Past Papers Advanced Higher Chemistry

Revised

2015 Marking Scheme

Grade Awarded	Mark Required		% candidates achieving grade
	(/125)	%	
A	89+	71.2%	32.5%
B	75+	60.0%	22.9%
C	62+	49.6%	21.7%
D	55+	44.0%	8.3%
No award	<55	<44.0%	11.8%

Section:	Multiple Choice	Extended Answer	Investigation
Average Mark:	29.4 /30	33.8 /70	15.0 /25

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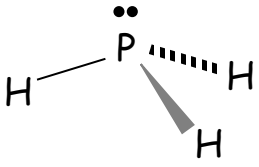
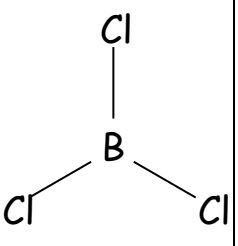
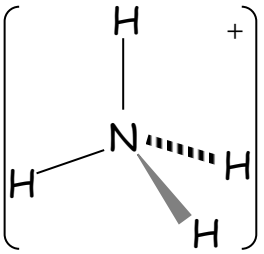
MC Qu	Answer	% Pupils Correct	Reasoning
1	C	80 oldAH=80	

EM Radiation	Gamma	X-ray	UV	Visible	Infrared	Microwave	Radio & TV
Velocity	$3x10^8 m\ s^{-1}$	$3x10^8 m\ s^{-1}$	$3x10^8 m\ s^{-1}$	$3x10^8 m\ s^{-1}$	$3x10^8 m\ s^{-1}$	$3x10^8 m\ s^{-1}$	$3x10^8 m\ s^{-1}$
Wavelength	short ←						→ Long
Frequency	high →						Low

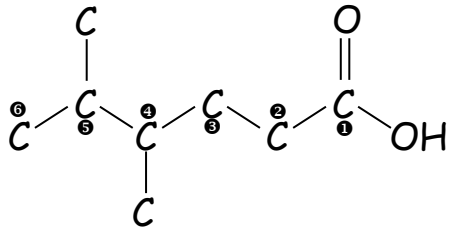
2	D	94 oldAH=91	☒A Each line is a particular wavelength of light from a particular energy difference ☒B Electrons moving up a level absorb energy not release energy ☒C The visible spectrum lies between the wavelengths 450nm – 700nm ☑D excited electrons dropping down release exact wavelengths as energy is released
3	D	94 oldAH=92	☒A Sr= $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s^2$ ∴ $Sr^{2+} = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$ ☒B Se= $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^4$ ∴ $Se^{2-} = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$ ☒C As= $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^3$ ∴ $As^{3-} = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$ ☑D Zr= $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^2 5s^2$ ∴ $Zr^{3+} = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^1$

				A	B	C	D
4	B	75		Co^{3+} $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$			
				Metals rarely form covalent bonds	pyramidal	trigonal	tetrahedral

5	B	77 oldAH=77	No. of electron pairs = $\frac{\text{no. of outer electrons in central atom + no. of bonds - charge}}{2}$ = $\frac{6+3-(+1)}{2}$ = $\frac{8}{2}$ = 4 electron pairs (3 bonding + 1 lone pair)
6	B	61 oldAH=55	Tetraamminedichlorocopper(II) = $[CuCl_2(NH_3)_4]$ no. of ligands — NH_3 ligand — no. of ligands — Cl^- ligand — metal name — Charge on metal ion

Neutral ligands include:		Negative Ligands include:		Central Ion:	Charge:
Ligand	Name	Ligand	Name	Positive Complex: metals keep their name Negative Complex: Metals end in ATE e.g. Cuprate, Ferrate, Cobaltate	Charge of central ion is converted into roman numerals and put in brackets
OH_2	aqua	Chloride Cl^-	chlorido		
NH_3	ammine	Cyanide CN^-	cyanido		
CO	carbonyl	Nitrite NO_2^-	nitrito		

7	C	66	☒A O^{2-} ion has 4 pairs of electrons and can act as a ligand ☒B both N atoms have lone pairs of electrons and can act as a ligand ☑C the lone pair on the N atom has been used up in the dative covalent bond of $-NH_3^+$ ☒D The oxygen atoms have lone pairs of electrons and can act as a ligand
8	C	65	Complex is $[Co(NH_3)_4(OH_2)_2]^{3+}$ and is balanced in charge by three Cl^- ions $4xNH_3$ ligands and $2xOH_2$ ligands give co-ordination number of 6 with central Co^{3+} ion.
9	A	62	☑A Zn^{2+} ions still have a complete d-subshell and form colourless solutions ☒B Ni^{2+} ions have an incomplete d-subshell and give solutions with a green colour ☒C oxidation number of Cr in CrO_4 is VI and gives solutions with yellow colour ☒D Co^{2+} ions have an incomplete d-subshell and give solutions with a red colour
10	C	57	Bond order = ½(number of bonding electrons) - number of anti-bonding electrons Bond order = ½(12) - 4 Bond order = 2

11	C	82	
12	B	91 oldAH=89	☒A Carbon only has 3 different groups attached to the central carbon ☑B Carbon only has 4 different groups attached to the central carbon ☒C Carbon only has 3 different groups attached to the central carbon ☒D Carbon only has 3 different groups attached to the central carbon
13	A	83	☑A C-Cl is already polar and the Cl^- ion forms by heterolytic fission ☒B Cl is more electronegative than C is will form Cl^- ion not Cl^+ ion ☒C bond in C-CH_3 is very unlikely to split as it is a non-polar hydrocarbon group ☒D free radicals with unpaired electrons are formed by homolytic fission
14	A	79 oldAH=68	☑A KOH in ethanol performs an elimination reaction as HBr is eliminated from C_3H_7Br ☒B CN^- ions swaps with Br in a nucleophilic substitution reaction ☒C $C_2H_5O^-$ ions swaps with Cl in a nucleophilic substitution reaction ☒D OH^- ions swaps with Br in a nucleophilic substitution reaction
15	A	48	sodium + ethanol ⟶ sodium ethoxide + hydrogen $2Na + 2C_2H_5OH \longrightarrow 2Na^+C_2H_5O^- + H_2$
16	B	83	Reaction shown: ketone ⟶ secondary alcohol • Ketone becoming a secondary alcohol is a reduction reaction • $LiAlH_4$ (lithium aluminium hydride) is a reducing agent
17	D	52 oldAH=61	☒A C_6H_5OH will react with alkalis but not acids ☒B $C_6H_5NH_2$ will react with acids but not alkalis ☒C HOC_6H_4COOH will react with alkalis but not acids ☑D $H_2NC_6H_4COOH$ will react with both acids and alkalis
18	A	60	☑A orange β-carotene has a shorter wavelength and higher energy gap than red light ☒B red lycopene has a longer wavelength and lower energy gap than orange light. ☒C if the energy gap was the same then the colour would be the same ☒D the energy gap corresponds to the particular wavelength absorbed to promote e^-
19	C	60	☒A peak δ=3→4 corresponds to O in alcohol/ether. Propanal lacks this chemical group ☒B peak δ=3→4 corresponds to O in alcohol/ether. Propanal lacks this chemical group ☑C peak δ=3→4 corresponds to O in alcohol/ether. Propan-1-ol has this chemical group ☒D peak δ=3→4 corresponds to O in alcohol/ether. Propanal lacks this chemical group
20	C	53	☒A formed from strong acid (HCl) and strong alkali (KOH) ∴ salt pH=7 ☒B formed from weak acid (CH_3COOH) and strong alkali (KOH) ∴ salt pH>7 ☑C formed from strong acid (HCl) and weak alkali (NH_4OH) ∴ salt pH<7 ☒D formed from weak acid (CH_3COOH) and weak alkali (NH_4OH) ∴ salt pH nearer 7
21	B	75 oldAH=77	☒A buffer: salt of a weak acid (sodium borate) dissolved in a weak acid (boric acid) ☑B buffers need a weak acid but nitric acid is a strong acid ☒C buffer: salt of a weak acid (sodium benzoate) dissolved in a weak acid (benzoic acid) ☒D buffer: salt of a weak acid (sodium propanoate) dissolved in a weak acid (propanoic acid)
22	A	79 oldAH=75	At absolute zero temperature (0K) crystals have perfect order and an entropy value of zero J K^{-1} mol^{-1}
23	A	85 oldAH=89	☑A line never crosses zero into positive and ΔG is always negative ∴ reaction always feasible ☒B when line crosses into positive ΔG value, reaction is not thermodynamically feasible ☒C when line has positive ΔG value, reaction is not thermodynamically feasible ☒D when line has positive ΔG value, reaction is not thermodynamically feasible

24 **B** **75** oldAH=77

$$K = \frac{[SO_3]^2}{[SO_2]^2 \times [O_2]^1} = \frac{16^2}{0.2^2 \times 0.2} = \frac{256}{0.04 \times 0.2} = \frac{256}{0.008} = 32000$$

☒A products are formed ∴ thermodynamically feasible ∴ ΔG must be less than zero
☑B $K > 1$ (much more products than reactants) and $\Delta G < 0$ (products formed ∴ must be feasible)
☒C products are formed ∴ thermodynamically feasible ∴ ΔG must be less than zero
☒D much more products in equilibrium mixture than reactants ∴ K greater than 1

25 **D** **78**

$$20^oC \xrightarrow{x2} 30^oC \xrightarrow{x2} 40^oC \xrightarrow{x2} 50^oC \xrightarrow{x2} 60^oC$$

∴ Rate increase = x2 x2 x2 x2 = x16

26 **A** **72** oldAH=71

Slow step is the rate determining step: $(CH_3)_3CBr \rightarrow (CH_3)_3C^+ + Br^-$
Slow step has only one reactant $(CH_3)_3CBr$ ∴ $(CH_3)_3CBr$ is 1st order and OH^- is zero order
∴ Rate = $k \times [(CH_3)_3CBr]^1 \times [OH^-]^0 = k\,[(CH_3)_3CBr]$

27 **B** **57**

Primary standards should:

have high molecular mass	not absorb moisture from atmosphere	be readily soluble in water	have a high degree of purity

Sodium hydroxide absorbs moisture from the atmosphere which increases its mass.

28 **D** **82**

☒A measuring cylinders are not accurate enough for this purpose
☒B 1:10 dilution cannot be accurately performed with $10cm^3$ pipette and $50cm^3$ flask
☒C measuring cylinders are not accurate enough for this purpose
☑D $25cm^3$ pipette and $250cm^3$ standard flask are need for a 1:10 dilution

29 **D** **15**

☒A The material of the stationary phase will directly affect the distances travelled
☒B The polarity of the component will effect the distances travelled
☒C The chemicals in the mobile phase will effect the distances travelled
☑D Distance moved by solvent front has no effect on the value of R_f. The equation divides the distance moved by the spot by the distance moved by the solvent front

30 **D** **65**

barium ions	+	sodium sulphate	⟶	barium sulpate	+	sodium ions
Ba^{2+}	+	Na_2SO_4	⟶	$BaSO_4$	+	$2Na^+$
1mol				1mol		
137.3g				233.4g		
137.3g x $^{0.513}/_{233.4}$				0.513g		
= 0.302g						

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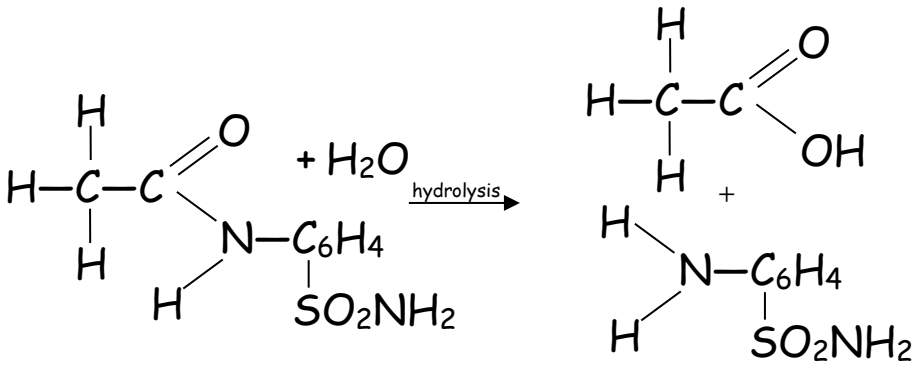
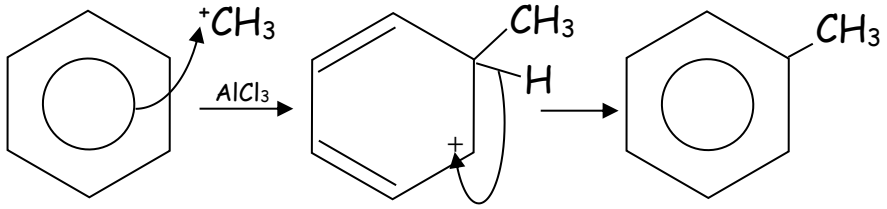
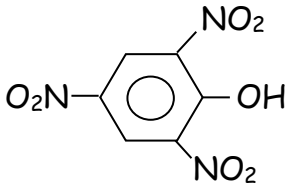
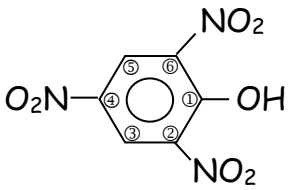
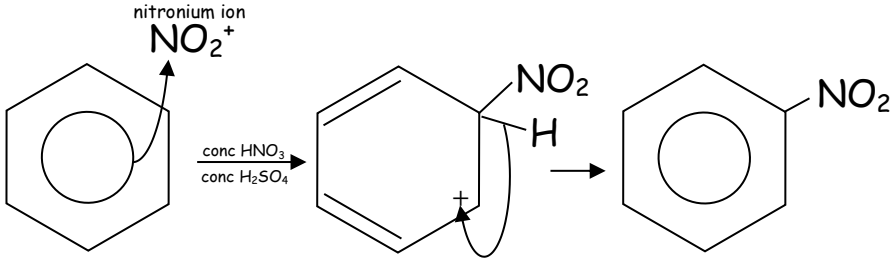
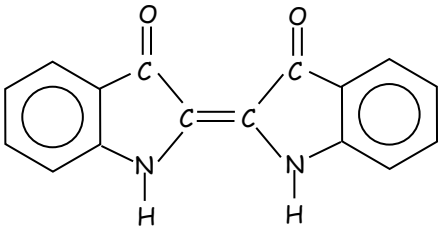
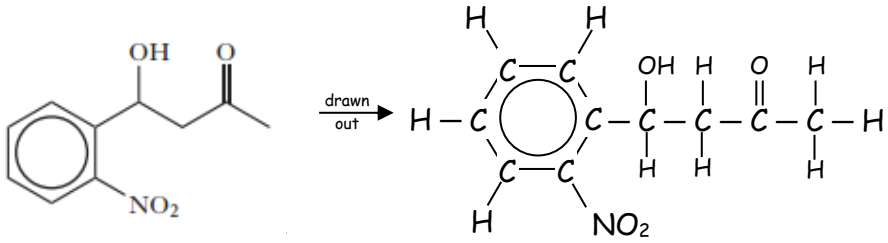
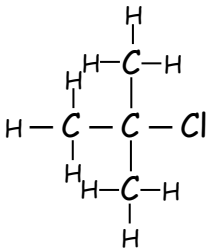
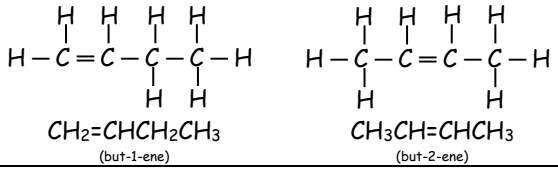
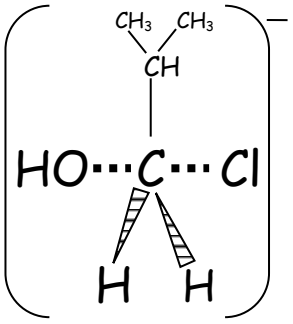
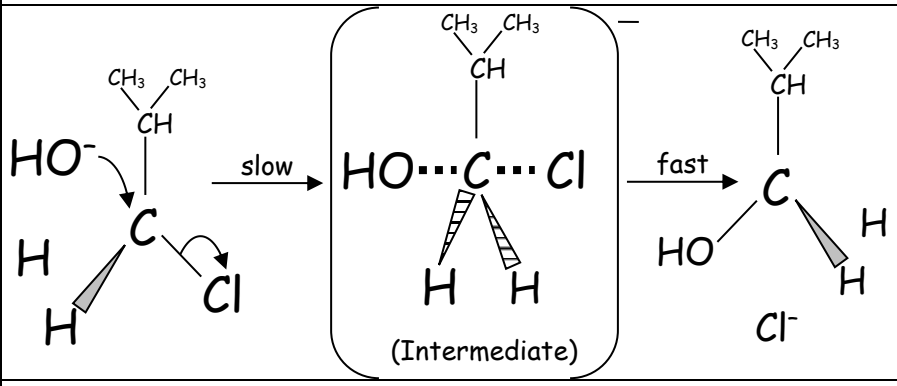
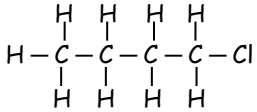
Long Qu	Answer	Reasoning
1a(i)	Equal/same energy	Degenerate means the orbitals are of equal energy.
1a(ii)	Any correct statement of Hund's Rules	Each orbital should be filled singly before a second electron fills each orbital.
1a(iii)	n = 3, l = 0, m = 0, s = $+\frac{1}{2}$ or $-\frac{1}{2}$	Quantum Number: Arrangement of electrons Principal (n): Shell 1st–4th → n = 1–4 Angular Momentum (l): s = 0, p = 1, d = 2, f = 3 Magnetic (m): s: 0; p: 1: -1,0,+1; d: 2: -2,-1,0,+1,+2; f: 3: 3,-2,-1,0,+1,+2,+3 Spin (s): Electron Spin Direction ↑ $+\frac{1}{2}$, ↓ $-\frac{1}{2}$
1b(i)	239nm or 2.39×10^{-7}m	$E = \frac{L \times h \times c}{\lambda} \therefore \lambda = \frac{L \times h \times c}{E} = \frac{6.02\times10^{23}\text{mol}^{-1} \times 6.63\times10^{-34}\text{ J s} \times 3\times10^{8}\text{ m s}^{-1}}{502 \times 1000\text{ J mol}^{-1}}$ $= 2.39 \times 10^{-7}$ m = 239nm
1b(ii)	No Light wavelengths longer than 239nm	Colour: Red 640-700; Orange 600-640; Yellow 560-600; Green 480-560; Blue 450-480; Violet 400-450 (Wavelength (nm)) EM radiation of 239nm has energy greater than visible light from 400nm-700nm. Visible light lacks enough energy to ionise gaseous sodium atoms
2a	194 kJ mol^{-1}	$\Delta H^\circ = \Sigma\Delta H_f^\circ(\text{products}) - \Sigma\Delta H_f^\circ(\text{reactants})$ $= (1x+130) + (1x-394) - (1x-348)+(1x-110)$ $= +130 - 394 - (-348 - 110)$ $= -264 - (-458)$ $= +194$ kJ mol^{-1}
2b	133 J K^{-1} mol^{-1}	$\Delta S^\circ = \Sigma S^\circ(\text{products}) - \Sigma S^\circ(\text{reactants})$ $= (1x161) + (1x214) - (1x44)+(1x198)$ $= 161 + 214 - (44 + 198)$ $= 375 - 242$ $= +133$ J K^{-1} mol^{-1}
2c	1459 K	The reaction becomes thermodynamically feasible when $\Delta G^\circ = 0$ $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ = 0 \therefore T\Delta S^\circ = \Delta H^\circ \therefore T = \frac{\Delta H^\circ}{\Delta S^\circ} = \frac{+194 \times 1000\text{ J mol}^{-1}}{+133\text{ J K}^{-1}\text{ mol}^{-1}} = 1458.6\text{K}$
3a	Excess reagent is added to analyte. The excess reagent is titrated with 2nd reagent to work out how much reacted with analyte	A known quantity of either an acid or base is reacted with an unknown quantity of some chemical. How much is left over acid or base remaining can be determined via titration and so how much of it reacted with the other chemical can be worked out to determine the chemical's concentration.
3b(i)	4.325×10^{-4}	Average titre = $\frac{8.7 + 8.6}{2} = \frac{17.3}{2} = 8.65\text{cm}^3$ no. of mol H_2SO_4 = volume x concentration = 0.00865 litres x 0.05 mol l^{-1} = 4.325×10^{-4} mol
3b(ii)	0.00865	$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$ 2mol : 1mol 8.65×10^{-4} mol : 4.325×10^{-4} mol 25cm³ sample contained 8.65×10^{-4} mol NaOH 250cm³ flask contained 8.65×10^{-3} mol NaOH
3b(iii)	0.01635	Total no. of mol NaOH = volume x concentration = 0.025litres x 1.00mol l^{-1} = 0.025mol NaOH reacted = total NaOH – excess NaOH = 0.025mol – 0.00865mol = 0.01635mol
3b(iv)	0.2943g	$2NaOH + C_9H_8O_4 \longrightarrow C_7H_5O_3Na + CH_3COONa + H_2O$ 2mol : 1mol 0.01635mol : 0.008175mol 1mol $C_9H_8O_4$ = (9x12)+(8x1)+(4x16) = 106+8+64 = 180g mass of aspirin in 5 tablets = no of mol x gfm = 0.008175 x 180 = 1.4715g mass of aspirin in 1 tablet = $^{1.4715g}/_{5}$ =0.2943g

3c	Answer to include:	Repeat the experiment with pure/analar acetylsalicylic acid Use known quantity of aspirin
4a	hydrolysis or acid hydrolysis	
4b	One answer from:	To purify (the sulphanilamide) | To get rid of impurities | To make purer
4c	65%	1mol $C_8H_{10}N_2SO_3$ = (8x12)+(10x1)+(2x14)+(1x32.1)+(3x16) = 96+10+28+32.1+48 = 214.1g 1mol $C_6H_8N_2SO_2$ = (6x12)+(8x1)+(2x14)+(1x32.1)+(2x16) = 72+8+28+32.1+32 = 172.1g $C_8H_{10}N_2SO_3 + H_2O \longrightarrow C_6H_8N_2SO_2 + CH_3COOH$ 1mol 1mol 1mol 1mol 214.1g 172.1g 4.282g 172.1g x $^{4.282}/_{214.1}$ = 3.442g % Yield = $\frac{\text{Actual}}{\text{Theoretical}}$ x100 = $\frac{2.237g}{3.442g}$ x100 = 65%
4d	Answer to include:	The sample is mixed with pure sulfanilamide. If melting point of the mixture will be the same as pure sulfanilamide if sample is pure.
4e	One from:	Thin layer chromatography (TLC) | Infrared Spectroscopy | Proton NMR
5a	4 or IV	VO^{2+}: Vanadium oxide no. + (-2) = +2 ∴ vanadium oxide no. = +2 – (-2) = +4
5b	Green colour from mixture of blue and yellow	During the reaction there will be a mixture of yellow VO_2^+ ions and blue VO^{2+} ions. For a short period the yellow and blue colours mix together
5c	3	V = $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^2$ ∴ V^{2+}= $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3$
5d	Vanadium ions oxidised/ reacts with oxygen	When the stopper is removed , oxygen enters flask and reacts with vanadium ions to form blue VO^{2+} by an oxidation reaction (oxidation number increases 2→4)
6a(i)	0.36	$N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$ 1mol 2mol 0.12mol 0.24mol ∴ no of mol of N_2O_4 at equilibrium = 0.28mol – 0.12mol = 0.16mol $K = \frac{[NO_2]^2}{[N_2O_4]} = \frac{(0.24)^2}{0.16} = \frac{0.0576}{0.16} = 0.36$
6a(ii)	Forward reaction is endothermic as decreasing temperature favours reverse reaction	Decreasing temperature favours the reverse reaction. At 127°C, K=0.36 and at 25°C, K=0.12 ∴ as temperature decreases K decrease ∴ value of K decreases when [products] decreases and [reactants] increases ∴ reverse reaction is favoured
6b(i)	x = $7.40x10^{-4}$ y = $2.96x10^{-3}$	From equation: rate = $k[NO]^2$ 2nd order with respect to NO zero order with respect to H_2 Compare ❶+❷: $[H_2]$x2 but H_2 is zero order ∴no change of rate ∴ x =$7.40x10^{-4}$ Compare ❷+❸: [NO]x2 but NO is 2nd order ∴ rate quadruples ∴ y =$7.40x10^{-4}$ x4 = $2.96x10^{-3}$
6b(ii)	185 l mol^{-1} s^{-1}	Rate = $k[NO]^2$ ∴ k = $\frac{\text{Rate}}{[NO]^2} = \frac{7.40x10^{-4}\ mol\ l^{-1}\ s^{-1}}{(2.00x10^{-3}\ mol\ l^{-1})^2} = \frac{7.40x10^{-4}\ mol\ l^{-1}\ s^{-1}}{4.00x10^{-6}\ mol^2\ l^{-2}}$ = 185 l mol^{-1} s^{-1}

<table>
<tr><td>7</td><td>Open Question
Answer to Include:</td><td>
<table>
<tr><th>3 mark answer</th><th>2 mark answer</th><th>1 mark answer</th></tr>
<tr><td>Demonstrates a <u>good</u> understanding of the chemistry involved. A good comprehension of the chemistry has provided in a logically correct, including a statement of the principles involved and the application of these to respond to the problem.</td><td>Demonstrates a <u>reasonable</u> understanding of the chemistry involved, making some statement(s) which are relevant to the situation, showing that the problem is understood.</td><td>Demonstrates a <u>limited</u> understanding of the chemistry involved. The candidate has made some statement(s) which are relevant to the situation, showing that at least a little of the chemistry within the problem is understood.</td></tr>
</table>
</td></tr>
<tr><td>8a</td><td>sp^2</td><td>The carbon atoms is a benzene ring have sp^2 hybridisation and the electron in the 4th unhybridised p–orbital becomes part of the delocalised ring of 6 π electrons</td></tr>
<tr><td>8b(i)</td><td>CH_3Cl and $AlCl_3$</td><td>Combination from:
<table>
<tr><td>Reactant</td><td colspan="2">Chloromethane CH_3Cl</td><td colspan="2">Bromomethane CH_3Br</td></tr>
<tr><td>Catalyst</td><td>$FeCl_3$</td><td>$AlCl_3$</td><td>$FeBr_3$</td><td>$AlBr_3$</td></tr>
</table>
</td></tr>
<tr><td>8b(ii)</td><td>Electrophilic substitution</td><td>CH_3Cl heterolytically splits into CH_3^+ and Cl^- with $AlCl_3$ catalyst
 

benzene methylbenzene</td></tr>
<tr><td>8c(i)</td><td> 
</td><td>-OH group is carbon number 1 in benzene ring
-NO_2 nitro groups then placed on carbons 2,4 and 6
 
</td></tr>
<tr><td>8c(ii)</td><td>NO_2^+</td><td>Nitronium ion formed by: $HNO_3 + H_2SO_4 \longrightarrow NO_2^+ + H_3O^+ + 2HSO_4^-$
 

benzene nitrobenzenenium intermediate ion nitrobenzene</td></tr>
<tr><td>9a</td><td>Alternating single and double bonds or conjugated system</td><td>A conjugated system is a section of a molecule with alternating single and double bonds between carbon atoms. The system of Pi bonds can absorb light in the visible region leaving the remaining wavelengths as the colour viewed from outside.</td></tr>
<tr><td>9b</td><td>Red and green wavelengths are absorbed but blue wavelengths are transmitted</td><td>The colour of a substance corresponds to the colour wavelengths that are not absorbed by the substance. For a substance to be blue in colour the red and green wavelengths are absorbed by the substance and the remaining wavelengths (in this case blue) are transmitted to give the blue colour.</td></tr>
<tr><td>9c</td><td>Diagram showing:</td><td> 
</td></tr>
</table>

<table>
<tr><td>9d</td><td>$C_{10}H_{11}NO_4$</td><td>  </td></tr>
<tr><td>9e</td><td>Addition</td><td>Propanone CH_3COCH_3 adds across C=O carbonyl group of 2-nitrobenzaldehyde with –H joining to the O of the C=O group and $-CH_2COCH_3$ adding to the C side of the C=O group.</td></tr>
<tr><td>10a</td><td>2-chloro-2-methylpropane
or 2-chloromethylpropane</td><td>$(CH_3)_3CCl$ has the full structural formula:
  </td></tr>
<tr><td>10b</td><td>Both structures:</td><td> 
$CH_2{=}CHCH_2CH_3$ (but-1-ene)
$CH_3CH{=}CHCH_3$ (but-2-ene)</td></tr>
<tr><td>10c(i)</td><td>2-methylpropan-1-ol</td><td>3 carbon alkane with –OH group on C_1 and $-CH_3$ group on C_2</td></tr>
<tr><td>10c(ii)</td><td>  </td><td>  </td></tr>
<tr><td>10d</td><td>  </td><td>
<table>
<tr><th>Isomer A</th><th>Isomer B</th><th>Isomer C</th><th>Isomer D</th></tr>
<tr><td>$CH_3CHClCH_2CH_3$</td><td>$(CH_3)_2CHCH_2Cl$</td><td>$(CH_3)_3CCl$</td><td>$CH_3CH_2CH_2CH_2Cl$</td></tr>
<tr><td>2-chlorobutane</td><td>1-chloro-2-methylpropane</td><td>2-chloro-2-methylprapane</td><td>1-chlorobutane</td></tr>
</table>
</td></tr>
<tr><td>10e</td><td>3</td><td>Isomer B $(CH_3)_2CHCH_2Cl$ would produce three peaks on a Proton NMR spectrum
<table>
<tr><td>Structural Unit</td><td>RCH_2X</td><td>RCH_3</td><td>R_3CH</td></tr>
<tr><td>Chemical Shift</td><td>4.2-2.2</td><td>1.5-0.9</td><td>1.5-0.9</td></tr>
<tr><td>Relative intensity</td><td>2</td><td>3</td><td>1</td></tr>
</table>
</td></tr>
<tr><td>10f</td><td>A must be racemic
B is no chiral carbon</td><td>A has a chiral carbon with four different groups attached. For isomer A to be optically inactive then the sample must have equal quantities of each optical isomer (called a racemic mixture). Isomer B is optically inactive as it lacks a chiral carbon with 4 different groups attached.</td></tr>
<tr><td>11a(i)</td><td>Answer to include:</td><td>Lone pair of electrons on the N atom/amine group of reactant B donates electrons to Reactant A so Reactant B is a nucleophile.</td></tr>
<tr><td>11a(ii)</td><td>3570-3200</td><td>The product has a hydroxyl group on the six carbon ring than neither reactant A or B has. Alcohols and phenols contain an –OH group and have an absorbance peak between 3570-3200 cm^{-1}.</td></tr>
<tr><td>11b</td><td>Open Question
Answer to Include:</td><td>
<table>
<tr><th>3 mark answer</th><th>2 mark answer</th><th>1 mark answer</th></tr>
<tr><td>Demonstrates a <u>good</u> understanding of the chemistry involved. A good comprehension of the chemistry has provided in a logically correct, including a statement of the principles involved and the application of these to respond to the problem.</td><td>Demonstrates a <u>reasonable</u> understanding of the chemistry involved, making some statement(s) which are relevant to the situation, showing that the problem is understood.</td><td>Demonstrates a <u>limited</u> understanding of the chemistry involved. The candidate has made some statement(s) which are relevant to the situation, showing that at least a little of the chemistry within the problem is understood.</td></tr>
</table>
</td></tr>
</table>

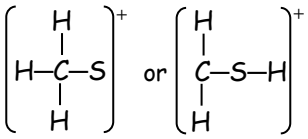
12a

C_2H_6S

Mass of carbon in CO_2 = $^{12}/_{44}$ x 3.52g = 0.96g
Mass of hydrogen in H_2O = $^{2}/_{18}$ x 2.16g = 0.24g
Mass of sulphur in SO_2 = $^{32.1}/_{64.1}$ x 2.56g = 1.28g

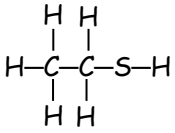
Elements	C	H	S
Mass or %	0.96g	0.24g	1.28g
Divide by RAM	$\frac{0.96g}{12g\ mol^{-1}}$ = 0.08mol	$\frac{0.24g}{1g\ mol^{-1}}$ = 0.24mol	$\frac{1.28g}{32.1g\ mol^{-1}}$ = 0.04mol
Divide through by smallest number	$\frac{0.08mol}{0.04mol}$ = 2	$\frac{0.24mol}{0.04mol}$ = 6	$\frac{0.04mol}{0.04mol}$ 1
Empirical Formula	2	6	1

12b



Peak at $^{m}/_{z}$ = 47 ∴ fragment has mass of 47amu
As S atom has mass or 32, remaining fragment has mass of 15
∴ remaining fragment is CH_3 with mass of 15

12c



Peak	1	2	3
Chemical Shift/ppm	1.2	1.5	2.4
Structure	CH_3		CH_2
Relative Area under peak	97	32	65
No of Hydrogen in group	3	1	2