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Past Papers Advanced Higher Chemistry

Revised

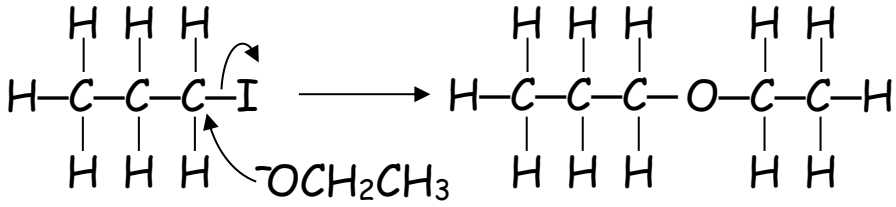
2014 Marking Scheme

Grade Awarded	Mark Required		% candidates achieving grade
	/125	%	
A	87+	69.6%	38.1%
B	74+	59.2%	29.5%
C	61+	48.8%	13.7%
D	54+	43.2%	6.5%
No award	<54	<43.2%	12.2%

Section:	Multiple Choice	Extended Answer	Investigation
Average Mark:	23.3 /30	42.2 /70	16.3 /25

2014 Revised Adv H Chemistry Marking Scheme

MC Qu	Answer	% Pupils Correct	Reasoning
1	B	70	☒A Principal Quantum Number (n) is the electron shell/energy level number ☑B Angular Momentum Quantum Number (l) specifies the subshell shape s,p,d or f ☒C Magnetic Quantum Number (m) specifies the individual s,p,d or f orbitals ☒D Spin Quantum Number (s) species which spin direction the electron has $+\frac{1}{2}$, $-\frac{1}{2}$
2	C	89	☒A s-block is group 1 → group 2 ☒B p-block is group 3 → group 0 ☑C d-block is the transition metals ☒D f-block is the Actinide and Lanthanide rows at the bottom of the Periodic Table
3	C	50	☒A the five 3d orbitals are degenerate (equal in energy) in the ground state ☒B all transition metal **atoms** have at least one electrons in the 4s orbital ☑C in chromium and copper, atoms have $4s^1$ to allow full/half-full 3d orbitals ☒D 4s electrons are further from the nucleus and are removed before 3d electrons
4	D	92	☒A for a red colour, the green and blue wavelengths need to be absorbed ☒B for a black colour, all visible wavelengths need to be absorbed ☒C for a violet(magenta) colour, the green wavelengths need to be absorbed ☑D if only ultraviolet wavelengths are absorbed the solution will be colourless
5	D	87	☒A Hund's Rule: orbitals fill up single rooms first to maximise the number of parallel spins ☒B Aufbau principle: Orbitals fill up in order of lowest energy (1s,2s,2p,3s,3p,4s,3d,4p,5s,4d,5p,6s,4f, etc) ☒C Hund's Rule: orbitals fill up single rooms first to maximise the number of parallel spins ☑D Pauli Exclusion Principle: No electron has the same 4 quantum numbers
6	B	90 oldAH=78	☒A Energy of photon is proportional to frequency of radiation $E = h f \therefore E \propto f$ ☑B Energy of photon is proportional to frequency of radiation $E = h f \therefore E \propto f$ ☒C Energy is inversely proportional to wavelength $E = {}^{hc}/_{\lambda} \therefore E \propto {}^{1}/_{\lambda}$ ☒D Energy of photon is proportional to frequency of radiation $E = h f \therefore E \propto f$
7	C	82 oldAH=76	☒A wavelength absorbed dependent on type of ion (not its concentration) ☒B frequency absorbed dependent on type of ion (not its concentration) ☑C As concentration of ion increases more radiation is absorbed by ion ☒D Less radiation is transmitted (more is absorbed by increased ion concentration)
8	A	70 oldAH=61	☒A SF_6: 6 bonding pairs = octahedral arrangement $\therefore$ bond angle = 90° ☒B NH_4^+:4 bonding pairs in tetrahedral arrangement $\therefore$ bond angle = 109.5° ☒C $SiCl_4$:4 bonding pairs in tetrahedral arrangement $\therefore$ bond angle = 109.5° ☑D BeF_4^{2-}: 4bonding pairs in tetrahedral arrangement $\therefore$ bond angle = 109.5°
9	A	75 oldAH=70	☑A BF_3: 3 bonding pair = trigonal planar ☒B NH_3: 3 bonding pairs + 1 lone pair = trigonal pyramidal ☒C OH_3^-: 3 bonding pairs + 1 lone pair = trigonal pyramidal ☒D PH_3: 3 bonding pairs + 1 lone pair = trigonal pyramidal
10	C	82 oldAH=80	☒A 4s shell fills up before 3d $\therefore$ electrons not in lowest ground state if 3d filled ☒B 3d shell fills up after 4s $\therefore$ electrons not in lowest ground state if 4p filled ☑C 4s fills up $4s^2$ before remaining 3 electrons fill 3d shell to $3d^3$ ☒D 4s must be completely filled before 3d starts to fill
11	D	83 oldAH=82	☒A ClO^- ion: Cl has oxidation state = +1 ☒B ClO_2^- ion: Cl has oxidation state = +3 ☒C ClO_3^- ion: Cl has oxidation state = +5 ☑D ClO_4^- ion: Cl has oxidation state = +7
12	B	46 oldAH=49	☒A $[I_2]$ in X decreases as I_2 leaves solvent X and transfers into solvent Y ☑B $[I_2]$ in X decreases as I_2 leaves solvent X and transfers into solvent Y ☒C Partition Coefficient remains constant ☒D Partition Coefficient remains constant

13	A	71 oldAH=52	☑A Order of reaction is determined by experiment to work out individual orders ☒B The order of a reaction does not determine the reaction rate ☒C The stoichiometry (number of moles of each reactant) does not fix the order ☒D The order is determined by the one step (RDS) not the sequence of steps
14	B	74 oldAH=67	Slow Step is the rate determining step in mechanism Order of X = 1 as 1 particle of X in RDS Order of Y = 1 as 1 particle of Y in RDS $\therefore$ rate = $k[X]^1[Y]^1 = k[X][Y]$
15	B	89 oldAH=86	☒A hybridisation is when s and p orbitals become degenerate and for sp^3 or sp^2 ☑B the central sigma bond involves the overlap of orbitals along central axis ☒C A pi bond has overlapping unhybridised orbitals around the central sigma bond ☒D A double bond has a central bond and further overlapping unhybridised orbitals
16	D	88 oldAH=86	☒A 1,2-dichloroethane has no geometric isomers ☒B 1,2-dichloropropane has no geometric isomers ☒C 1,1-dichloroethene has no geometric isomers ☑D 1,2-dichloroethene has cis- and trans- geometric isomers
17	A	66 oldAH=63	$25cm^3$ of Y will be cancelled out by $25cm^3$ (of the total $75cm^3$) of X $\therefore$ remaining $50cm^3$ of Y in a total volume of $100cm^3$ gives rotation of -79^o
18	B	95	☒A Tertiary haloalkanes have only one halogen atom not three ☑B Tertiary Haloalkane: 3 carbons directly attached to the C-Br group ☒C Secondary Haloalkane: 2 carbons directly attached to the C-Br group ☒D Primary Haloalkane: 1 carbon directly attached to the C-Br group
19	C	93	☒A reduction: decrease in the oxygen : hydrogen ratio. ☒B hydrolysis: splitting molecule into two adding a small molecule over the break ☑C ethanolic potassium hydroxide is a chemical agent in elimination reactions ☒D condensation: joining molecules with the removal of a small molecule at the join
20	B	79 oldAH=71	☒A alcohols can be made by nucleophilic substitution of haloalkanes with OH^- ions and ethers can be made by nucleophilic substitution of haloalkanes with alkoxide ions. ☑B alcohols contain O-H bond with H-bonds between molecules. Ethers have no O-H bonds (no H bonds between molecules of pure ether) ☒C alcohol and ethers can both be used as solvents ☒D both alcohols and ethers are flammable
21	C	71 oldAH=64	
22	D	55 oldAH=54	☒A –OH group heterolytically splits to produce H^+ ion when attached to C=O group ☒B –OH group heterolytically splits to produce H^+ ion when attached to C=O group ☒C electrons in C=O delocalise when attached to –OH group ☑D electrons delocalise in COO^- group as both groups behave differently attached
23	B	63 oldAH=62	☒A one $-NH_2$ in structure which reacts with acid ☑B both $-NH_2$ groups in structure will react with acid ☒C one $-NH_2$ in structure which reacts with acid ☒D one $-NH_2$ in structure which reacts with acid
24	A	90	☑A Tertiary amine: 3 carbons directly attached to the N atom ☒B Secondary amine: 2 carbons directly attached to the N atom ☒C Primary amine: 1 carbon directly attached to the N atom ☒D Triamine: molecule with three separate amine $-NH_2$ groups
25	A	89	☑A addition/hydration: water added across C=C double bond ☒B hydrolysis: water added as C≡N bond splits ☒C hydrolysis: water added back in as ester splits into alcohol and carboxylic acid ☒D hydrolysis: water added back in as ester splits into alcohol and carboxylic acid

26	D	79	Peak with highest $^{m}/_{z}$ ratio represents mass of original structure = 58 ☒A Propane C_3H_8 = (3x12)+(8x1) = 36+8 = 44 ☒B Propan-1-ol $CH_3CH_2CH_2OH$ = (3x12)+(8x1)+(1x16) = 36+8+16 = 60 ☒C Propan-2-ol $CH_3CHOHCH_3$ = (3x12)+(8x1)+(1x16) = 36+8+16 = 60 ☑D Propanone CH_3COCH_3 = (3x12)+(6x1)+(1x16) = 36+6+16 = 58
27	C	80	☒A Proton NMR: flipping of spins of hydrogen nuclei in a strong magnetic field ☒B Emission Spectroscopy: Measuring wavelengths produced when excited electrons drop down energy levels ☑C IR-spectroscopy: absorbed IR radiation of particular wavenumber vibrates particular bonds ☒D Mass Spectroscopy: Mass measured by the bending of charged particles in electric field
28	D	49	☒A Ion fragments have a positive charge ☒B $[CH_2Br]^+$ has mass (1x12)+(2x1)+(1x79.9) = 12+2+80 = 94 ☒C Ion fragments have a positive charge ☑D $[C_6H_4NH_2]^+$ has mass (6x12)+(6x1)+(1x14) = 72+6+14 = 92
29	A	90	From data booklet: 3300cm^{-1} – 3500cm^{-1} IR absorption = amine (not hydrogen bonded) ☑A $(CH_3)_3N$ is a tertiary amine and has no hydrogen bonding as it lacks N-H bond ☒B CH_3NHCH_3 is a secondary amine - contains hydrogen bonding on its N-H bond ☒C $-NH_2$ group leads to hydrogen bonding through its N-H bond ☒D $-NH_2$ group leads to hydrogen bonding through its N-H bond
30	A	82	☑A Active structure as it has NH_2 group on left and NH group attached to S ☒B H_3C- group at far left makes structure inactive ☒C Cl attached to S would make structure inactive as N-H must be attached to S ☒D CH_3- attached to N on far left would rotate and make structure inactive

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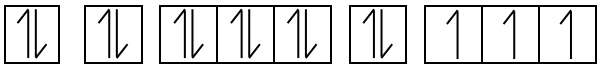
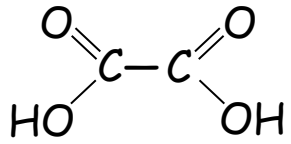
Long Qu	Answer	Reasoning
1a(i)	Answer to include:	1st Mark: An electron is excited/promoted to higher energy level 2nd Mark: When electron falls to lower/ground state energy/red light is emitted
1a(ii)	169.6	$E = \frac{L \times h \times c}{\lambda} = \frac{6.02\times10^{23}\ mol^{-1} \times 6.63\times10^{-34}\ J\ s \times 3\times10^{8}\ m\ s^{-1}}{706 \times 10^{-9} m}$ $= 169600\ J\ mol^{-1}$ $= 169.6\ kJ\ mol^{-1}$
1b	n=1, l=0, m=0, s=$-\frac{1}{2}$	Quantum Number: Arrangement of electrons Principal (n): Shell 1st=1, 2nd=2, 3rd=3, 4th=4 Angular Momentum (l): s=0, p=1, d=2, f=3 Magnetic (m): s: 0; p: -1,0,+1; d: -2,-1,0,+1,+2; f: 3,-2,-1,0,+1,+2,+3 Spin (s): Electron Spin Direction ↑ $+\frac{1}{2}$, ↓ $-\frac{1}{2}$
1c(i)	Answer showing:	 1s 2s 2p 3s 3p
1c(ii)	3p orbitals are filled singly	Hund's Rule of Maximum Multiplicity: Orbitals fill up is such a way to maximise the number of parallel spins
1c(iii)	n=4, l=0, m=0, s=$+\frac{1}{2}$ or $-\frac{1}{2}$	Quantum Number: Arrangement of electrons Principal (n): Shell 1st=1, 2nd=2, 3rd=3, **4th=4** Angular Momentum (l): **s=0**, p=1, d=2, f=3 Magnetic (m): **s: 0**; p: -1,0,+1; d: -2,-1,0,+1,+2; f: 3,-2,-1,0,+1,+2,+3 Spin (s): Electron Spin Direction ↑ $+\frac{1}{2}$, ↓ $-\frac{1}{2}$
1d	Many different electron transitions possible	Lines on an emission spectrum are caused by excited electrons dropping back to lower electron level and the energy released is released as electromagnetic radiation. For the release of visible light, the electrons must drop down to n=2.
1e	3.64×10^{-13}	73ppm = 73mg per kg = 7.3×10^{-2}g per 1000g Sample size = 1.0×10^{-6}g ∴ 7.3×10^{-11}g per 1×10^{-6}g 1mol Hg = 200.6g $\text{no. of mol} = \frac{\text{mass}}{\text{gfm}} = \frac{7.3\times10^{-11}\ g}{200.6\ g\ mol^{-1}} = 3.64\times10^{-13} mol$
2a		Carboxyl groups are –COOH ∴ oxalic acid has 2 carboxyl groups back to back.
2b	x=2	1mol $CaSO_4$ = (1x40.0)+(1x32.1)+(4x16) = 40+32.1+64 = 136.1g $\text{no. of mol} = \frac{\text{mass}}{\text{gfm}} = \frac{3.89g}{136.1g\ mol^{-1}} = 0.0286 mol$ mass of H_2O = mass of hydrated $CaSO_4$ – mass of dehydrated $CaSO_4$ = 4.94 – 3.89 = 1.05g 1mol H_2O = (2x1)+(1x16) = 2+16 = 18g $\text{no. of mol} = \frac{\text{mass}}{\text{gfm}} = \frac{1.05g}{18g\ mol^{-1}} = 0.0583 mol$ 0.0583mol is approximately twice 0.0286mol ∴ $CaSO_4 \cdot 2H_2O$
2c	0.0932 mol l^{-1}	Average titre = $^{16.6+16.5}/_{2} = 16.55cm^3$ no of mol = volume x concentration = 0.01655 x 0.0563 = 9.32×10^{-4} mol $H_2C_2O_4 + 2NaOH \longrightarrow Na_2C_2O_4 + 2H_2O$ 1mol : 2mol 9.32×10^{-4}mol : 1.86×10^{-3}mol $\text{concentration} = \frac{\text{no. of mol}}{\text{volume}} = \frac{1.86\times10^{-3}\ mol}{0.02\ litres} = 0.0932\ mol\ l^{-1}$

2d — One answer from:

Not available in high purity	Not stable in solid or solution	Solid is deliquescent
Hygroscopic	Absorbs water	Absorbs CO_2	Low gfm

3a(i) — $-164\ J\ K^{-1}\ mol^{-1}$

$$\begin{aligned}\Delta H^\circ &= \Sigma\Delta H_f{}^\circ_{(products)} - \Sigma\Delta H_f{}^\circ_{(reactants)}\\ &= (1x-239) - (\ (1x-75)+(\tfrac{1}{2}x0)\ )\\ &= -239 - (\ -75+0\ )\\ &= -239 - (-75)\\ &= -164\ kJ\ mol^{-1}\end{aligned}$$

3a(ii) — $-162.5\ J\ K^{-1}\ mol^{-1}$

$$\begin{aligned}\Delta S^\circ &= \Sigma S^\circ_{(products)} - \Sigma S^\circ_{(reactants)}\\ &= (1x127) - (\ (1x187)+(\tfrac{1}{2}x205)\ )\\ &= 127 - (\ 187+102.5\ )\\ &= 127 - 289.5\\ &= -162.5\ J\ K^{-1}\ mol^{-1}\end{aligned}$$

3b — 1009.2K

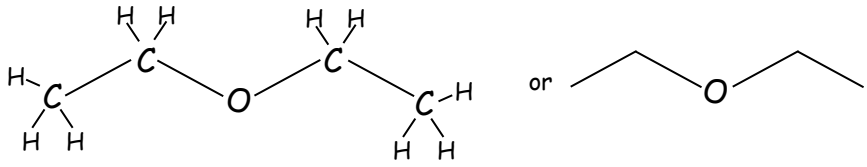
The reaction becomes thermodynamically feasible when $\Delta G^\circ = 0$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ = 0 \quad \therefore T\Delta S^\circ = \Delta H^\circ \quad \therefore T = \frac{\Delta H^\circ}{\Delta S^\circ} = \frac{-164 \times 1000\ J\ mol^{-1}}{-162.5\ J\ K^{-1}\ mol^{-1}} = 1009.2K$$

4 — Open Question Answer to Include:

3 mark answer	2 mark answer	1 mark answer
Demonstrates a **good 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.	Demonstrates a **reasonable understanding** of the chemistry involved, making some statement(s) which are relevant to the situation, showing that the problem is understood.	Demonstrates a **limited 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.

5a — Diagram showing:



5b — separating funnel

A separating funnel is used as it can be used to shake the two layers and transfer the organic acid from the water layer into the ethoxyethane layer in a ratio decided by the value of K. Once the appropriate quantity of organic acid has transferred to the ethoxyethane, the layers can be separated using the tap in the separating funnel.

5c — 30.3

no. of mol in ethoxyethane = **v**olume x **c**oncentration = 0.0227 x 1.10 = 0.02497mol

$$\text{concentration} = \frac{\text{no. of mol}}{\text{volume}} = \frac{0.02497mol}{0.025litres} = 0.0999\ mol\ l^{-1}$$

no. of mol in water = **v**olume x **c**oncentration = 0.00825x 0.10 = 0.000825mol

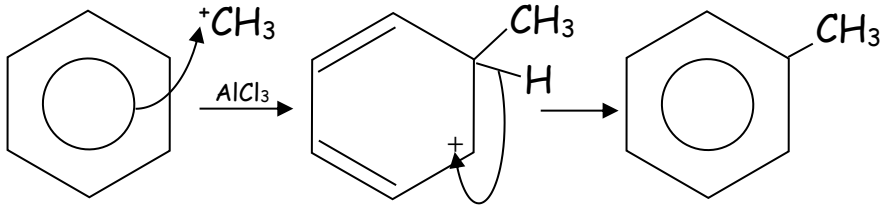
$$\text{concentration} = \frac{\text{no. of mol}}{\text{volume}} = \frac{0.000825mol}{0.025litres} = 0.033\ mol\ l^{-1}$$

$$K = \frac{[\text{organic acid}]_{ethoxyethane}}{[\text{organic acid}]_{water}} = \frac{0.0999}{0.033} = 30.3$$

6a — Chloromethane

6b — Aluminium Chloride or $AlCl_3$

CH_3Cl heterolytically splits into CH_3^+ and Cl^- with $AlCl_3$ catalyst



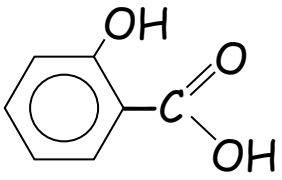
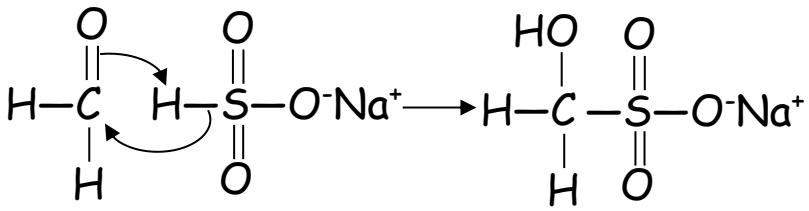
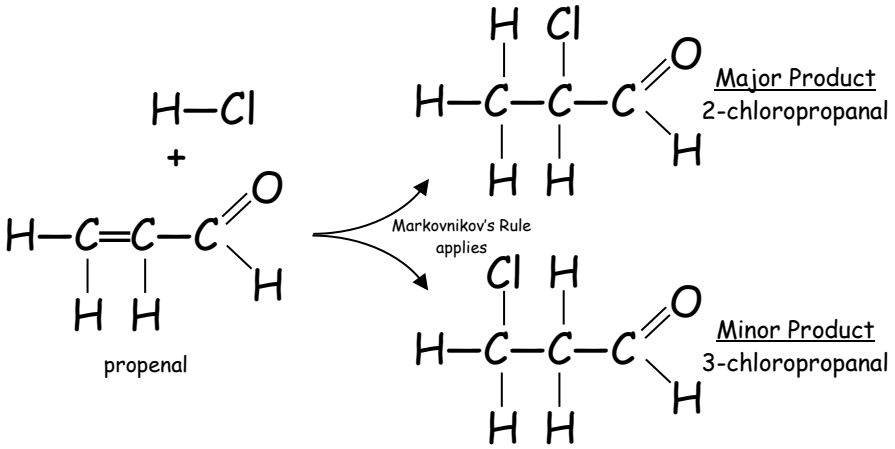
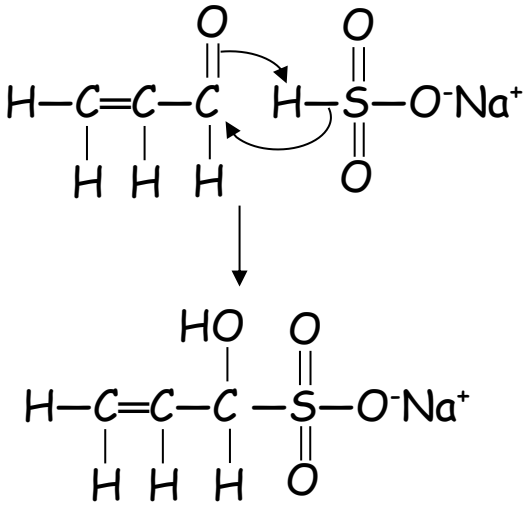
benzene — methylbenzene

6c — Electrophilic Substitution

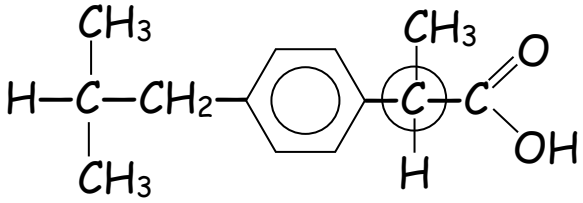
The reaction is substitution as a group is removed and a group joins on to replace it.
The substitution must be of electrophilic type as the chemical joining must be attracted to centres of negative charge like the benzene ring.

7a — Antagonist

Agonists	fit the binding site and cause a biological response inside the cell
Antagonists	fit the binding site of the receptor but does not cause the biological response and prevents any other chemical doing so.

7b(i)		**2-hydroxybenzoic acid** -OH group on C_2 benzene ring carboxyl group on C_1
7b(ii)	5.72g	1mol $C_9H_8O_4$ = (9x12)+(8x1)+(4x16) = 108+8+64 = 180g 67% yield ↔ 5g aspirin 100% yield ↔ 5g x $^{100}/_{67}$ = 7.463g aspirin no. of mol = $\frac{\text{mass}}{\text{gfm}} = \frac{7.463}{180}$ = 0.0415 mol $C_7H_6O_3$ + $C_4H_6O_3$ ⟶ $C_9H_8O_4$ + CH_3COOH 2-hydroxybenzoic acid, ethanoic anhydride → aspirin, ethanoic acid 1mol : 1mol 0.0415mol : 00.0415mol 1mol $C_7H_6O_3$ = (7x12)+(6x1)+(3x16) = 84+6+48 = 138g mass = no. of mol x gfm = 0.0415 x 138 = 5.72g
8a(i)	addition	
8a(ii)	One from:	Thin layer chromatography (TLC) | Infrared Spectroscopy | Proton NMR Melting point/mixed melting point | Make a derivative & measure melting point
8b(i)	Diagram of: 2-chloropropanal or 3-chloropropanal	 propenal Markovnikov's Rule applies Major Product: 2-chloropropanal Minor Product: 3-chloropropanal
8b(ii)	Diagram showing the product shown:	
8b(iii)	Lithium Aluminium Hydride	Aldehyde → Primary Alcohol is a reduction reaction. Possible Reducing Agents: Lithium aluminium hydride | Sodium borohydride | Sodium tetrahydroborate

9a — Diagram showing:



9b(i) — Compound A due to presence of peak at 1690cm^{-1}

Peak (cm^{-1})	Group Identified	Present in		
		Ibuprofen	A	B
1600	Benzene ring	✓	✓	✓
1690	C=O stretch in aromatic/alkyl ketones		✓	
1720	Aromatic carboxylic acid	✓		
3300	Alcohol/phenol (hydrogen bonded)	✓		

9b(ii) — One answer from:

Equilibrium	Reversible reaction	Side reactions
Incomplete	Losses during purification	Crystallisation
Mechanical losses	Mass transfer losses	Impure reactants

9b(iii) — Answer to include:

1st Mark: Br atom in molecule B is replaced with nitrile -CN group (by nucleophilic substitution with HCN)

2nd Mark: (Acid) Hydrolysis of the nitrile –CN group will produce a carboxyl group

10 — Open Question Answer to Include:

3 mark answer	2 mark answer	1 mark answer
Demonstrates a **good 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.	Demonstrates a **reasonable understanding** of the chemistry involved, making some statement(s) which are relevant to the situation, showing that the problem is understood.	Demonstrates a **limited 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.

11a(i) — 1

11a(ii) — 0

Experiment	Change	Effect on Rate	Order of reactant
1+3	$[CH_3CHIC_2H_5]$ x3	x3	$[CH_3CHIC_2H_5]^1$
1+2	$CH_3CHIC_2H_5]$ x2 and $[OH]$x 2	x2	If $[CH_3CHIC_2H_5]^1$ then $[OH]^0$

11b(i) — Rate = k$[CH_3CHIC_2H_5]$ Rate = k x $[CH_3CHIC_2H_5]^1$ x $[OH]^0$ ∴ Rate = k$[CH_3CHIC_2H_5]$

11b(ii) — 1.4×10^{-3} s^{-1}

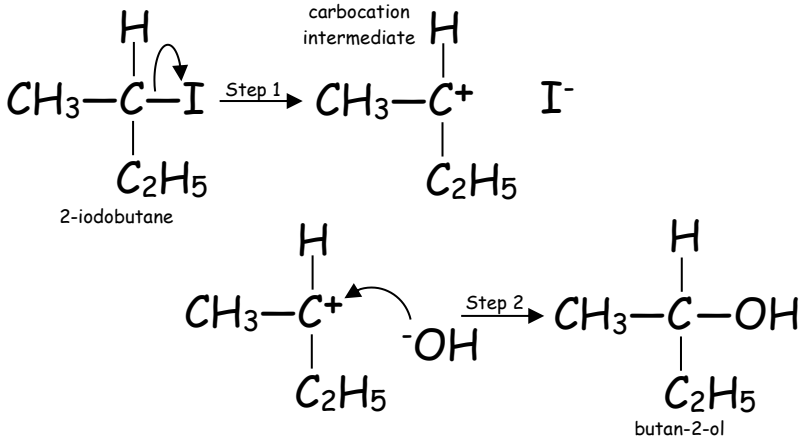
$$\text{rate} = k \times [CH_3CHIC_2H_5]$$

$$\therefore k = \frac{\text{rate}}{[CH_3CHIC_2H_5]}$$

$$= \frac{1{\cdot}4 \times 10^{-4} \text{ mol l}^{-1} \text{ s}^{-1}}{0{\cdot}10 \text{ mol l}^{-1}}$$

$$= 1.4 \times 10^{-3} \text{ s}^{-1}$$

11c — Mechanism showing:



S_N1 nucleophilic substitution will take place as only 2-iodobutane is involved in the Rate Determining Step (Step 1) as hydroxide ions are zero order.

11d — OH^- attacks from either side

OH^- attacks carbocation from either side to produce equal quantities of both optical isomers to give a racemic mixture with no optical activity.

12a(i)	46.5	1mol AgCl = (1x107.9)+(1x35.5) = 107.9+35.5 = 143.4g mass of silver in $100cm^3 = \frac{gfm\ Ag}{gfm\ AgCl} \times 0.620g = \frac{107.9}{143.4} \times 0.620g = 0.467g$ mass of silver in $1000cm^3 = 4.67g$ $\%\ Ag\ in\ coin = \frac{Mass\ of\ Ag}{Mass\ of\ coin} \times 100 = \frac{4.67g}{10.04g} \times 100 = 46.5\%$
12a(ii)	Add more HCl and no more precipitate should form.	The chloride Cl^- ions in HCl precipitate with the Ag^+ ions in coin solution but not Cu^{2+} or Ni^{2+} ions. When all the Ag^+ ions have precipitated then adding more HCl will not cause any more precipitation and this would mean that the solution would not go cloudy anymore (cloudy is the signal that precipitation is taking place).
12b	16.6	1mol CuCNS = (1x63.5)+(1x12)+(1x14)+(1x32.1) = 121.6g $\textbf{n}o.\ of\ mol = \frac{\textbf{mass}}{\textbf{gfm}} = \frac{0.320g}{121.6g\ mol^{-1}} = 0.00263mol$ **m**ass Cu in $100cm^3$ = **n**o. of mol x gfm = $0.00263mol \times 63.5g\ mol^{-1} = 0.167g$ **m**ass Cu in $1000cm^3 = 1.67g$ $\%\ Cu\ in\ coin = \frac{\textbf{mass of Cu}}{\textbf{mass of coin}} \times 100 = \frac{1.67g}{10.04g} \times 100 = 16.6\%$
13a(i)	0.333 mol l^{-1}	**n**o of mol K^+ = **v**olume x **c**oncentration = 0.02 litres x 1 mol l^{-1} = 0.02mol $\textbf{c}oncentration = \frac{\textbf{no. of moles}}{\textbf{volume}} = \frac{0.02\ mol}{0.06litres} = 0.333\ mol\ l^{-1}$
13a(ii)	3.47×10^{-5} mol l^{-1}	**n**o. of moles H^+ = **v**olume x **c**oncentration = 0.04 litres x 1 mol l^{-1} = 0.04mol $\textbf{c}oncentration = \frac{\textbf{no. of moles}}{\textbf{volume}} = \frac{0.04\ mol}{0.06litres} = 0.667\ mol\ l^{-1}$ $pH = pK_a - \log\frac{[acid]}{[salt]} = 4.76 - \log\frac{0.667\ mol\ l^{-1}}{0.333\ mol\ l^{-1}} = 4.76 - \log(2.00)$ $= 4.76 - 0.301$ $= 4.46$ $pH = -\log_{10}[H^+] = 4.46 \therefore \log_{10}[H^+] = -4.46 \therefore [H^+] = 10^{-4.46} = 3.47 \times 10^{-5}\ mol\ l^{-1}$
13b	Answer to include:	1st Mark: OH^- ions would neutralise H^+ ions 2nd Mark: H^+ ions would be replaced as ethanoic acid would dissociate into ethanoate ions