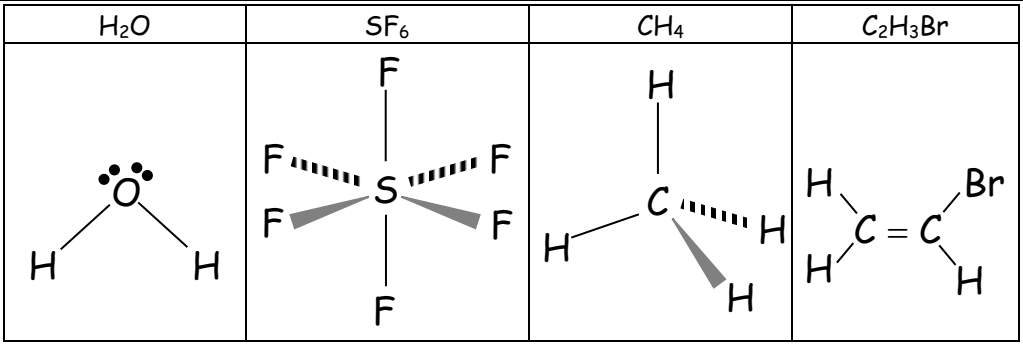
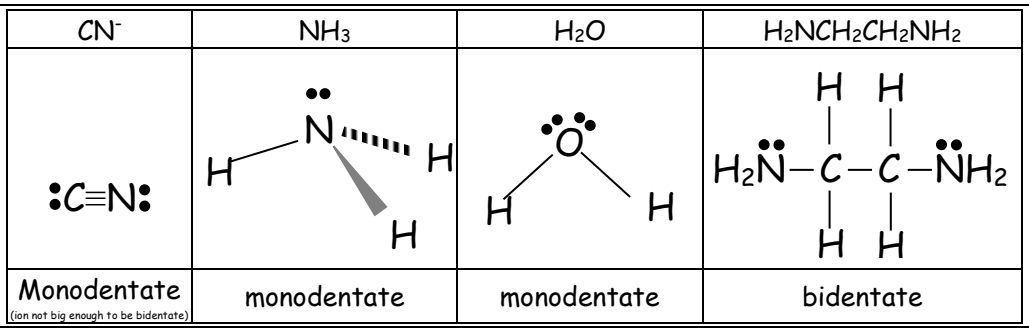
Past Papers Advanced Higher Chemistry

2012 Marking Scheme

Grade Awarded	Mark Required		% candidates achieving grade
	(/125)	%	
A	84+	67%	27.9%
B	71+	57%	25.8%
C	58+	46%	24.3%
D	51+	41%	9.9%
No award	<51	<41%	12.1%

Section:	Multiple Choice	Extended Answer	Investigation
Average Mark:	25.8 /40	30.9 /60	15.6 /25

2012 Adv Higher Chemistry Marking Scheme

MC Qu	Answer	% Pupils Correct	Reasoning
1	A	87	☑A Alpha radiation is a helium nucleus (not electromagnetic radiation spectrum) ☒B Gamma radiation is part of the EM spectrum (high frequency & low wavelength) ☒C Ultra-violet radiation is part of the electromagnetic radiation spectrum ☒D X-Rays are part of the electromagnetic radiation spectrum
2	D	46	If X^{3+} has 55 electrons, atoms of X would contain 58 electrons and have 58 protons ∴Element with atomic number 58 is Cerium ∴Cerium is a Lanthanide element and an f-block element
3	D	76	Co atoms have an electron configuration of $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^7\ 4s^2$ ∴ Co^{2+} ions have an electron configuration of $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^7$ ☒A $3d^7$ contains 3 unpaired electrons and 2 pairs of electrons ☒B Co^{2+} ions have 6 electrons in s-orbitals (NB $4s^2$ electrons have been removed) ☒C Co^{2+} ions have 15 electrons in 3rd shell ($3s^2\ 3p^6\ 3d^7$) ☑D 3d orbital is the highest energy level in Co^{2+} (NB $4s^2$ has been removed)
4	A	37	☑A More radiation travels through the solution is ion concentration decreases ☒B More radiation travels through the solution is ion concentration decreases ☒C Wavelength of transmitted radiation remains the same if ion is the same ☒D Wavelength of transmitted radiation remains the same if ion is the same
5	B	69	☒A neon discharge lamps do not absorb radiation ☑B emission of red end radiation would give a red colour ☒C emission of blue end radiation would give a blue colour ☒D neon discharge lamps do not absorb radiation
6	B	57	
7	D	46	
8	C	80	☒A equilibrium will shift to maintain the value of the equilibrium constant ☒B equilibrium will shift to maintain the value of the equilibrium constant ☑C adding a product sends equilibrium to left ∴increasing the concentration of PCl_5 ☒D removing a product sends equilibrium to right ∴decreasing the concentration of PCl_5
9	C	22	$K_s = [Ag^+_{(aq)}] \times [Cl^-_{(aq)}]$ but $[Ag^+_{(aq)}] = [Cl^-_{(aq)}]$ ∴ $K_s = [Ag^+_{(aq)}]^2 = 1.80\times10^{-10}$ ∴ $[Ag^+_{(aq)}] = 1.34\times10^{-5}$

10 A 30

$2NO_{2(g)} \rightleftharpoons 2NO_{(g)} + O_{2(g)}$

2mol (+6mol leftover) 2mol 1mol

$[NO_2] = 6mol\ l^{-1}$ $[NO] = 2mol\ l^{-1}$ $[O_2] = 1mol\ l^{-1}$

$$K = \frac{[NO]^2 \times [O_2]}{[NO_2]^2} = \frac{[2]^2 \times [1]}{[6]^2} = \frac{4x1}{36} = 0.11$$

11 C 49

☒A Weak acid: propanoic acid Salt: Sodium propanoate
☒B Benzene ring has a carboxyl -COOH group (weak acid) and salt group ($-COO^-Na^+$)
☑C Nitric acid HNO_3 is a strong acid and cannot be used in a buffer
☒D Weak Alkali: ammonium hydroxide (ammonia solution) Salt: Ammonium chloride

12 D 50

pH=2 ∴ $[H^+] = 1x10^{-2}\ mol\ l^{-1}$

no. of mol H^+ = volume x concentration = 0.25 litres x $1x10^{-2}\ mol\ l^{-1}$ = 0.0025mol

$$concentration = \frac{no.\ of\ mol}{volume} = \frac{0.0025\ mol}{0.005\ litres} = 5.0x10^{-1}\ mol\ l^{-1}$$

13 D 92

☒A suitable indicator as colour change (pH=3.1-4.4) takes place in vertical region
☒B suitable indicator as colour change (pH=5.2-6.8) takes place in vertical region
☒C suitable indicator as colour change (pH=6.0-7.6) takes place in vertical region
☑D Colour change of indicator (pH=8.3-10.0) takes place out with vertical region

14 B 74

❶	$C + O_2$	→	CO_2	$\Delta H^o = -396kJ\ mol^{-1}$
❷	$Pb + \frac{1}{2}O_2$	→	PbO	$\Delta H^o = -210kJ\ mol^{-1}$
❸	$PbO + CO$	→	$Pb + CO_2$	$\Delta H^o = -74kJ\ mol^{-1}$
❶	$C + O_2$	→	CO_2	$\Delta H^o = -396kJ$
❷x-1	PbO	→	$Pb + \frac{1}{2}O_2$	$\Delta H^o = +210kJ$
❸x-1	$Pb + CO_2$	→	$PbO + CO$	$\Delta H^o = +74kJ$
❶+❷'+❸'	$C + \frac{1}{2}O_2$	→	CO	$\Delta H^o = -112kJ\ mol^{-1}$

15 A 79

☑A Neutralisation is complete at $50cm^3$ and temperature will start to fall
☒B Neutralisation is an exothermic reaction as temperature rises (initially)
☒C Neutralisation is an exothermic reaction as temperature rises (initially)
☒D Neutralisation is complete at $50cm^3$ and temperature will stop rising

16 A 56

☑A Can only be calculated by Hess's Law calculation of other enthalpies
☒B enthalpy of combustion can be calculated in a calorimeter
☒C enthalpy of formation of CO_2 is same equation as enthalpy of combustion of C
☒D enthalpy of combustion can be calculated in a calorimeter

17 A 36

Enthalpy of formation of HCl: $\frac{1}{2}H_{2(g)} + \frac{1}{2}Cl_{2(g)} \longrightarrow HCl_{(g)}$

Bond Breaking Steps		Bond Forming Steps	
½mol H-H	½ x 432kJ = 216kJ	1mol H-Cl	428kJ
½mol Cl-Cl	½ x 243kJ = 121.5kJ		
	+337.5kJ		428kJ

∴ Enthalpy Change = +337.5kJ - 428kJ = $-90.5kJ\ mol^{-1}$

18 C 73

☒A Enthalpy of atomisation of $I_{2(s)}$ is a step in the formation of Rubidium Iodide
☒B Breaking I-I bond is a step in the formation of Rubidium Iodide
☑C Iodine atoms are ionised into negative ions as iodine is a non-metal
☒D Electron Affinity of Iodine atoms is a step in the formation of Rubidium Iodide

19 C 81

❶	2nd ionisation energy	$Cr^+_{(g)}$	→ $Cr^{2+}_{(g)} + e^-$	ΔH=+1600kJ	These figures are from the old data booklet
❷	3rd ionisation energy	$Cr^{2+}_{(g)}$	→ $Cr^{3+}_{(g)} + e^-$	ΔH=+3000kJ	
❶+❷		$Cr^+_{(g)}$	→ $Cr^{3+}_{(g)} + 2e^-$	ΔH=+4600kJ	

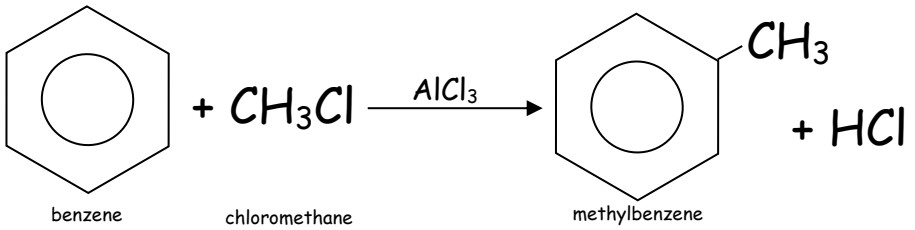
20 D 89

$$\Delta S_{vapourisation} = \frac{\Delta H_{vapourisation}}{T_b} \therefore T_b = \frac{\Delta H_{vapourisation}}{\Delta S_{vapourisation}} = \frac{40600J\ mol^{-1}}{88\ J\ K^{-1}\ mol^{-1}} = 461.3K$$

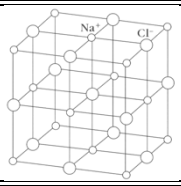
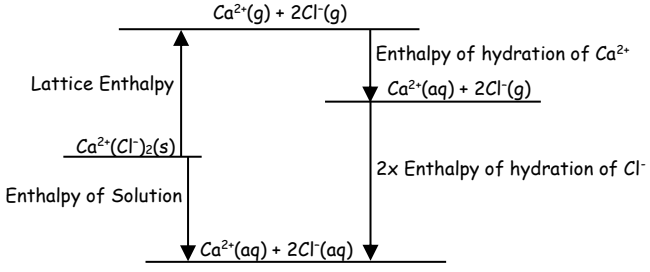
21 C 47

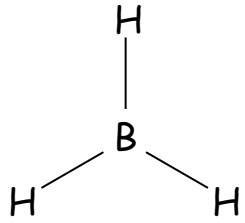
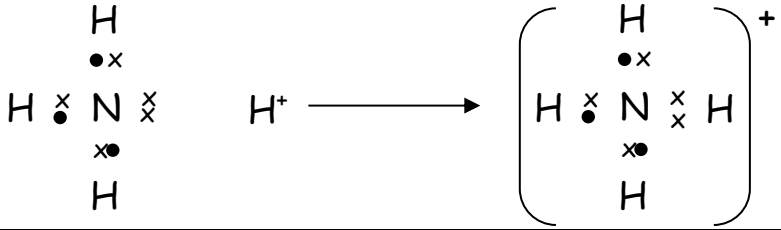
ΔH	ΔS
Condensation is an exothermic process as heat is given out as steam turns into water	Condensation decreases the entropy (disorder) as the steam particles become more ordered as they get closer together into water.

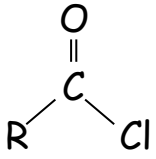
22	C	67	Value of G increases from 20 to 50 $\therefore \Delta G$= 50-20 = +30 kJ mol^{-1}
23	B	68	☒A addition reactions require C=C double bond ☑B elimination reaction: 2bromobutane becomes but-1-ene and but-2-ene ☒C oxidation involves an increase in the oxygen : hydrogen ratio ☒D potassium hydroxide in ethanol causes elimination reactions not substitution
24	D	86	☒A This step is an initiation step as free radicals are generated. ☒B This step is a termination step as free radicals join together. ☒C This step is a termination step as free radicals join together. ☑D This step is a propagation step as free radicals are on both sides of the arrow.
25	B	72	☒A Primary halogenalkane reacts by S_N2 mechanism (no carbocation formed) ☑B Tertiary halogenalkanes react by S_N1 mechanism forming carbocations ☒C Primary halogenalkanes react by S_N2 mechanism (no carbocation formed) ☒D Secondary halogenalkanes react by S_N2 mechanism (no carbocation formed)
26	A	72	☑A Carboxylic acids form dimers which explains higher boiling point ☒B No hydrogen bonding in an aldehyde (only permanent dipole to permanent dipole attractions) ☒C No hydrogen bonding in an ketone (only permanent dipole to permanent dipole attractions) ☒D Alcohols have hydrogen bonding but do not form dimers
27	C	66	☒A Insolubility in water is not essential for use in recrystallisation ☒B Low boiling points are not essential for use in recrystallisation. ☑C High solubility when hot and low solubility when cold is an essential property ☒D High solubility when hot and low solubility when cold is an essential property
28	D	78	☒A Addition of HBr into propene produces 1-bromopropane and 2-bromopropane ☒B Markovnikov's Rule: 1-bromopropane is the minor product ☒C Addition of HBr into propene produces 1-bromopropane and 2-bromopropane ☑D Markovnikov's Rule: 1-bromopropane is the major product
29	A	56	☑A sp hybridisation is found in C≡C triple bonds ☒B sp^2 hybridisation is found in C=C double bonds ☒C sp^3 hybridisation is found in C–C single bonds ☒D s^2p hybridisation is a made up answer for a fourth answer in the multiple choice
30	B	88	C=O double bond contains 1 sigma (σ) bond and 1 pi (π) bond CO_2 contains 2x C=O bonds $\therefore$ CO_2 contains 2 sigma (σ) bonds and 2 pi (π) bonds
31	B	20	<table><tr><th>P chlorobenzene</th><th>Q chloroethene</th><th>R 3-chloropropene</th></tr><tr><td>Chlorobenzene is planar as chlorine atom is in same plane as the flat benzene ring</td><td>Chlorine atom is in same plane as rest of ethene molecule</td><td>-CH_2Cl portion of molecule is in different plane to ethene portion of molecule</td></tr><tr><td>Planar</td><td>Planar</td><td>Non-planar</td></tr></table>
32	A	69	☑A Aldehydes/ketones react with 2,4-dinitrophenylhydrazone ☒B Alcohols do not react with 2,4-dinitrophenylhydrazone ☒C Carboxylic acids do not react with 2,4-dinitrophenylhydrazone ☒D Ethers do not react with 2,4-dinitrophenylhydrazone
33	B	92	☒A C_3H_8O is the formula of either an alcohol or an ether ☑B C_3H_6O can be the formula of an aldehyde or a ketone ☒C C_2H_4O is the formula of ethanal and is an aldehyde ☒D CH_2O is the formula of methanal and is an aldehyde
34	D	82	☒A Nitriles have high pK_a value and there is little dissociation. ☒B Aldehydes have a neutral pH ☒C Alcohols have a neutral pH ☑D Amines have an alkaline pH

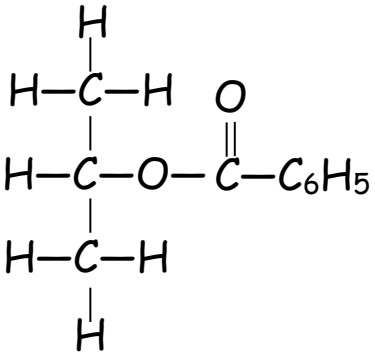
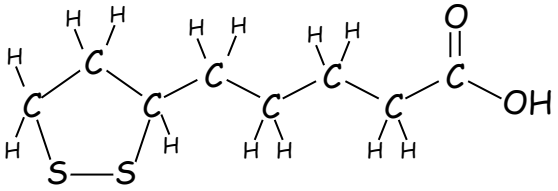
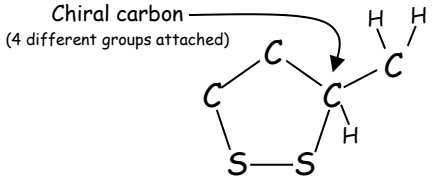
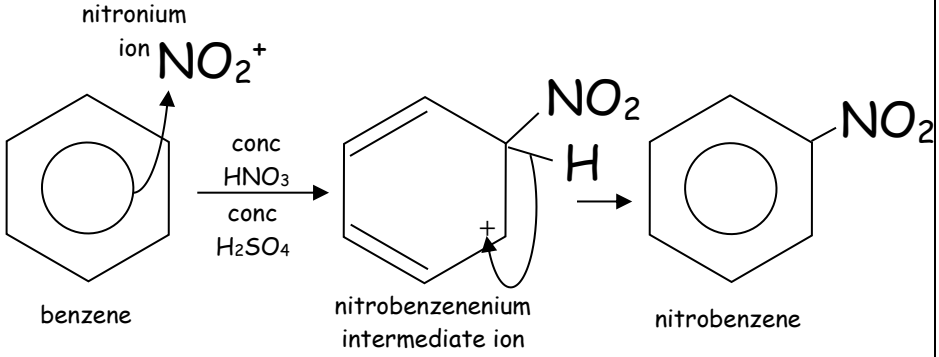
<table>
<tr><td>35</td><td>B</td><td>68</td><td> 
</td></tr>
<tr><td>36</td><td>B</td><td>50</td><td>☒A This type of isomerism is called optical isomerism or enantiomers
☑B Ring of carbons will secure geometric isomerism as would a C=C double bond
☒C for geometric isomerism, -CH3 groups are on opposite sides of the C=C bond
☒D C=C double required for geometric isomerism</td></tr>
<tr><td>37</td><td>D</td><td>20</td><td><table>
<tr><td>Element</td><td>C</td><td>H</td></tr>
<tr><td>%</td><td>82.7</td><td>17.3</td></tr>
<tr><td>No. of moles
(divide % by gfm)</td><td>82.7 / 12 = 6.89</td><td>17.3 / 1 = 17.3</td></tr>
<tr><td>Mole ratio
(divide through by smallest value)</td><td>6.89 / 6.89 = 1</td><td>17.3 / 6.89 = 2.51</td></tr>
<tr><td>Double and Round to Whole Number</td><td>2</td><td>5</td></tr>
</table></td></tr>
<tr><td>38</td><td>A</td><td>74</td><td>☑A Wavenumber: Number of waves per centimetre if measured in cm^{-1}
☒B Wavelength: The distance of one complete wave (e.g. peak to peak)
☒C Frequency: The number of waves per second
☒D Intensity: Amplitude (height from centre) of a wave</td></tr>
<tr><td>39</td><td>D</td><td>82</td><td>☒A Colorimetry: visible wavelengths being absorbed by coloured solution to determine conc.
☒B Mass Spectroscopy: Mass measured by the bending of charged particles in electric field
☒C Proton NMR: flipping of hydrogen nuclei in a strong magnetic field
☑D IR-spectroscopy: absorbed IR radiation of particular wavenumber vibrates particular bonds</td></tr>
<tr><td>40</td><td>D</td><td>94</td><td>☒A Agonists produce the biological response of the natural substrate
☒B A receptor binds to the drug/natural substrate
☒C Antagonists bind with the binding site of the receptor but do not produce the biological response
☑D Pharmacophore is the shape which fits the binding site of the receptor</td></tr>
</table>

2012 Adv Higher Chemistry Marking Scheme

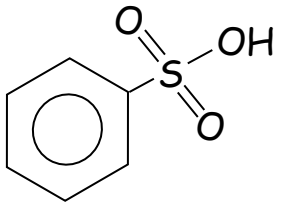
Long Qu	Answer	Reasoning
1a(i)	295.6	$E = \frac{L \times h \times c}{\lambda} = \frac{6.02\times10^{23}\,mol^{-1} \times 6.63\times10^{-34}\,J\,s \times 3\times10^{8}\,m\,s^{-1}}{405 \times 10^{-9}\,m}$ $= 295648.9\,J\,mol^{-1}$ $= 295.6\,kJ\,mol^{-1}$
1a(ii)	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}$	Ga atoms have electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^1$ Ga^{3+} ions have electronic configuration : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}$ as electrons will be lost from 4p then 4s subshells first.
1b	Photovoltaic effect	The photovoltaic effect is when a semiconductor produces a voltage when light is exposed to the semiconductor.
1c	Positive Holes	Silicon doped with group three elements like boron, aluminium or indium have positive holes because group three elements have three outer electrons and cannot make a fourth bond with the silicon leading to a positive hole which conducts the charge across the semiconductor.
2a(i)	+5	oxidation state of N in NO_3^-: N + (3x-2) = -1 ∴ N – 6 = -1 ∴ N = +5
2a(ii)	+3	oxidation state of N in HNO_2: 1 + N + (2x-2) = 0 ∴ 1+ N – 4 = 0 ∴ N = +3
2b	$2HNO_2 + 4H^+ + 4e^-$ ↓ $H_2N_2O_2 + 2H_2O$	$HNO_2 \rightarrow H_2N_2O_2$ $2HNO_2 \rightarrow H_2N_2O_2$ $2HNO_2 \rightarrow H_2N_2O_2 + 2H_2O$ $2HNO_2 + 4H^+ \rightarrow H_2N_2O_2 + 2H_2O$ $2HNO_2 + 4H^+ + 4e^- \rightarrow H_2N_2O_2 + 2H_2O$
2c	dicyanidocuprate(I)	**Dicyanidocuprate (I) = $[Cu(CN)_2]^-$** no. of ligands; cyanide ion ligand; metal name; negative complex; Charge on metal ion Neutral ligands include: Ligand / Name: H_2O aqua; NH_3 ammine; CO carbonyl Negative Ligands include: Ligand / Name: Chloride Cl^- chlorido; Cyanide CN^- cyanido; Nitrite NO_2^- nitrito Central Ion: Positive Complex: metals keep their name. Negative Complex: Metals end in ATE e.g. Cuprate, Ferrate, Cobaltate Charge: Charge of central ion is converted into roman numerals and put in brackets
3a	The radius ratio of the ions	Also acceptable: The relative radii of the ions / Relative ionic radii of the elements The relative size of the ions / Size of ionic radii in relation to each other
3b	Each sodium ion has 6 chloride ions surrounding it and vice versa	
3c	(potassium) fluoride	Ion: Cs^+ Cl^- K^+ F^- Ionic Radii (pm): 174 181 138 133 Ratio of radii: ∴ ratio = $^{174}/_{181}$ = 0.96; ∴ ratio = $^{138}/_{133}$ = 1.04
3d(i)	Lattice enthalpy Hydration enthalpy	

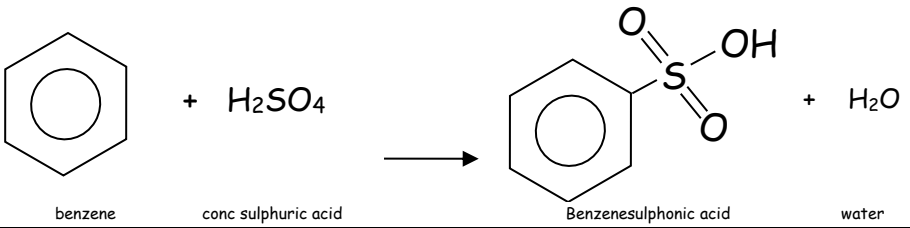
<table>
<tr><td>3d(ii)</td><td>Increase in disorder</td><td>$\Delta G^o = \Delta H - T\Delta S^o$ but $\Delta H = 0$ $\therefore$ $\Delta G^o = 0 - T\Delta S^o$
$\therefore$ ΔG^o will always be negative (feasible) if value of ΔS^o is positive.
Reactions were there is a increase in disorder have a positive ΔS^o</td></tr>
<tr><td>4a</td><td>Trigonal planar</td><td>  </td></tr>
<tr><td>4b</td><td>Both electrons in dative covalent bond provided by oxygen</td><td>  </td></tr>
<tr><td>4c</td><td>(cyclic) ethers</td><td>Ethers contain the functional group: C-O-C</td></tr>
<tr><td>5a</td><td>3.95g</td><td>Average volume of thiosulphate = $^{(15.20+15.30)}/_2$ = 15.25cm^3 = 0.01525litres
no. of mol $S_2O_3^{2-}$ = volume x concentration = 0.01525 x 0.102 = 1.56x10^{-3}mol
$I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$
1mol 2mol
7.80x10^{-4}mol 1.56x10^{-3}mol
$2Cu^{2+} + 4I^- \rightarrow 2CuI + I_2$
2mol 1mol
1.56x10^{-3}mol 7.80x10^{-4}mol
Mass Cu^{2+} in 25cm^3 solution = no of moles x gfm = 1.56x10^{-3} x 63.5 = 0.0988g
Mass of Cu^{2+} in 1litre solution = 0.0988g x $^{1000}/_{25}$ = 3.95g</td></tr>
<tr><td>5b</td><td>Answers from:</td><td>Use distilled/ deionised water.
Rinsings.
(Start with different samples from the key and) carry out replicates / duplicates.
Cover beaker with watch glass when key is being dissolved
Increase sample size for titration</td></tr>
<tr><td>5c</td><td>Answers from:</td><td>EDTA complexes with Cu (and Ni)
Other interfering metal ions
EDTA complexing with something else/impurities
Error in EDTA concentration</td></tr>
<tr><td>6a</td><td>Separation Funnel</td><td>Partition Co-efficient experiments are carried out in a separation funnel</td></tr>
<tr><td>6b</td><td>Accept
0·127 – 0·130/0·13</td><td>
<table>
<tr><th>Mass of Propanedioic acid (g)</th><th>$[X]_{hexane}$</th><th>$[X]_{water}$</th><th>$K = \frac{[X]_{hexane}}{[X]_{water}}$</th></tr>
<tr><td>0.31</td><td>0.031</td><td>0.24</td><td>0.129</td></tr>
<tr><td>0.44</td><td>0.038</td><td>0.30</td><td>0.127</td></tr>
<tr><td>0.61</td><td>0.048</td><td>0.37</td><td>0.130</td></tr>
</table>
</td></tr>
<tr><td>6c</td><td>Different temperature</td><td>Also acceptable:
One of the solutions may be saturated
System hadn't reached equilibrium (before separation)</td></tr>
<tr><td>6d</td><td>One Answer from:</td><td>Ethanol and water are miscible
or ethanol soluble in water
or two layers won't be formed</td></tr>
</table>

7a	0.575 mol l^{-1}	$pH = \frac{1}{2}pK_a - \frac{1}{2}\log c$ $2.5 = \frac{1}{2} \times 4.76 - \frac{1}{2}\log c$ $2.5 = 2.38 - \frac{1}{2}\log c$ $\frac{1}{2}\log c = 2.38 - 2.5$ $\frac{1}{2}\log c = -0.12$ $\log c = -0.24$ $c = 10^{-0.24}$ $= 0.575$
7b	Colour change hard to see in dark vinegar	Balsamic vinegar is a dark brown liquid (as stated in the stem of the question) and it might mask the colour change at neutralisation.
7c	CH_3COO^- or $C_2H_3O_2^-$	$HA_{(aq)}$ (acid) + $H_2O_{(l)}$ (base) $\rightleftharpoons$ $H_3O^+_{(aq)}$ (conjugate acid) + $A^-_{(aq)}$ (conjugate base) $CH_3COOH_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + CH_3COO^-_{(aq)}$
8a	Temperature below 2000°C	The upper line of a pair is the one which is reversed: At temperatures <u>below</u> 2000°C: $TiO_2 \rightarrow Ti + O_2$; $2Mg + O_2 \rightarrow 2MgO$ At temperatures <u>above</u> 2000°C: $Ti + O_2 \rightarrow TiO_2$; $2MgO \rightarrow 2Mg + O_2$
8b	One answer from:	Gradient of line is $-\Delta S$ or $2C+O_2 \rightarrow 2CO$ has increase in entropy or 1mole of gas makes two moles of gas or increase in disorder or ΔS is positive
8c	One answer from:	Boiling point of magnesium or Change of state or magnesium becomes a gas
9	1.45V	$\Delta G = -nFE^o \therefore E^o = -\frac{\Delta G}{nF} = -\frac{-279.8\times10^3}{2\times96500} = 1.45V$
10a	Zero or 0	Changing [A] does not alter the reaction rate i.e the gradient of the line $\therefore$ A is zero order as rate is constant regardless of concentration of A
10b	First or 1	At [B] = 0.003 mol l^{-1}, time = 30s and at [B] = 0.0015 mol l^{-1}, time = 60s $\therefore$ doubling [B] doubles the reaction rate $\therefore$ first order reaction
10c	s^{-1}	Rate = $k \times [A]^0 \times [B]^1 = k \times [B]$ Rate = k [B] $\therefore k = \frac{\text{Rate}}{[B]} = \frac{\text{mol } l^{-1} s^{-1}}{\text{mol } l^{-1}} = s^{-1}$
11a(i)	Hydrogen	Hydrides react with water to form hydroxide compounds and hydrogen gas
11a(ii)	Hydrogen chloride	$PCl_5 + H_2O \longrightarrow POCl_3 + 2HCl$
11b(i)	Acid Chlorides	Acids chloride have the structure: 

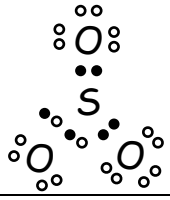
11b(ii)	Diagram showing:	
11b(iii)	One answer from:	<table><tr><td>faster reaction</td><td>more vigorous reaction</td><td>reacts more readily</td></tr><tr><td>greater yield</td><td>needs no catalyst</td><td>produces HCl which can be sold</td></tr><tr><td>no equilibrium reached</td><td>lower temperature</td><td>HCl produced not H_2O then no H_2O to hydrolyse ester</td></tr></table>
12a	$C_8H_{14}S_2O_2$ (Elements in any order)	 Each carbon makes four bonds and if there are no other atoms/groups indicated then the remaining bonds must be for H atoms.
12b(ii)	The carbon atom where the tail joins the ring	
12b(ii)	Four different atoms/groups attached to it	
13a	Answers from:	To prevent evaporation or reactants/products/chemicals escaping To reduce smell Idea of flammability of ethylbenzoate or ethanol
13b	(alkaline) hydrolysis Or hydrolysing	Ethyl benzoate is an ester ∴ hydrolysis of esters produces alcohols and carboxylic acids.
13c	Anti-bumping granules or few glass beads	Beads/granules prevent bumping of the chemicals in the refluxing process and this prevents chemicals jumping up reflux apparatus.
13d	Answers including:	<table><tr><td>Oily layer disappears</td><td>Goes clear</td><td>No more oily droplets</td></tr><tr><td>No longer two layers</td><td>Lack of film</td><td>Cloudy to colourless</td></tr></table>
13e	3.36g	$C_6H_5COOC_2H_5 + H_2O \longrightarrow C_6H_5COOH + HOC_2H_5$ 1mol 1mol 150g 122g 5.64g $122g \times {}^{5.64}/_{150}$ $= 4.59\ g$ 73.2% of 4.59g = $\frac{73.2}{100} \times 4.59g = 3.36g$
14a(i)	Electrophillic substitution	Nitronium ion formed by: $HNO_3 + H_2SO_4 \longrightarrow NO_2^+ + H_3O^+ + 2HSO_4^-$ 
14a(ii)	$C_6H_5NH_2$ or Aniline or Aminobenzene or phenylamine	Organic bases contain the Amino $-NH_2$ group where the nitro-NO_2 group is converted into the amino $-NH_2$ group by the tin/conc HCl mixture.

14b(i)



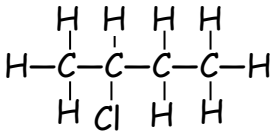


14b(ii)



Total of 24 electrons in diagram (electrons can be x, filled or unfilled circles)
8 electrons per atom

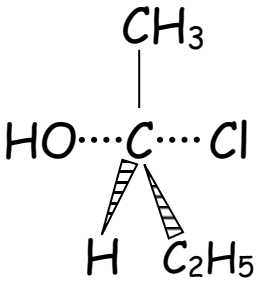
15a

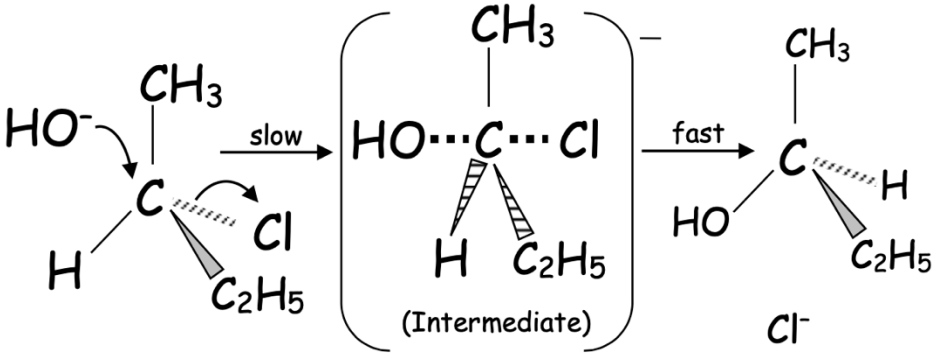


C_4H_9Cl will form a four carbon alcohol C_4H_9OH when heated with NaOH(aq).
Alcohol B must be the secondary alcohol butan-2-ol

- produces two alkenes on dehydration (but-2-ene and but-1-ene).
- If Alcohol B were a primary alcohol (e.g. butan-1-ol) there would only be one product on dehydration (e.g. but-1-ene).
- Alcohol B cannot be a tertiary alcohol (e.g. 2-methylpropan-2-ol) as it is oxidised by acidified potassium dichromate solution.

15b





15c

Graph showing:

Proton nmr spectrum in question must be for but-1-ene $CH_3{-}CH_2{-}CH{=}CH_2$ as it has 4 separate lines on proton nmr spectrum:

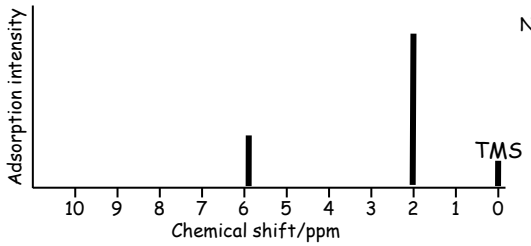
Group	$CH_3{-}$	$-CH_2-$	$-CH{=}C$	$C{=}CH_2$
Relative Intensity (Height on graph)	3xH ∴ 3	2xH ∴ 2	1xH ∴ 1	2xH ∴ 2
Chemical Shift Position	1ppm		5.9ppm	
Group as Listed in Data booklet	Alkyl $R{-}CH_3$		$-C{=}CH$	

Proton nmr spectrum for but-2-ene $CH_3{-}CH{=}CH{-}CH_3$ is:

Group	$CH_3{-}$	$-CH{=}C$	$C{=}CH-$	$-CH_3$
Relative Intensity (Height on graph)	3xH ∴ 3	1xH ∴ 1	1xH ∴ 1	3xH ∴ 3
Group as Listed in Data booklet	$CH_3{-}CH{=}CH$	$-C{=}CH$	$-C{=}CH$	$CH_3{-}CH{=}CH$
Chemical Shift Position	2ppm	5.9ppm	5.9ppm	2ppm

same peak

same peak



Notes:

1. 2ppm peak must be between 1-6-2.6
2. 2ppm peak 3x height of peak at 5.9
3. 5.9ppm peak must be between 4.5-6.0
4. TMS peak optional