JABchem

Past Papers Advanced Higher Chemistry

2014

Marking Scheme

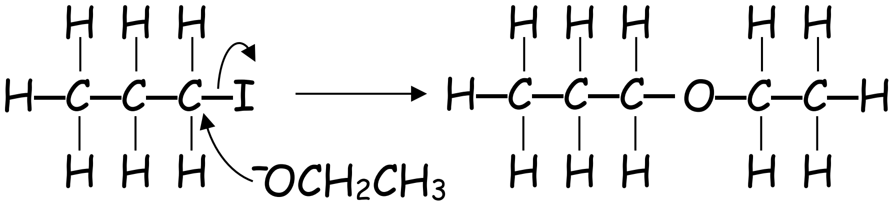
Grade Awarded	Mark Required		% candidates achieving grade
	(/125)	%	
A	86+	68.8%	23.4%
B	72+	57.6%	28.0%
C	59+	47.2%	25.0%
D	52+	41.6%	9.5%
No award	<52	<41.6%	14.0%

Section:	Multiple Choice	Extended Answer	Investigation
Average Mark:	29.1 /40	27.7 /60	15.1 /25

2014 Adv Higher Chemistry Marking Scheme

MC Qu	Answer	% Pupils Correct	Reasoning
1	B	78	☒A Energy of photon is proportional to frequency of radiation $E = h f$ ∴ $E \propto f$ ☑B Energy of photon is proportional to frequency of radiation $E = h f$ ∴ $E \propto f$ ☒C Energy of photon is inversely proportional to wavelength $E = {}^{hc}/_{\lambda}$ ∴ $E \propto {}^{1}/_{\lambda}$ ☒D Energy of photon is proportional to frequency of radiation $E = h f$ ∴ $E \propto f$
2	C	76	$E = \frac{L\,h\,c}{\lambda} = \frac{6.02\times10^{23} \times 6.63\times10^{-34} \times 3\times10^{8}}{501\times10^{-9}} = 238997.6 \text{ J mol}^{-1} = 239.0 \text{ kJ mol}^{-1}$
3	C	80	☒A 4s shell fills up before 3d ∴ electrons not in lowest ground state if 3d filled ☒B 3d shell fills up after 4s ∴ 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
4	C	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)
5	D	86	☒A Electronegativity difference for KCl = 3.0 - 0.8 =2.2 ☒B Electronegativity difference for CaO = 3.5 - 1.0 =2.5 ∴ most ionic character ☒C Electronegativity difference for BF_3 = 4.0 - 2.0 =2.0 ☑D Electronegativity difference for PH_3 = 2.2 - 2.2 =0 ∴ least ionic character
6	A	61	☑A SF_6: 6 bonding pairs = octahedral arrangement ∴ bond angle = 90° ☒B NH_4^+:4 bonding pairs in tetrahedral arrangement ∴ bond angle = 109.5° ☒C $SiCl_4$:4 bonding pairs in tetrahedral arrangement ∴ bond angle = 109.5° ☒D BeF_4^{2-}: 4bonding pairs in tetrahedral arrangement ∴ bond angle = 109.5°
7	A	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
8	D	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
9	C	54	☒A silicon carbide and diamond are networks and do not form molecules ☒B silicon carbide and diamond are networks and do not form molecules ☑C carbon and silicon form tetrahedrally arranged networks ☒D carbon and silicon form tetrahedrally arranged networks
10	B	79	☒A Concentration need not be equal between weak acid and base used. ☑B The base used should always have a high purity and stability for standardisation ☒C strong bases should be used to neutralise weak acids ☒D 1 mol : 1 mole ratio in balanced equation is not necessary for standardisation
11	D	86	☒A changes in concentration, pressure & temperature can change equilibrium position ☒B enthalpy changes for forward & reverse cannot be equal (one is +ve, one is –ve) ☒C if activation energies are equal then ΔH would be zero ☑D at equilibrium, rate of forward reaction = rate of reverse reaction
12	B	78	$K = \frac{[CH_4]\text{x}[H_2O]}{[CO]\text{x}[H_2]^3}$ ∴ $[CH_4] = \frac{K \times [CO] \times [H_2]^3}{[H_2O]} = \frac{3.9 \times 5.0\times10^{-2} \times (1.0\times10^{-2})^3}{4.0\times10^{-3}} = 4.87\times10^{-5}$
13	D	65	$K = \frac{[NO]^2}{[N_2]\text{x}[O_2]} = \frac{[6]^2}{[1] \times [3]} = \frac{36}{3} = 12$

14	B	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
15	B	77	<u>Bond Breaking Steps</u> 6mol C-H 6 x 414kJ = 2484kJ 1mol Br-Br 1 x 194kJ = 194kJ 1mol C-C 1 x 346kJ = 346kJ 3024kJ <u>Bond Forming Steps</u> 5mol C-H 5 x 414kJ = 2070kJ 1mol C-Br 1 x285kJ = 285kJ 1mol H-Br 1 x362kJ = 362kJ 1mol C-C 1 x 346kJ = 346kJ 3063kJ ∴ Enthalpy Change = +3024kJ - 3063kJ = -39kJ mol^{-1}
16	C	71	<u>Endothermic Steps: Bond Breaking</u> 1mol C-C 1 x 346kJ = 346kJ 5mol C-H 5 x 414kJ = 2070kJ 1mol C-Cl 1 x 326kJ = 326kJ 2742kJ NB: The data booklet has been updated since this question was asked in 2014 and values for bond enthalpies are slightly different in current data booklet.
17	B	69	☒A Breaking Cl-Cl bond in Cl_2 is always endothermic ☑B Hydration enthalpies are exothermic as gaseous ions dissolve in water ☒C 1st Ionisation energy is always endothermic ☒D Lattice Breaking energy are always highly endothermic
18	D	94	☒A lattice enthalpy is Step vi: Gaseous ions forming solid ionic lattice ☒B Electron affinity is Step v: Gaining electron to form negative ion ☒C Formation enthalpy is Step i: Forming 1mol of compound from elements ☑D Atomisation enthalpy is Step ii: Turning 1 mol of element into gaseous atoms
19	A	87	☑A lattice enthalpy is Step vi: Gaseous ions forming solid ionic lattice ☒B Electron affinity is Step v: Gaining electron to form negative ion ☒C Formation enthalpy is Step i: Forming 1mol of compound from elements ☒D Atomisation enthalpy is Step ii: Turning 1 mol of element into gaseous atoms
20	A	94	$Ag^+ + e^- \rightarrow Ag$ $E^o = 0.80V$ $M^{2+} + 2e^- \rightarrow M$ $E^o = X$ $2Ag^+ + 2e^- \rightarrow 2Ag$ $E^o = 0.80V$ $M \rightarrow M^{2+} + 2e^-$ $E^o = -X$ $2Ag^+ + M \rightarrow 2Ag + M^{2+}$ $E^o = 0.80 - X$ $E^o = 0.80 - X = 1.03V$ ∴ X = 0.80 – 1.03 = -0.23V ∴ Metal M is Nickel
21	D	80	2mol of electrons transferred between half reactions ∴ n = 2 $\Delta G^o = - n \times F \times E^o$ $= - 2 \times 96500\ C\ mol^{-1} \times 1.03V$ $= - 198790\ J\ mol^{-1}$ $= - 198.79\ kJ\ mol^{-1}$
22	C	65	☒A Na^+ do not react with Ag^+ ions (no displacement reaction as both ions) ☒B Ag^+ ions will not oxidise Cl^- ions (Ag^+ ☑C $Ag^+_{(aq)}$ ions will precipitate with $Cl^-_{(aq)}$ ions as silver chloride is insoluble. ☒D $NaCl_{(aq)}$ is an ionic solution and will conduct electricity
23	B	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 ∴ rate = k $[X]^1[Y]^1$ = k [X] [Y]
24	A	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

25	C	86	☒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
26	B	86	☒A hybridisation is when s and p orbitals become degenerate and form 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
27	B	54	☒A HCl is formed by the joining together of $H^\bullet$ and $Cl^\bullet$ free radicals ☑B C_2H_3Cl is chloroethene but a C=C cannot be created by this reaction ☒C C_2H_5Cl is formed by the joining together of $C_2H_5^\bullet$ and $Cl^\bullet$ free radicals ☒D C_4H_{10} is formed by the joining together of two $C_2H_5^\bullet$ free radicals
28	C	71	☒A both alcohols and ethers are flammable ☒B alcohol and ethers can both be used as solvents ☑C alcohols contain O-H bond with H-bonds between molecules. Ethers have no O-H bonds ☒D alcohols can be made by nucleophilic substitution of halogenalkanes with alkali ethers can be made by nucleophilic substitution of halogenalkanes with alkoxides
29	C	64	
30	A	68	☑A methanol has a neutral pH=7 ☒B methanoic acid has an acidic pH ☒C phenol produces an acidic pH ☒D benzoic acid has an acidic pH
31	D	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
32	A	76	☑A Fehling's solution turns brick red with aldehydes but not ketones ☒B bromine reacts with C=C bonds but not C=O bonds found in aldehydes/ketones ☒C 2,4-dinitrophenylhydrazine react with both aldehydes and ketones ☒D Lithium aluminium hydride reduces both aldehydes and ketones
33	A	83	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
34	B	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
35	D	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
36	A	63	25cm^3 of Y will be cancelled out by 25cm^3 (of the total 75cm^3) of X ∴ remaining 50cm^3 of Y in a total volume of 100cm^3 gives rotation of -79°
37	D	46	☒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

38	D	75	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
39	C	80	☒A Proton NMR: flipping spin 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
40	A	81	☑A Active structure as it NH_2 on left and NH attached to S ☒B H_3C- group at extreme 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 extreme left would rotate and make structure inactive

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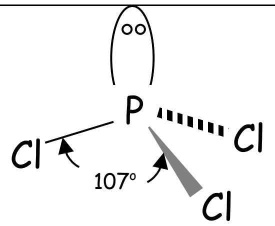
<table>
<tr><th>Long Qu</th><th>Answer</th><th>Reasoning</th></tr>
<tr><td>1a</td><td>NaCl
Al_2O_3</td><td>
<table>
<tr><td>Compound</td><td>NaCl</td><td>Na_2O</td><td>MgO</td><td>Al_2O_3</td><td>$SiCl_4$</td><td>PCl_3</td></tr>
<tr><td>pH in water</td><td>pH=7</td><td>pH>7</td><td>pH>7</td><td>Insoluble</td><td>pH<7</td><td>pH<7</td></tr>
</table>
</td></tr>
<tr><td>1b</td><td>$SiCl_4$
PCl_3</td><td>Both $SiCl_4$ and PCl_3 hydrolyse on addition to water and produced fumes of white hydrogen chloride gas.</td></tr>
<tr><td>1c</td><td>Reacts with both acids and bases</td><td>Al_2O_3 acts as basic oxide: $Al_2O_3 + 6HCl \longrightarrow 2AlCl_3 + 3H_2O$
Al_2O_3 acts as acidic oxide: $Al_2O_3 + 3H_2O + 2NaOH \longrightarrow 2NaAl(OH)_4$</td></tr>
<tr><td>1d</td><td>Trigonal Pyramidal</td><td>
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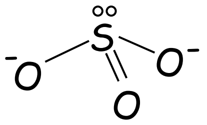
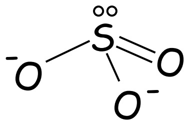
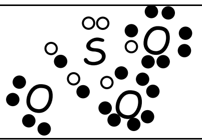
<tr><td>2a</td><td>One from:</td><td> or </td></tr>
<tr><td>2b</td><td>Diagram showing:</td><td>
</td></tr>
<tr><td>2c</td><td>4 or +4 or IV</td><td>Oxidation State (1xS) + (3xO) = -2
S + (3x-2) = -2
S + (-6) = -2
S = -2 – (-6) = +4</td></tr>
<tr><td>3a(i)</td><td>-164 kJ mol^{-1}</td><td>

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

</td></tr>
<tr><td>3a(ii)</td><td>-162.5 J K^{-1} mol^{-1}</td><td>

$$\begin{array}{lllll} \Delta S^\circ & = & \Sigma S^\circ(\text{products}) & - & \Sigma S^\circ(\text{reactants}) \\ & = & (1\text{x}127) & - & ((1\text{x}187)+(\tfrac{1}{2}\text{x}205)) \\ & = & 127 & - & (187 + 102.5) \\ & = & 127 & - & 289.5 \\ & = & -162.5\text{ J K}^{-1}\text{ mol}^{-1} & & \end{array}$$

</td></tr>
<tr><td>3b</td><td>1009.2K</td><td>The reaction becomes thermodynamically feasible when $\Delta G^\circ = 0$

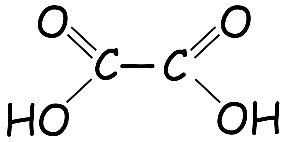
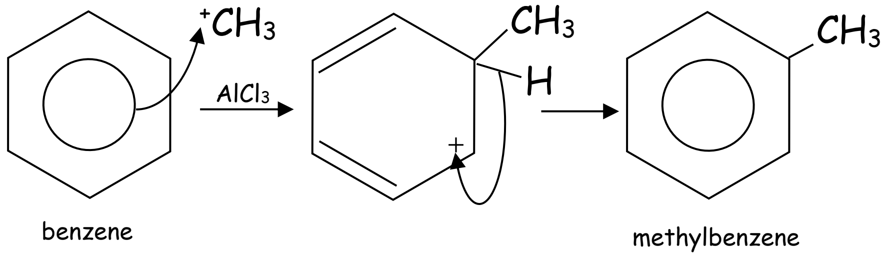
$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ = 0 \quad \therefore\ T\Delta S^\circ = \Delta H^\circ \quad \therefore\ T = \frac{\Delta H^\circ}{\Delta S^\circ} = \frac{-164 \times 1000\text{ J mol}^{-1}}{-162.5\text{ J K}^{-1}\text{ mol}^{-1}} = 1009.2\text{K}$$

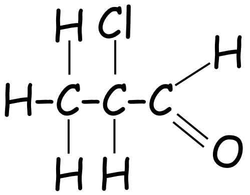
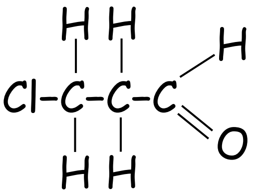
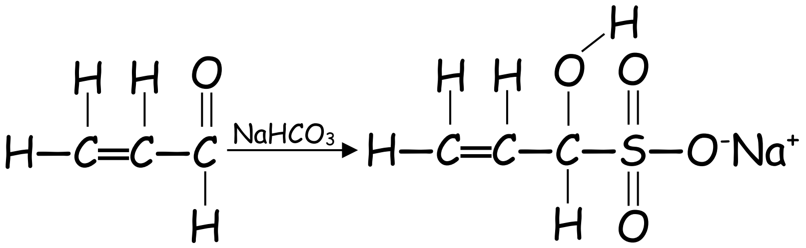
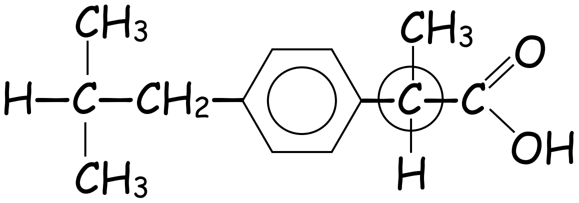
</td></tr>
<tr><td>4a</td><td>6</td><td>Each complex has a central chromium ion surrounded by 6 ligands</td></tr>
<tr><td>4b</td><td>Tetraaquachromium (III)</td><td>

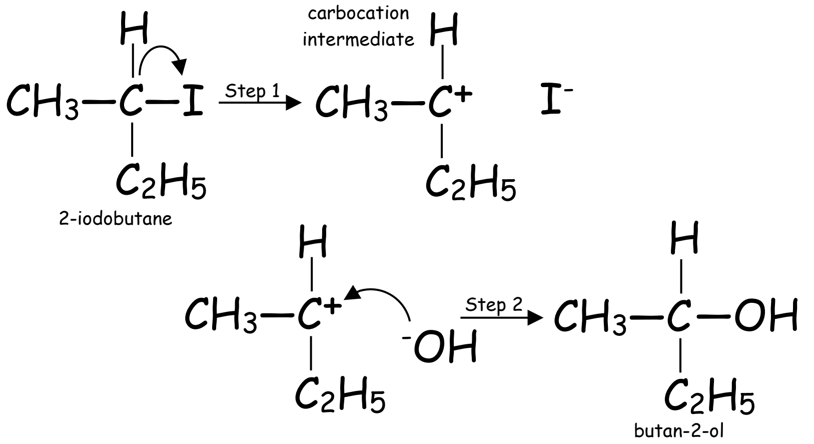
$$\underbrace{\text{Tetra}}_{\text{no. of ligands}}\underbrace{\text{aqua}}_{\text{water ligand}}\underbrace{\text{chromium}}_{\text{metal name}}\underbrace{\text{(III)}}_{\text{Charge on metal ion}} = [Cr(H_2O)_4]^{3+}$$

<table>
<tr><th>Neutral ligands include:</th><th>Negative Ligands include:</th><th>Central Ion:</th><th>Charge:</th></tr>
<tr><td>
<table>
<tr><th>Ligand</th><th>Name</th></tr>
<tr><td>H_2O</td><td>aqua</td></tr>
<tr><td>NH_3</td><td>ammine</td></tr>
<tr><td>CO</td><td>carbonyl</td></tr>
</table>
</td><td>
<table>
<tr><th>Ligand</th><th>Name</th></tr>
<tr><td>Chloride Cl^-</td><td>chlorido</td></tr>
<tr><td>Cyanide CN^-</td><td>cyanido</td></tr>
<tr><td>Nitrite NO_2^-</td><td>nitrito</td></tr>
</table>
</td><td><u>Positive Complex</u>: metals keep their name
<u>Negative Complex</u>: Metals end in ATE
e.g. Cuprate, Ferrate, Cobaltate</td><td>Charge of central ion is converted into roman numerals and put in brackets</td></tr>
</table>

</td></tr>
</table>

4c(i)	Answer to include:	Ligands split degenerate 3d-orbitals into two separate levels of energy. Electrons absorb energy from visible light to as this jump up to the higher 3d-orbital by d-d transitions. Once a particular wavelength has been removed, the complementary colour is transmitted
4c(ii)	Answer to include:	Different ligands stretch the 3d-orbitals by different amounts so different wavelengths of light are required to be absorbed to provide the exact amount of energy to excite electrons by d-d transitions.
4d	Octahedral	Chromium ion surrounded by 6 ligands in an octahedral arrangement
4e	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5$ or $[Ne]\ 3s^2\ 3p^6\ 3d^5$	Chromium atoms have an electron arrangement of 2,8,13,1 and have an electronic configuration of $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$. Cr atoms lose one electron from the 4s orbital to become Cr^+ ions and have the electronic configuration of $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5$
4f(i)	0.0162mol	Each Chromium ion has three chloride ions associated ∴ $CrCl_3$ is formula 1mol of each isomer = (1x52.0)+(3x35.5)+(12x1)+(6x16) = = 52+106.5+12+96 = 266.5g $\text{no. of mol} = \frac{\text{mass}}{\text{gfm}} = \frac{2.565g}{266.5g\ mol^{-1}} = 0.00962mol$
4f(ii)	0.0192mol	1mol AgCl = (1x107.9)+(1x35.5) = 107.9 + 35.5 = 143.4g $\text{no. of mol} = \frac{\text{mass}}{\text{gfm}} = \frac{2.748g}{143.4g\ mol^{-1}} = 0.0192mol$
4f(iii)	Isomer B	Ratio no of moles of isomer : no of moles of AgCl precipitate 0.00962mol : 0.0192mol 1mol : 2 mol ∴ 2 mol Cl^- ions free to precipitate with Ag^+ ions ∴ 1 mol Cl^- ions contained in the complex ∴ Formula of Complex = $[Cr(H_2O)_5Cl^-]^{2+}\ (Cl^-)_2{\cdot}H_2O$
5a		Carboxyl groups are –COOH ∴ oxalic acid has 2 carboxyl groups back to back.
5b	x=2	1mol $CaSO_4$ = (1x40.1)+(1x32.1)+(4x16) = 40+32.1+64 = 136.2g $\text{no. of mol} = \frac{\text{mass}}{\text{gfm}} = \frac{3.89g}{136.1g\ mol^{-1}} = 0.0286mol$ 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 $\text{no. of mol} = \frac{\text{mass}}{\text{gfm}} = \frac{1.05g}{18g\ mol^{-1}} = 0.0583mol$ 0.0583mol is approximately twice 0.0286mol ∴ $CaSO_4{\cdot}2H_2O$
6a	Chloromethane	CH_3Cl heterolytically splits into CH_3^+ and Cl^- with $AlCl_3$ catalyst 
6b	Aluminium Chloride or $AlCl_3$	
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(i)	Addition	C=O group in methanal has H added onto the O end and the remainder added to the C end of C=O bond.
7a(ii)	One answer from:	melting point thin layer chromatography infra-red spectra nmr spectra make derivative and measure melting point

<table>
<tr><td>7b(i)</td><td>Answer showing:</td><td>
(2-chloropropanal)
or

(3-chloropropanal)</td></tr>
<tr><td>7b(ii)</td><td>Product as shown:</td><td>
 </td></tr>
<tr><td>7b(iii)</td><td>Lithium Aluminium Hydride</td><td>Lithium Aluminium Hydride is a reducing agent and will reduce the aldehyde group to a hydroxyl group</td></tr>
<tr><td>8a</td><td>Diagram showing:</td><td></td></tr>
<tr><td>8b(i)</td><td>A</td><td>
<table>
<tr><th rowspan="2">Peak (cm⁻¹)</th><th rowspan="2">Group Identified</th><th colspan="3">Present in</th></tr>
<tr><th>Ibuprofen</th><th>A</th><th>B</th></tr>
<tr><td>1600</td><td>Benzene ring</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>1690</td><td>C=O stretch in aromatic/alkyl ketones</td><td></td><td>✓</td><td></td></tr>
<tr><td>1720</td><td>Aromatic carboxylic acid</td><td>✓</td><td></td><td></td></tr>
<tr><td>3300</td><td>Alcohol/phenol (hydrogen bonded)</td><td>✓</td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>8b(ii)</td><td>A would form a derivative with Brady's Reagent (2,4-dinitrophenylhydrazine) with a precise melting point</td><td>Brady's Reagent (2,4-dinitrophenylhydrazine) forms a solid derivative with the carbonyl C=O group in chemical A which has a precise melting point. Chemical B does not have a carbonyl C=O group and no derivative is formed with Brady's Reagent.</td></tr>
<tr><td>8b(iii)</td><td>Answer to include:</td><td>Bromine atom in chemical B is replaced with nitrile -CN group (this a achieved by nucleophilic substitution with HCN)
Hydrolysis of the nitrile –CN group will produce a carboxyl group (this is achieved by acid hydrolysis)</td></tr>
<tr><td>9a</td><td>Phosphoric acid</td><td>AH PPA 3.4 Technique Question</td></tr>
<tr><td>9b</td><td>Ethanol</td><td>AH PPA 3.4 Technique Question</td></tr>
<tr><td>9c</td><td>5.72g</td><td>1 mole aspirin $C_9H_8O_4$ = (9x12)+(8x1)+(4x16) = 108+8+64 = 180g
67% yield produces 5.00g aspirin
∴ 100% yield produces 5.00g x $^{100}/_{67}$ = 7.46g aspirin
no. of mol aspirin = $\frac{\textbf{mass}}{\textbf{gfm}} = \frac{7.46}{180}$ = 0.0414mol
2-hydroxybenzoic acid $\longrightarrow$ aspirin
1mol 1mol
0.0414mol 0.0414mol
1mol 2-hydroxybenzoic acid $C_7H_6O_3$ = (7x12)+(6x1)+(3x16) = 84+6+48 = 138g
mass = **no.** of mol x **gfm** = 0.0414mol x 138g mol^{-1} = 5.72g</td></tr>
</table>

<table>
<tr><td>10a(i)</td><td>1</td><td rowspan="2">
<table>
<tr><th>Experiment</th><th>Change</th><th>Effect on Rate</th><th>Order of reactant</th></tr>
<tr><td>1+3</td><td>$[CH_3CHIC_2H_5]$ x3</td><td>x3</td><td>$[CH_3CHIC_2H_5]^1$</td></tr>
<tr><td>1+2</td><td>$CH_3CHIC_2H_5]$ x2 and [OH]x 2</td><td>x2</td><td>If $[CH_3CHIC_2H_5]^1$ then $[OH]^0$</td></tr>
</table>
</td></tr>
<tr><td>10a(ii)</td><td>0</td></tr>
<tr><td>10b(i)</td><td>Rate = $k[CH_3CHIC_2H_5]$</td><td>Rate = k x $[CH_3CHIC_2H_5]^1$ x $[OH]^0$ ∴ Rate = $k[CH_3CHIC_2H_5]$</td></tr>
<tr><td>10b(ii)</td><td>$1.4\text{x}10^{-3}\ s^{-1}$</td><td>$\text{rate} = k \times [CH_3CHIC_2H_5]$
$\therefore k = \dfrac{\text{rate}}{[CH_3CHIC_2H_5]}$
$= \dfrac{1{\cdot}4 \times 10^{-4}\ \text{mol l}^{-1}\ s^{-1}}{0{\cdot}10\ \text{mol l}^{-1}}$
$= 1.4 \times 10^{-3}\ s^{-1}$</td></tr>
<tr><td>10c</td><td>Mechanism showing:</td><td>

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.</td></tr>
<tr><td>10d</td><td>Answer to include:</td><td>OH^- ions can attack the planar carbocation intermediate from either side which would produce both optical isomers. A racemic mixture of both optical isomers does not bend plane polarised light.</td></tr>
<tr><td>11a</td><td>so only the $[I_2]$ varies <u>or</u> so $[H^+]$ and $[CH_3COCH_3]$ remain constant/same</td><td>AH PPA 1.5 Technique Question</td></tr>
<tr><td>11b</td><td>sodium hydrogencarbonate
(solution)</td><td>AH PPA 1.5 Technique Question</td></tr>
<tr><td>11c</td><td>Sodium thiosulphate</td><td>AH PPA 1.5 Technique Question</td></tr>
<tr><td>11d</td><td>Zero order</td><td>Straight line relationship in graph ∴ gradient is constant at any concentration
Rate of reaction = gradient of line ∴ changing $[I_2]$ has no effect of reaction rate
∴ zero order kinetics with respect to I_2</td></tr>
<tr><td>12a(i)</td><td>0.333 mol l^{-1}</td><td>no. of mol K^+ = volume x concentration = 0.02 litres x 1 mol l^{-1} = 0.02mol
$\text{concentration} = \dfrac{\text{no. of mol}}{\text{volume}} = \dfrac{0.02\ \text{mol}}{0.06\text{litres}} = 0.333\ \text{mol l}^{-1}$</td></tr>
<tr><td>12a(ii)</td><td>6.17</td><td>no. of mol H^+ = volume x concentration = 0.04 litres x 1 mol l^{-1} = 0.04mol
$\text{concentration} = \dfrac{\text{no. of mol}}{\text{volume}} = \dfrac{0.04\ \text{mol}}{0.06\text{litres}} = 0.667\ \text{mol l}^{-1}$
$pH = pK_a - \log\dfrac{[\text{acid}]}{[\text{salt}]} = 4.76 - \log\dfrac{0.667\ \text{mol l}^{-1}}{0.333\ \text{mol l}^{-1}} = 4.76 - \log(2.00)$
$= 4.76 - 0.301$
$= 4.46$
$pH = -\log_{10}[H^+] = 4.46 \therefore \log_{10}[H^+] = -4.46 \therefore [H^+] = 10^{-4.46} = 3.47\text{x}10^{-5}\ \text{mol l}^{-1}$</td></tr>
<tr><td>12b</td><td>Answer to include:</td><td>OH^- ions would neutralise H^+ ions
H^+ ions would be replaced as ethanoic acid would dissociate in ethanoate ions</td></tr>
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