrow Ni^{2+}_{(aq)} + 2e^-$ ☒B $Ni^{2+}_{(aq)}$ is a product in this reaction ☑C $Cu^{2+}_{(aq)}$ is reduced: $Cu^{2+}_{(aq)} + 2e^- \longrightarrow Cu_{(s)}$ ☒D $Cu_{(s)}$ is a product in this reaction
24	A	33	❶ $Fe^{3+} + e^- \rightarrow Fe^{2+}$ $E^o = +0.77V$ ❷ $I_2 + 2e^- \rightarrow 2I^-$ $E^o = +0.54V$ ❶x2 $2Fe^{3+} + 2e^- \rightarrow 2Fe^{2+}$ $E^o = +0.77V$ ❷x-1 $2I^- \rightarrow I_2 + 2e^-$ $E^o = -0.54V$ Add ❶'+❷' $2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$ $E^o = +0.23V$
25	C	77	☒A Elimination reactions have a molecule removed leaving behind a C=C double bond ☒B Addition reactions involve adding across a C=C double bond ☑C $C_2H_5O^-$ is a nucleophile and substitutes into the position of the chlorine atom ☒D Electrophilic substitution reactions usually take place on aromatic rings
26	D	75	☒A The propagation step is part of a chain reaction: $CH_3^\bullet + Cl_2 \longrightarrow CH_3Cl + Cl^\bullet$ ☒B The initiation step is homolytic fission: $Cl_2 \longrightarrow Cl^\bullet + Cl^\bullet$ ☒C Free Radical Formation is found in the initiation step: $Cl_2 \longrightarrow Cl^\bullet + Cl^\bullet$ ☑D There are no C=C double bonds for an addition reaction
27	C	75	☒A Ketones have low solubility due to lack of a –OH bond ☒B Aldehydes have low solubility due to lack of a –OH bond ☑C Shorter carboxylic acids have higher solubility than longer ones ☒D Longer carboxylic acids have lower solubility than shorter ones
28	B	87	☒A hybridisation is when s and p orbitals become equal in energy ☑B pi bond has side on overlap of parallel orbitals lying perpendicular to sigma bond ☒C sigma bond is the end on overlap of orbitals along the axis of the bond ☒D A double bond is a combination of a sigma bond and a pi bond
29	A	51	 
30	B	49	☒A Alkane with 15 carbons = $C_{15}H_{32}$ but 1 cyclo- ring makes formula $C_{15}H_{30}$ ☑B Alkane with 15 carbons = $C_{15}H_{32}$ but 2 cyclo- rings makes formula $C_{15}H_{28}$ ☒C 4 hydrogen atoms added to molecule across 2x C=C double bonds ☒D 4 hydrogen atoms added to molecule across 2x C=C double bonds

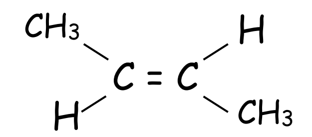
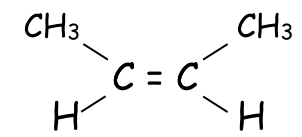
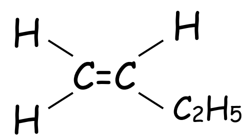
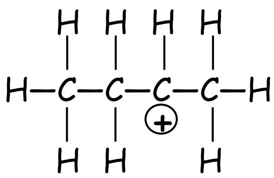
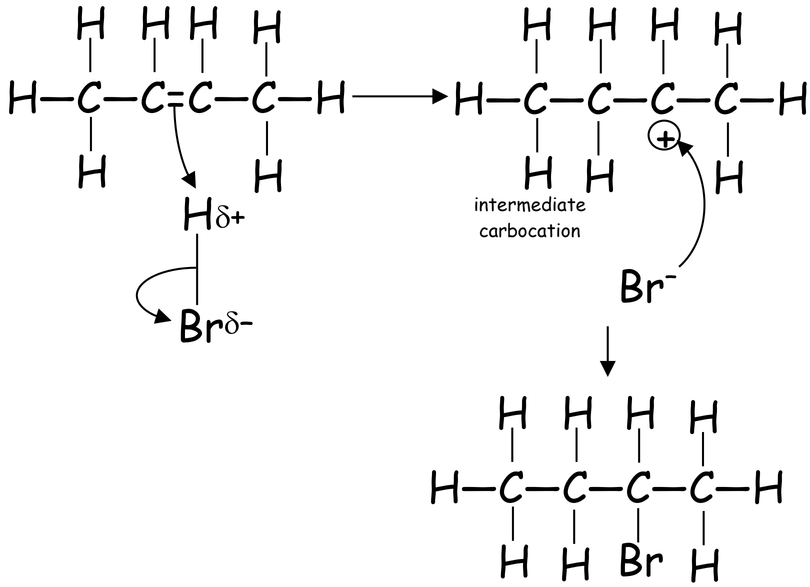
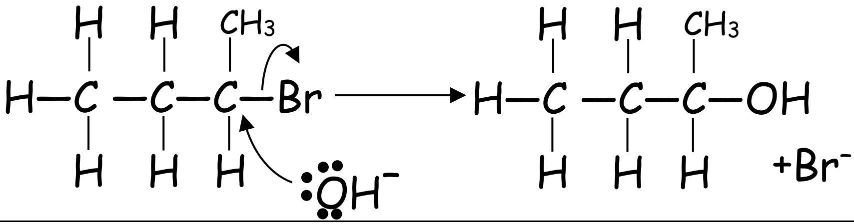
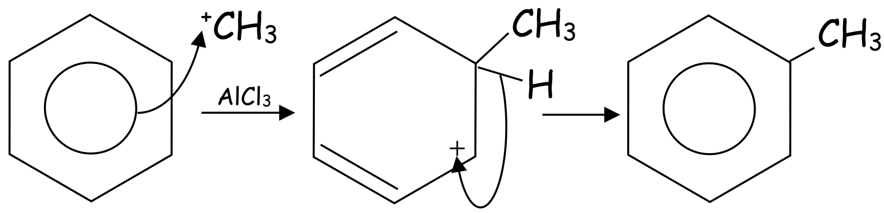
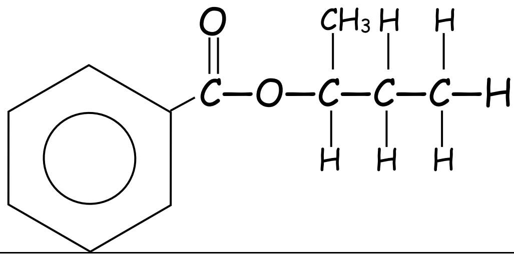
31	D	55	☒A Br_2 is not attracted to sites of positive charge ☒B CH_3I is more likely to react with a nucleophile in a substitution reaction ☒C NH_4^+ is more likely to be an electrophiles as it has a positive charge ☑D NH_3 has lone pair of electrons and is attracted to centres of positive charge
32	B	83	☒A CH_3I has no O-H, N-H or H-F bonds ☑B Methanol CH_3OH has an O-H bond and has hydrogen bonding between molecules ☒C CH_3OCH_3 has no O-H, N-H or H-F bonds ☒D CH_3CH_2CHO has no O-H, N-H or H-F bonds
33	A	58	☑A no –OH group or –COOH group to react with sodium metal ☒B bromine solution will react with C=C double bond ☒C Lithium Aluminium Hydride will reduce the –CHO aldehyde group ☒D Acidified Dichromate Solution will oxidise the –CHO aldehyde group
34	B	48	Step 1: $NH_{3(g)} + H_2O_{(l)} \longrightarrow NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$ Step 2: $NH_4^+{}_{(aq)} + OH^-{}_{(aq)} + CH_3COOH_{(l)} \longrightarrow CH_3COO^-NH_4^+{}_{(aq)} + H_2O_{(l)}$
35	D	70	☒A Molecule adding to $(CH_3)_2NH$ must have 4 carbons to make eramine with 6 carbons ☒B Molecule adding to $(CH_3)_2NH$ must have 4 carbons to make eramine with 6 carbons ☒C C=C is between C_2 and C_3 ∴C=O must be in middle of 4 carbons not on end. ☑D C=C is between C_2 and C_3 ∴C=O must be in middle of 4 carbons not on end.
36	A	69	☑A H_2SO_4/HNO_3 reacts with benzene to substitute on a nitro $–NO_2$ group ☒B H_2SO_4/HNO_3 reacts with benzene to substitute on a nitro $–NO_2$ not SO_2H group ☒C Benzene usually reacts by electrophilic substitution ☒D Benzene usually reacts by electrophilic substitution
37	C	64	☒A Benzene is a flat planar molecule ☒B Benzene has the formula C_6H_6 which simplifies to CH ☑C Benzene lacks C=C double bonds and will not decolourise bromine solution ☒D The bond lengths between carbons in benzene is equal
38	B	75	☒A C_3H_6 has two isomeric forms: cyclopropane and propene ☑B C_3H_8 is propane and only has one structure. ☒C C_3H_7Br has two isomeric forms: 1-bromopropane and 2-bromopropane ☒D $C_2H_4Cl_2$ has two isomeric forms: 1,1-dichloroethane and 1,2-dichloroethane
39	A	42	☑A The positively charged ions are deflected in a magnetic field to separate them ☒B The vacuum pump is designed to allow the flow are particles to be separated ☒C The ionisation chamber is to put a positive charge onto the particle to allow separation ☒D Electron Bombardment is the mechanism of charging the particles
40	C	88	IR adsorption at 2725cm^{-1} corresponds to C=O bond within an aldehyde -CHO group ☒A Propanone does not have an aldehyde –CHO group ☒B CH_2=$CHCH_2OH$ does not have an aldehyde –CHO group ☑C Propanal does have an aldehyde –CHO group ☒D CH_2=CH-O-CH_3 does not have an aldehyde –CHO group

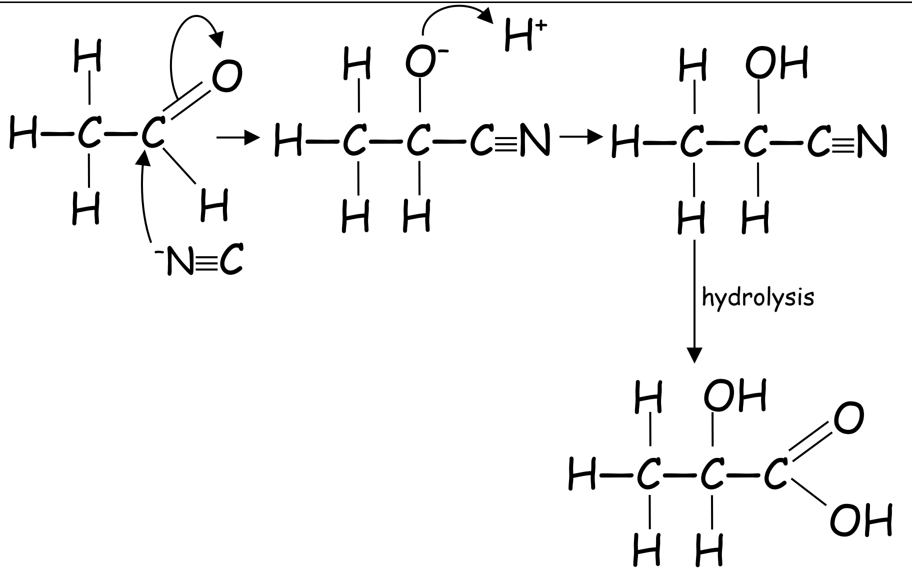
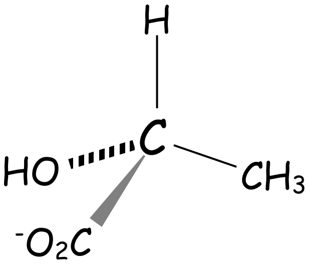
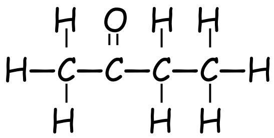
2010 Adv Higher Chemistry Marking Scheme

Long Qu	Answer	Reasoning
1a	748kJ mol^{-1}	$E= \frac{L \times h \times c}{\lambda} = \frac{6.02\times10^{23} mol^{-1} \times 6.63\times10^{-34} J\ s \times 3\times10^{8} m\ s^{-1}}{160\times10^{-9} m}$ $= 748361\ J\ mol^{-1}$ $= 748\ kJ\ mol^{-1}$
1b(i)	5	No. of electron pairs $= \frac{\text{no. of outer electrons in central atom + no. of bonds - charge}}{2}$ $= \frac{8+2-(0)}{2} = \frac{10}{2} = 5$ electron pairs (2 bonding + 3 lone pair)
1b(ii)	Trigonal bipyramidal	
2a	+3	Charge on Cr = charge on complex - charge on $(H_2O)_4$ - charge on $(Cl^-)_2$ = 1 - 0 - (-2) = 3
2b	Answer: Tetraaquadichlorochromium(III)	$\underbrace{\text{Tetraaqua}}_{4\times H_2O}\ \underbrace{\text{dichlorido}}_{2\times Cl^-}\ \underbrace{\text{chrom}}_{\text{metal}}\underbrace{\text{ium}}_{\text{+ve complex}}\ \underbrace{\text{(III)}}_{\text{complex charge}}$
2c	One from:	 or  or 
3a	-852kJ mol^{-1}	$\Delta H^o = \Sigma\Delta H_f^o{}_{(products)} - \Sigma\Delta H_f^o{}_{(reactants)}$ $= (2\times0) + (1\times-1676) - (2\times0) + (1\times-824)$ $= (0 - 1676) - (0 - 824)$ $= -1676 - (-824)$ $= -852\ kJ\ mol^{-1}$
3b	-38 J K^{-1} mol^{-1}	$\Delta S^o = \Sigma S^o{}_{(products)} - \Sigma S^o{}_{(reactants)}$ $= (2\times27.0) + (1\times51.0) - (2\times28.0) + (1\times87.0)$ $= (54.0 + 51.0) - (56.0 + 87.0)$ $= 105.0 - 143.0$ $= -38\ J\ K^{-1}\ mol^{-1}$
3c	-841 kJ mol^{-1}	$\Delta G^o = \Delta H^o - T\Delta S^o = -852 - (298\times \frac{-38}{1000}) = -852 - (-11.32) = -841\ kJ\ mol^{-1}$
4a(i)	One from:	Brown Fumes Fizzing Solution turning yellow NO_2 forming
4a(ii)	Oxidising agent	Oxidation Step: $Mn^{2+} + 4H_2O \rightarrow MnO_4^- + 8H^+ + 5e^-$ Potassium Periodate is an oxidising agent as it oxidises the Mn^{2+} ions

<table>
<tr><td>4a(iii)</td><td>Answer from:</td><td>Maximum absorbance of Permanganate is at 520nm
or Green is the complementary colour of Purple
or Maximum reading on meter</td></tr>
<tr><td>4b</td><td>0.40%</td><td>From Graph: Absorbance = 0.25 $\therefore$ Concentration of permanganate = 1.4×10^{-4} mol l^{-1}
no. of mol Mn^{2+} = volume x concentration = 0.1l x 1.4×10^{-4}mol l^{-1} = 1.4×10^{-5} mol
mass of Mn^{2+} = no of mol x gfm = 1.4×10^{-5} x 54.9 = 7.686×10^{-4}g
$\%Mn = \frac{\text{mass of } Mn^{2+}}{\text{mass of steel}} \times 100 = \frac{7.686\times10^{-4}}{0.19} \times 100 = 0.40\%$</td></tr>
<tr><td>5a</td><td>One from:</td><td>
or
</td></tr>
<tr><td>5b</td><td>b=0
c=-1
d=-1</td><td><table>
<tr><td>Atom</td><td>=</td><td>Periodic Table Group</td><td>-</td><td>No. of lone pairs</td><td>-</td><td>½x</td><td>No. of bonding electrons</td><td>=</td><td>Formal Charge</td></tr>
<tr><td>(a)</td><td>=</td><td>5</td><td>-</td><td>0</td><td>-</td><td></td><td>½x8</td><td>=</td><td>+1</td></tr>
<tr><td>(b)</td><td>=</td><td>6</td><td>-</td><td>2</td><td>-</td><td></td><td>½x8</td><td>=</td><td>0</td></tr>
<tr><td>(c)</td><td>=</td><td>6</td><td>-</td><td>3</td><td>-</td><td></td><td>½x8</td><td>=</td><td>-1</td></tr>
<tr><td>(d)</td><td>=</td><td>6</td><td>-</td><td>3</td><td>-</td><td></td><td>½x8</td><td>=</td><td>-1</td></tr>
</table></td></tr>
<tr><td>6a(i)</td><td>colourless to purple</td><td>$5C_2O_4^{2-} + 16H^+ + 2MnO_4^- \longrightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$
oxalate ion permanganate ion manganese ion
Permanganate ions are used up as they are titrated into oxalate solution.
$\therefore$ solution is therefore colourless to start with.
When oxalate ions are used up, permanganate ions remain and not used up
$\therefore$ solution turns purple.</td></tr>
<tr><td>6a(ii)</td><td>0.000825mol
or
8.25×10^{-4}mol</td><td>no of mol MnO_4^- = volume x concentration = 0.0165 litres x 0.0200mol l^{-1} = 0.00033mol
$5C_2O_4^{2-} + 16H^+ + 2MnO_4^- \longrightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$
5mol 2mol
5mol x $^{0.00033}/_2$ 0.00033mol
= 0.000825mol</td></tr>
<tr><td>6a(iii)</td><td>3.63g</td><td>1mol $C_2O_4^-$ = (2x12) + (4x16) = 24 + 64 = 88g
20cm^3 = 0.000825mol
1 litre = 1000cm^3 = 0.000825mol x $^{1000}/_{20}$ = 0.04125mol
mass = no of mol x gfm
= 0.04125mol x 88 g mol^{-1} = 3.63g</td></tr>
<tr><td>6a(iv)</td><td>0.8g</td><td>mass of Potassium = total mass – mass of hydrogen – mass of oxalate
= 4.49g - 0.060g - 3.63g
= 0.8g</td></tr>
<tr><td>6b</td><td>X=1
Y=3
Z=2</td><td><table>
<tr><td>Particle</td><td>K</td><td>H</td><td>C_2O_4</td></tr>
<tr><td>mass</td><td>0.8</td><td>0.060g</td><td>3.63g</td></tr>
<tr><td>No. of moles
(divide % by gfm)</td><td>$\frac{0.8}{39}$
= 0.020</td><td>$\frac{0.060}{1}$
= 0.060</td><td>$\frac{3.63}{88}$
= 0.041</td></tr>
<tr><td>Mole ratio
(divide through by smallest value)</td><td>$\frac{0.020}{0.020}$
= 1</td><td>$\frac{0.060}{0.020}$
= 3</td><td>$\frac{0.041}{0.020}$
= 2.05</td></tr>
<tr><td>Round to Whole Number</td><td>1</td><td>3</td><td>2</td></tr>
</table></td></tr>
<tr><td>7a</td><td>$CH_3COOH + CH_3CH_2OH$
↓
$CH_3COOCH_2CH_3 + H_2O$</td><td>$CH_3COOH + CH_3CH_2OH \longrightarrow CH_3COOCH_2CH_3 + H_2O$</td></tr>
</table>

7b(i)	System will not reach equilibrium	If reactants or products are allowed to escape then the system will never reach equilibrium.
7b(ii)	4.0	Ethanoic Acid Remaining at equilibrium = 0.24mol ∴ Ethanoic acid reacted = 0.70 – 0.24mol = 0.46mol $CH_3COOH + CH_3CH_2OH \longrightarrow CH_3COOCH_2CH_3 + H_2O$ 1mol, 1mol, 1mol, 1mol 0.46mol, 0.46mol, 0.46mol, 0.46mol ∴0.24mol remaining, ∴ 0.22mol remaining $K = \frac{[CH_3COOCH_2CH_3]\,[H_2O]}{[CH_3COOH]\,[CH_3CH_2OH]} = \frac{0.46 \times 0.46}{0.24 \times 0.22} = 4.0$
8a	Diagram Showing:	 + H^+
8b	0.0020 mol l^{-1}	$pK_a = -\log_{10}K_a = -\log_{10}(1.4\times10^{-5}) = -(-4.85) = 4.85$ $pH = \frac{1}{2}pK_a - \frac{1}{2}\log_{10} c$ $\frac{1}{2}\log_{10} c = \frac{1}{2}pK_a - pH$ $= (\frac{1}{2} \times 4.85) - 3.77$ $= 2.425 - 3.77$ $= -1.34$ $\log_{10} c = -2.68$ $c = 0.0020\text{mol } l^{-1}$
9a	Step 2 $NO_2 + F \rightarrow NO_2F$	Step 1 is the (slow) rate determining step as only the reactants of step 1 appear in the rate equation.
9b	$2NO_2 + F_2 \longrightarrow 2NO_2F$	❶ $NO_2 + F_2 \longrightarrow NO_2F + F$ ❷ $NO_2 + F \longrightarrow NO_2F$ add ❶+❷ $2NO_2 + F_2 \longrightarrow 2NO_2F$
9c	2nd order	Rate = $k\,[NO_2]\,[F_2] = k\,[NO_2]^1\,[F_2]^1$ Order of NO_2 = 1 and Order of F_2 = 1 ∴ overall order 1 + 1 = 2
9d	40 l mol^{-1} s^{-1}	$\text{rate} = k \times [NO_2]\,[F_2]$ $k = \frac{\text{rate}}{[NO_2]\,[F_2]}$ $= \frac{1.2\times10^{-4}\text{ mol } l^{-1} s^{-1}}{0.001\text{mol } l^{-1} \times 0.003\text{mol } l^{-1}}$ $= 40\ l\ mol^{-1}\ s^{-1}$
10a	One answer from:	To give a higher yield | To reduce side reactions | To prevent charring
10b	Sodium chloride solution or brine or salt water	PPA Technique Question
10c	To dry the cyclohexene	PPA Technique Question
10d	35%	cyclohexanol → cyclohexene + water 1mol, 1mol 100g, 82g 22.56g, 82g x $^{22.56}/_{100}$ = 18.5g (theoretical) $\%\text{yield} = \frac{\text{Actual}}{\text{Theoretical}} \times 100 = \frac{6.52g}{18.5g} \times 100 = 35\%$

11a	But-2-ene has two different groups attached across the $C{=}C$ double bond or But-1-ene has only 1 group around the $C{=}C$ double bond and 3 identical groups attached	*trans*-but-2-ene  *cis*-but-2-ene  But-2-ene has 2 geometric isomers because the $-CH_3$ methyl groups can be on either the same or opposite to the non-rotatory $C{=}C$ double bond but-1-ene  The $-C_2H_5$ ethyl group has not partner group to position around $C{=}C$
11b		
11c	Alkali solution or sodium hydroxide solution or potassium hydroxide solution	
11d	$AlCl_3$ or $FeCl_3$ or $FeBr_3$ or $AlBr_3$	CH_3Cl heterolytically splits into CH_3^+ and Cl^- with $AlCl_3$ catalyst  benzene methylbenzene
11e	Diagram showing	

<table>
<tr><td>12a</td><td>ethanal</td><td rowspan="3"></td></tr>
<tr><td>12b</td><td>cyanohydrin
or hydroxynitrile</td></tr>
<tr><td>12c</td><td>hydrolysis</td></tr>
<tr><td>12d(i)</td><td>Van Der Waals'</td><td>The hydrophobic region ($-CH_3$) is non-polar so this rules out hydrogen bonding, ionic bonding or permanent dipole polar attractions.</td></tr>
<tr><td>12d(ii)</td><td></td><td>Optical isomers are non-superimposable mirror images of each other.</td></tr>
<tr><td>12d(iii)</td><td>3 functional groups do not match up to the site on enzyme</td><td>The mirror image has all the same groups but the order is different in three dimensions (think about your fingers on your left and right hands)
The groups no longer fit the match up points in the enzyme/receptor.</td></tr>
<tr><td>13a</td><td>Alcohol and ether</td><td>Alkanols/Alcohols contain the hydroxyl –OH group
Ethers have alkyl groups either side of an oxygen atom e.g. CH_3-O-CH_3</td></tr>
<tr><td>13b(i)</td><td>Butanone
</td><td>
<table>
<tr><th>Peak</th><th>Chemical Shift (ppm)</th><th>Relative Area Under Peak</th><th>No of H in group</th><th>Chemical Group</th></tr>
<tr><td>1</td><td>0.95</td><td>3</td><td>3</td><td>$-CH_3$</td></tr>
<tr><td>2</td><td>2.05</td><td>3</td><td>3</td><td>CH_3-C=O</td></tr>
<tr><td>3</td><td>2.35</td><td>2</td><td>2</td><td>CH_2-C=O</td></tr>
</table>
</td></tr>
<tr><td>13b(ii)</td><td>butan-2-ol</td><td>If Compound B is butanone, them Compound A must be a secondary alkanol and therefore must be butanone</td></tr>
</table>