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Past Papers Higher Chemistry

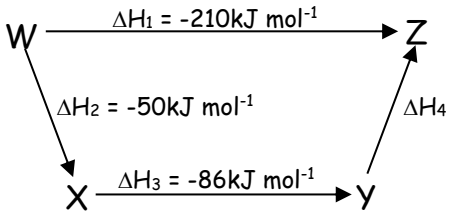
2015 Marking Scheme

Grade Awarded	Mark Required (/120)	Mark Required %	% candidates achieving grade
A	82	68.3%	22.0%
B	68	56.7%	24.9%
C	54	45.0%	26.7%
D	47	39.2%	10.5%
No award	<47	<39.2%	15.9%

Section:	Multiple Choice	Extended Answer	Assignment
Average Mark:	13.7 /20	40.5 /80	12.1 /20

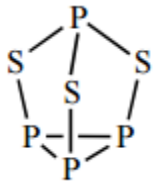
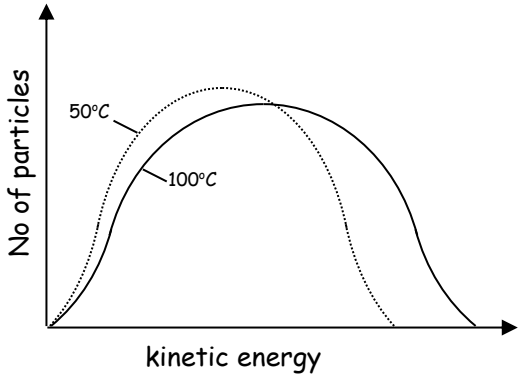
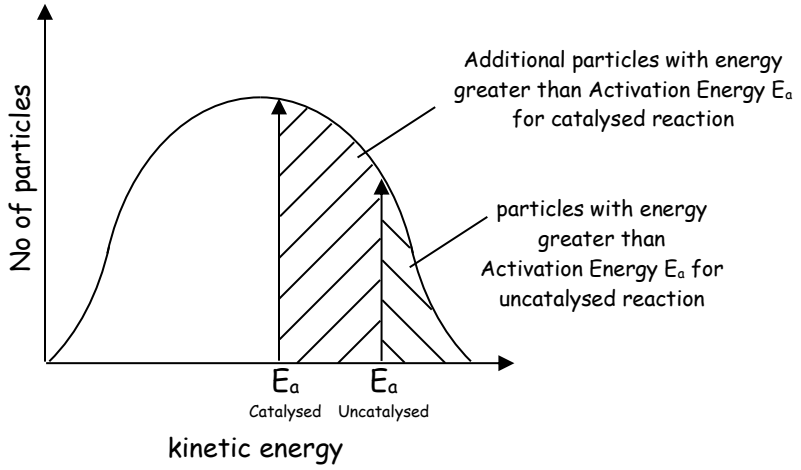
2015 CfE Higher Chemistry Marking Scheme

MC Qu	Answer	% Pupils Correct	Reasoning
1	D	84	☒A Neon is a noble gas with a full outer shell and does not need to form ions. ☒B Neon is a noble gas and is monatomic not diatomic. ☒C Neon is a noble gas and does not need to form bonds to get a full outer shell. ☑D Nitrogen, oxygen, fluorine and neon are all gases at room temperature.
2	C	89 oldH=85	☒A First ionisation energy forms positive ions not negative ions ☒B First ionisation energy removes one electron from a gaseous neutral atom ☑C One mole of electrons is removed from one mole of atoms in the gaseous state ☒D First ionisation removes one electron from gaseous single atoms
3	D	74	☒A Electronegativity of C = 2.5 ☒B Electronegativity of N = 3.0 ∴ most attraction for bonding electrons ☒C Electronegativity of P = 2.2 ☑D Electronegativity of Si = 1.9 ∴ least attraction for bonding electrons
4	A	94	☑A Covalent bonding is found inside molecules not between molecules ☒B Hydrogen bonding is an intermolecular force between molecules ☒C London dispersion forces are intermolecular forces between molecules ☒D permanent dipole – permanent dipole attractions are forces between molecules
5	C	80	☒A Br_2 is non-polar as both atoms in molecule have same electronegativity ☒B CO_2 is non-polar due to the spacial arrangement of atoms in the molecule ☑C NH_3 is polar due to the large electronegativity difference of the N-H bond ☒D CH_4 is non-polar due to the similar electronegativities within the C-H bond
6	B	63	☒A oils are reduced when hydrogen adds across the C=C double bond in an oil ☑B the oxidation of the C=C double bonds in an oil results in rancidity ☒C hydrolysis of an oil would produce three fatty acids and glycerol ☒D oils are already unsaturated due to the presence of C=C double bonds
7	A	29	☑A propanol does not react with NaOH but sodium propanoate would form in the neutralisation reaction between alkali (NaOH) and acid (ethanoic acid) ☒B all ethanoic acid would react with NaOH to form a salt plus water ☒C no propylethanoate would be formed as H^+ ions are required to form esters ☒D ester theoretically formed would be propylethanoate not ethylpropanoate
8	B	50	Oil with lowest melting point will have the highest number of C=C double bonds ∴ highest number of C=C double bonds would react with the most iodine ∴ highest iodine number
9	B	79	☒A Glycerol formed has three –OH hydroxyl bonds but no –COOH carboxyl groups ☑B Glycerol formed has three –OH groups on a different carbon each ☒C different fatty acids produced by hydrolysis of oils, not just $C_{17}H_{35}COOH$ ☒D different fatty acids produced by hydrolysis of oils, not just $C_{17}H_{33}COOH$
10	A	58	☑A oxidation: increase in oxygen : hydrogen ratio in molecule ☒B reduction: decrease in oxygen : hydrogen ratio in molecule ☒C hydrolysis: molecules splitting into smaller molecules with H_2O added at break ☒D condensation: small molecules joining to form larger molecule with H_2O removed
11	D	68	☒A secondary alcohols oxidise to ketones, tertiary alcohols do no oxidise ☒B –CHO group is found in aldehydes not ketones ☒C carboxyl –COOH groups are found in carboxylic acids not ketones ☑D ketones will not oxidise by oxidising agents e.g. Fehling's solution
12	D	48	☒A Carvone contains C=C double bonds ∴ Carvone decolourises bromine solution ☒B Carvone contains C=C double bonds ∴ Carvone decolourises bromine solution ☒C Carvone has ketone group ∴ does not oxidised with acidified dichromate solution ☑D Carvone decolourises bromine solution and is oxidised by acidified dichromate

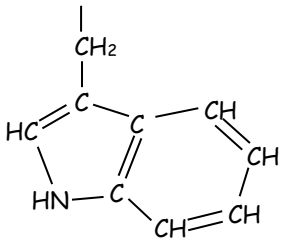
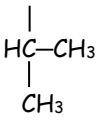
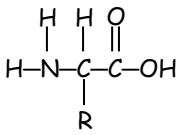
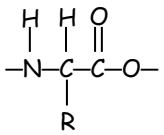
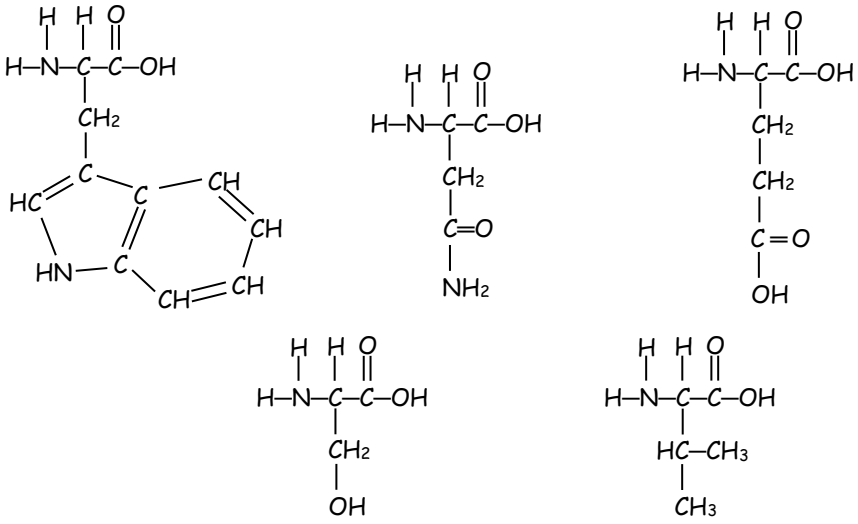
13	B	83	☒A isoprene is a hydrocarbon ∴ no oxygen atoms ☑B isoprene is 2-methylbuta-1,3-diene C_5H_8 ☒C isoprene is a 5 carbon unit of C_5H_8 ☒D isoprene is a hydrocarbon ∴ no oxygen atoms
14	C	74	The –OH bond in erthyromycin can be reacted with a carboxylic acid to form an ester by a condensation reaction.
15	B	69	2,2-dimethylpentan-1-ol has the molecular formula $C_7H_{15}OH$ ☒A $CH_3CH_2CH_2CH(CH_3)CH_2OH$ has the molecular formula of $C_6H_{13}OH$ ☑B $(CH_3)_3CCH(CH_3)CH_2OH$ has the molecular formula of $C_7H_{15}OH$ ∴ isomer ☒C $CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2OH$ has the molecular formula of $C_8H_{17}OH$ ☒D $(CH_3)_2CHC(CH_3)_2CH_2CH_2OH$ has the molecular formula of $C_8H_{17}OH$
16	A	58 oldH=64	$\Delta H_1 = \Delta H_2 + \Delta H_3 + \Delta H_4$ $\Delta H_4 = \Delta H_1 - \Delta H_2 - \Delta H_3$ $\Delta H_4 = -210 - (-50) - (-86)$ $\Delta H_4 = -74kJ\ mol^{-1}$ But ΔH for Z to Y = $+74kJ\ mol^{-1}$ 
17	D	67 oldH=70	☒A $2I_{(g)} + 2e^- \longrightarrow 2I^-_{(g)}$ should have $\Delta H = 2x-349kJ = -698kJ$ ☒B $2I_{(g)} + 2e^- \longrightarrow 2I^-_{(g)}$ should have $\Delta H = 2x-349kJ = -698kJ$ ☒C $I_{2(g)} \longrightarrow 2I_{(g)}$ should have $\Delta H = +243kJ$ ☑D all steps have the correct enthalpy changes: Enthalpy of sublimation $I_{2(s)} \longrightarrow I_{2(g)}$ $\Delta H = +60kJ$ Bond dissociation of I_2 $I_{2(g)} \longrightarrow 2I_{(g)}$ $\Delta H = +243kJ$ 2xelectron affinity of iodine $2I_{(g)} + 2e^- \longrightarrow 2I^-_{(g)}$ $\Delta H = -698kJ$
18	A	89 oldH=87	☑A at equilibrium, rate of forward reaction = rate of reverse reaction ☒B At equilibrium, the rates of the forward and reverse reactions are rarely equal ☒C Forward and reverse reactions continue at equilibrium and don't stop ☒D Adding an catalyst has no effect on the position of equilibrium
19	A	67 oldH=74	☑A X-Y is energy difference between the reactants (R) and the activated complex ☒B Y-X would give a negative value but activation energy (E_a) must be positive ☒C Y-Z is the enthalpy change (ΔH) of the reverse reaction ☒D Z-Y is the enthalpy change (ΔH) of the forward reaction

20	C	38	Necessary equations in the same order as the electrochemical series in data booklet $SO_4^{2-} + 2H^+ + 2e^- \longrightarrow SO_3^{2-} + H_2O$ $O_2 + 2H_2O + 4e^- \longrightarrow 4OH^-$ $I_2 + 2e^- \longrightarrow 2I^-$ $Fe^{3+} + e^- \longrightarrow Fe^{2+}$ $Br_2 + 2e^- \longrightarrow 2Br^-$ $MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$ ☒A OH^- would react with both Br_2 or I_2 as OH^- is above both on ECS $O_2 + 2H_2O + 4e^- \longrightarrow 4OH^-$ / $Br_2 + 2e^- \longrightarrow 2Br^-$ *upper reaction reverses* $4OH^- \longrightarrow O_2 + 2H_2O + 4e^-$ / $Br_2 + 2e^- \longrightarrow 2Br^-$ *add together and cancel electrons* $Br_2 + 4OH^- \longrightarrow 2Br^- + O_2 + 2H_2O$ $O_2 + 2H_2O + 4e^- \longrightarrow 4OH^-$ / $I_2 + 2e^- \longrightarrow 2I^-$ *upper reaction reverses* $4OH^- \longrightarrow O_2 + 2H_2O + 4e^-$ / $I_2 + 2e^- \longrightarrow 2I^-$ *add together and cancel electrons* $I_2 + 4OH^- \longrightarrow 2I^- + O_2 + 2H_2O$ ☒B SO_3^{2-} would react with both Br_2 or I_2 as SO_3^{2-} is above both on ECS $SO_4^{2-} + 2H^+ + 2e^- \longrightarrow SO_3^{2-} + H_2O$ / $Br_2 + 2e^- \longrightarrow 2Br^-$ *upper reaction reverses* $SO_3^{2-} + H_2O \longrightarrow SO_4^{2-} + 2H^+ + 2e^-$ / $Br_2 + 2e^- \longrightarrow 2Br^-$ *add together and cancel electrons* $Br_2 + SO_3^{2-} + H_2O \longrightarrow 2Br^- + SO_4^{2-} + 2H^+$ $SO_4^{2-} + 2H^+ + 2e^- \longrightarrow SO_3^{2-} + H_2O$ / $I_2 + 2e^- \longrightarrow 2I^-$ *upper reaction reverses* $SO_3^{2-} + H_2O \longrightarrow SO_4^{2-} + 2H^+ + 2e^-$ / $I_2 + 2e^- \longrightarrow 2I^-$ *add together and cancel electrons* $I_2 + SO_3^{2-} + H_2O \longrightarrow 2I^- + SO_4^{2-} + 2H^+$ ☑C Fe^{2+} is above Br_2 so would react with Br_2 but Fe^{2+} is below I_2 so no reaction $Fe^{3+} + e^- \longrightarrow Fe^{2+}$ / $Br_2 + 2e^- \longrightarrow 2Br^-$ *upper reaction reverses* $Fe^{2+} \longrightarrow Fe^{3+} + e^-$ / $Br_2 + 2e^- \longrightarrow 2Br^-$ *Multiple to equalise electrons, add together & cancel electrons* $Br_2 + 2Fe^{2+} \longrightarrow 2Br^- + 2Fe^{3+}$ $I_2 + 2e^- \longrightarrow 2I^-$ / $Fe^{3+} + e^- \longrightarrow Fe^{2+}$ *upper reaction reverses* $2I^- \longrightarrow I_2 + 2e^-$ / $Fe^{3+} + e^- \longrightarrow Fe^{2+}$ *Multiple to equalise electrons, add together & cancel electrons* $2I^- + 2Fe^{3+} \longrightarrow I_2 + 2Fe^{2+}$ (This reaction is not the reaction of I_2 with Fe^{2+}) ☒D Mn^{2+} would not react with either Br_2 or I_2 as Mn^{2+} is below them on ECS $Br_2 + 2e^- \longrightarrow 2Br^-$ / $MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$ *upper reaction reverses* $2Br^- \longrightarrow Br_2 + 2e^-$ / $MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$ *add together and cancel electrons* $2MnO_4^- + 16H^+ + 10Br^- \longrightarrow Br_2 + Mn^{2+} + 8H_2O$ (This reaction is not the reaction of Br_2 with Mn^{2+}) $I_2 + 2e^- \longrightarrow 2I^-$ / $MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$ *upper reaction reverses* $2I^- \longrightarrow I_2 + 2e^-$ / $MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$ *add together and cancel electrons* $2MnO_4^- + 16H^+ + 10I^- \longrightarrow I_2 + Mn^{2+} + 8H_2O$ (This reaction is not the reaction of I_2 with Mn^{2+})

2015 CfE Higher Chemistry Marking Scheme

Long Qu	Answer	Reasoning
1a	London dispersion forces covalent bonds	The covalent bonds inside the S_8 rings do not break as the sulphur melts. When sulphur S_8 melts, London dispersion forces between the S_8 rings must be overcome but as these are weak then sulphur has a lower melting point. Silicon dioxide is a covalent network. Covalent bonds must be broken before a covalent network will melt into a liquid resulting in a high melting point.
1b(i)		Any structure for P_4S_3 that obeys the following valency rules: • 3 bonds per P atoms • 2 bonds per S atom
1b(ii)	Increased nuclear attraction/charge or more protons in sulphur nucleus	Sulphur and phosphorus are in the same period of the periodic table and the same shell is being filled with electrons. Sulphur has 16 protons which pull in the outer shell of the sulphur atom further than the 15 protons in a phosphorus nucleus would do. Electrons closer to the nucleus are harder to remove.
1b(iii)	Answer to include:	1st Mark: Forces are stronger between sulphur than between phosphorus 2nd Mark: London dispersion forces are the forces between the molecules. 3rd Mark: Forces are stronger between Sulphur molecules of 8 atoms than between phosphorus molecules of 4 atoms.
2a	45-46	From graph: rate = 0.0022 s^{-1} $\text{Rate} = \frac{1}{\text{time}} \therefore \text{time} = \frac{1}{\text{rate}} = \frac{1}{0.022} = 45s$
2b(i)	Curve and peak drawn to left of original curve	
2b(ii)	Line drawn to the left of the E_a line.	
3a(i)	Diagram showing:	1mark: workable apparatus for passing the steam through the strawberry gum (steam must pass through the strawberry gum leaves not just pass over) 1mark: workable apparatus for condensing the steam and essential oil
3a(ii)	(fractional) distillation or chromatography	Distillation separates chemicals with different boiling points. Chromatography separates chemicals due to difference in polarity or size.

<table>
<tr><td>3b(i)</td><td>Answer to include:</td><td>
gfm cinnamic acid = 148g
no. of mol = $\frac{\textbf{mass}}{\textbf{gfm}} = \frac{6.5g}{148g} = 0.0439mol$
gfm methanol = 32g
no. of mol = $\frac{\textbf{mass}}{\textbf{gfm}} = \frac{2.0g}{32g} = 0.0625mol$
cinnamic acid + methanol → methyl cinnamate + water
1mol 1mol 1mol 1mol
0.0439mol 0.0439mol
(+0.0186mol leftover)
Cinnamic acid is the limiting reactant as all 0.0439mol of cinnamic acid is used up in the reaction. 0.0186mol methanol is left over in the reaction.
</td></tr>
<tr><td>3b(ii)
Part A</td><td>52%</td><td>
Cinnamic acid + methanol → methyl cinnamate + water
1mol 1mol
148g 162g
6.5g $162g \times {}^{6.5}/_{148}$
= 7.1g (theoretical)
$\%\ yield = \frac{actual}{theoretical} \times 100 = \frac{3.7}{7.1} \times 100 = 52\%$
</td></tr>
<tr><td>3b(ii)
Part B</td><td>£24.59</td><td>
Cinnamic acid + methanol → methyl cinnamate + water
6.5g 3.7g (at 52% yield)
$6.5g \times {}^{100}/_{3.7}$ 100g
=175.7g
250g cinnamic acid costs £35.00
175.7g cinnamic acid costs $£35.00 \times {}^{175.7}/_{250} = £24.59$
</td></tr>
<tr><td>4a</td><td>Citronellol or geraniol or anisyl alcohol</td><td>Only peaks B (citronellol), C (geraniol) and E (anisyl alcohol) appear on all three chromatograms</td></tr>
<tr><td>4b</td><td>Counterfeit perfumes have lower concentrations of compounds</td><td>The area under each peak is proportional to the quantity of that chemical in the sample. The smaller the peak, the lower the concentration of that chemical.</td></tr>
<tr><td>4c(i)</td><td>Inert/does not react with molecules</td><td>Gas chromatography needs a carrier gas to flow through the separating column. The sample compounds pass through the column at different rates dependent on their attraction to the mobile phase (the helium gas) or the stationary phase (the contents of the column)</td></tr>
<tr><td>4c(ii)</td><td>Size of molecules or temperature of column</td><td>The smaller molecules will pass through the column more quickly than larger molecules. Increasing the temperature in the column would increase the kinetic energy of the particles and they would pass through the column more quickly.</td></tr>
<tr><td>4d(i)</td><td>Terpenes</td><td>Terpenes are formed when multiple units of isoprene join together.</td></tr>
<tr><td>4d(ii)
Part A</td><td>3,7-dimethylocta-1,6-dien-3-ol</td><td>
3,7-dimethylocta-1,6-dien-3-ol
$-CH_3$ groups on carbon C_3 and C_7 | 8 carbons with 2xC=C on C_1 and C_6 | -OH group on C_3
</td></tr>
<tr><td>4d(ii)
Part B</td><td>3 carbons attached to the Carbon with the –OH group</td><td>
<table>
<tr><th>Alcohol</th><th>Description</th></tr>
<tr><td>Primary</td><td>1 carbon directly attached to the carbon with the –OH group</td></tr>
<tr><td>Secondary</td><td>2 carbons directly attached to the carbon with the –OH group</td></tr>
<tr><td>Tertiary</td><td>3 carbons directly attached to the carbon with the –OH group</td></tr>
</table>
</td></tr>
<tr><td>4e</td><td>1.7g</td><td>
1kg body mass allowed 0.10mg coumarin
75kg body mass allowed 0.10mg coumarin $\times {}^{75}/_{1}$
= 7.5mg coumarin = 0.0075g coumarin
4.4g coumarin contained in 1000g cinnamon powder
0.0075g coumarin contained in 1000g cinnamon powder $\times {}^{0.0075}/_{4.4}$
= 1.70g cinnamon powder
</td></tr>
<tr><td>5</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>

6a	Heat breaks hydrogen bonds	Globular proteins have a very specific shape and hydrogen bonding is important in holding these proteins chains together. Hydrogen bonds break on heating, the shape of the protein unravels and won't return to the original shape when the temperature decreases again.
6b(i)	One structure from:	  These side groups are non-polar and predominantly hydrocarbon. Hydrocarbons are hydrophobic in nature. The other side groups shown are hydrophilic as they have polar groups e.g. $-NH_2$, -OH and -COOH
6b(ii)	50.5 ± 1°C	Highest Fluorescence = 2600 units Lowest Fluorescence = 875 units } Halfway fluorescence value = 1737.5 ∴ temperature at 1737.5 units = 50.5°C
6c(i)	Hydrolysis	When protein is broken down into amino acids in the body by digestive enzymes, the process breaks the protein into amino acids adding a water molecule across the break point each time. This is a hydrolysis reaction.
6c(ii) Part A	5	Amino acids are monomers with an $-NH_2$ group and a –COOH group. All amino acids have this structure with only the side group R changing from amino acid to amino acid.   When amino acids join together by a condensation reaction and a water molecule is removed between amino acids and the repeating unit is. There are five of these units in the diagram in the question
6c(ii) Part B	One amino acid structure from:	
7a	88.5 litres	1mol CH_3OH = (1x12)+(4x1)+(1x16) = 12+4+16 = 32g no. of mol = $\frac{\text{mass}}{\text{gfm}} = \frac{118g}{32g\ mol^{-1}} = 3.69mol$ $2CH_3OH + 3O_2 \longrightarrow 2CO_2 + 4H_2O$ 2mol 2mol 3.69mol 3.69mol Volume = no. of mol x Molar Volume = 3.69mol x 24 litres mol^{-1} = 88.5litres
7b(i) Part A	One answer from:	Thermometer touching bottom of beaker / Thermometer is directly above flame / Temperature rise recorded would be greater than expected
7b(i) Part B	One answer from:	Distance between flame and beaker / Height of wick in burner / Same draught proofing / Beaker made of same material e.g. copper

7b(i) Part C

-288 kJ mol^{-1}

E_h = c x m x ΔT

E_h = 4.18 x 0.1 x 23

E_h = 9.614 kJ

1mol CH_3OH = (1x12)+(4x1)+(1x16) = 12+4+16 = 32g

1.07g ↔ 9.614kJ

32g ↔ 9.614kJ x $^{32}/_{1.07}$

= -287.52 kJ mol^{-1}

7b(ii)

0.799

$$\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{19.98\text{g}}{25.0\text{cm}^3} = 0.799\text{g cm}^{-3}$$

7c(i)

Heat produced by exothermic reactions will need to be removed

The heat produced by an exothermic reaction must be removed or the system will continually rise in temperature. Endothermic reactions must have heat energy continually supplied to system for the chemical reaction to take place. The design of the reaction chamber must take account of the supply or removal of heat energy.

7c(ii)

+191 kJ mol^{-1}

Bond Breaking Steps		Bond Forming Steps	
3x*C*-H bonds	3x +412kJ = 1236kJ	3xH-H bonds	3x -436kJ = 1308kJ
1x*C*-*O* bond	1x +360kJ = 360kJ	2x*C*=*O* bonds	2x -743kJ = 1486kJ
3x *O*-H bonds	3x +463kJ = 1389kJ		
Total	= +2985kJ	Total	= 2794 kJ

Enthalpy change = +2985 – 2794 = +191kJ mol^{-1}

ΔH = ΣBond enthalpies for bonds broken - ΣBond enthalpies for bonds formed

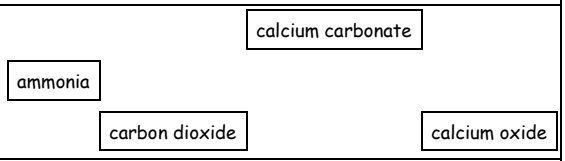
ΔH = 2985 - 2794

ΔH = +191 kJ mol^{-1}

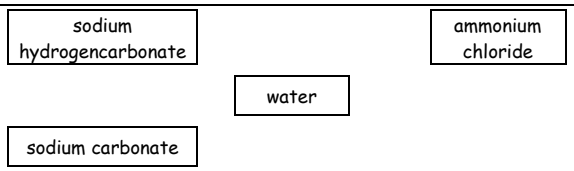
8a

Flow chart complete with:

1st Mark:



2nd Mark:



8b

Adding Na^+ shifts equilibrium to right

Brine contains Na^+ ions. Na^+ ions are a reactant in the reaction. When a reactant is added to a reaction at equilibrium, the equilibrium shifts to the right to make additional products and remove the additional Na^+ ions.

9

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.

10a(i)

24 hours allows time for all zinc to react
No stopper allows gas to escape from flask

The reactants need time to react so leaving them over night for 24 hours allows more than sufficient time for every particle of reactants to react and become products.
If a stopper were to prevent the hydrogen gas from escaping then the pressure would build up and the flask could explode.

10a(ii)

One answer from:

zinc ions, impurities, metal ions, salts

(may be present in tap water)

10b(i)

Pipette

Measuring cylinders and beakers do not measure volumes accurately enough to prepare standard solutions. A pipette is more accurate at measuring exact volumes of liquid.

10b(ii)

10

mass = volume x concentration (in g l^{-1}) = 0.010 litres x 1 g l^{-1} = 0.01g = 10mg

$$\text{concentration} = \frac{\text{mass}}{\text{volume}} = \frac{10\text{mg}}{1\text{litre}} = 10\text{mg l}^{-1}$$

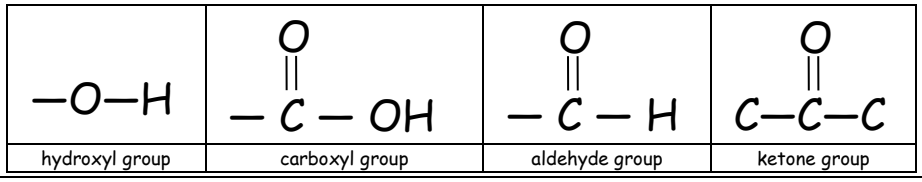
10c

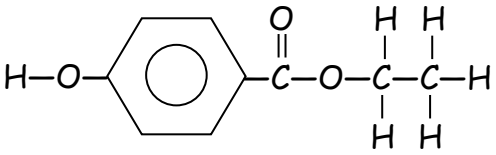
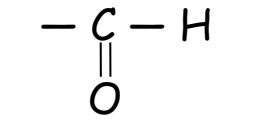
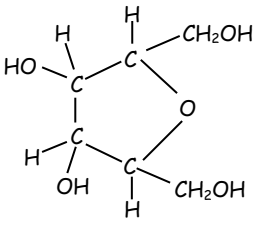
4.6-4.8

A line of best fit should be drawn on the graph which ignores the obvious rogue result.
When the absorbance at 0.3 is extrapolated from the drawn line, a concentration of 4.6-4.8 is obtained (not 4.0 which would be obtained using the rogue point)

11a

Carboxyl or carboxylic acid



<table>
<tr><td>11b</td><td>Esterification or condensation</td><td>Carboxylic acids react with alcohols to make esters by a condensation reaction with water removed as they join. Condensation reactions which form esters are also known as esterification reactions.</td></tr>
<tr><td>11c</td><td>Diagram showing:</td><td>  </td></tr>
<tr><td>11d</td><td>As molecular size increases, adsorption decreases</td><td>Problem Solving: drawing a conclusion from a table of results</td></tr>
<tr><td>12a(i)</td><td>Answer to include:</td><td>1st mark: rinse the burette with (thiosulphate) solution.
2nd and 3rd marks for two of the following points:
<table>
<tr><td>Fill burette above the scale with thiosulphate solution</td><td>Filter funnel to be removed</td><td>Tap opened/some solution drained to ensure no air bubbles</td><td>(thiosulphate) solution run into scale reading</td><td>Reading should be made from bottom of the meniscus</td></tr>
</table></td></tr>
<tr><td>12a(ii)</td><td>$2I^- \rightarrow I_2 + 2e^-$</td><td>Redox equation: $NaOCl + 2I^- + 2H^+ \rightarrow I_2 + NaCl + H_2O$
Oxidation step: $2I^- \rightarrow I_2 + 2e^-$
Reduction step: $NaOCl + 2H^+ + 2e^- \rightarrow NaCl + H_2O$</td></tr>
<tr><td>12a(iii)</td><td>6.20×10^{-5} mol l^{-1}</td><td>$S_2O_3^{2-}$ no. of mol = concentration x volume = 0.00100_{litres} x 0.0124 mol l^{-1} = 1.24×10^{-5} mol
$I_2 + 2Na_2S_2O_3 \rightarrow 2NaI + Na_2S_4O_6$
1mol 2mol
6.20×10^{-6}mol 1.24×10^{-5}mol
$NaOCl + 2I^- + 2H^+ \rightarrow I_2 + NaCl + H_2O$
1mol 1mol
6.20×10^{-6}mol 6.20×10^{-6}mol
100cm^3 of swimming pool water contains 6.20×10^{-6} mol NaOCl
1000cm^3 of swimming pool water contains 6.20×10^{-6} mol x $^{1000}/_{100}$
$=6.20\times10^{-5}$ mol l^{-1}</td></tr>
<tr><td>12b</td><td>44.4 litres</td><td>45 000 litres of swimming pool water requires 400cm^3 hypochlorite to raise by 1ppm
45 000 litres of swimming pool water requires 800cm^3 hypochlorite to raise by 2ppm
2500000 litres of pool water requires 800cm^3 x $^{2500000}/_{45000}$
= 44444cm^3
=44.4 litres</td></tr>
<tr><td>12c(i)</td><td>Answer to include:</td><td>1st mark: ammonia is polar and trichloramine is non-polar
2nd mark: electronegativity difference is bigger in N-H bond than N-Cl bond
$\therefore$ NH_3 is polar and NCl is non-polar</td></tr>
<tr><td>12c(ii)</td><td>Substance with unpaired electron</td><td>Free radicals are very reactive particles which have an unpaired electron. The free radical will react with a large variety of substances to achieve the pairing of the unpaired electron.</td></tr>
<tr><td>12a(iii)</td><td>propagation</td><td>
<table>
<tr><td>Step</td><td>Reactants (before Arrow) → Products (after Arrow)</td></tr>
<tr><td>Initiation</td><td>No free radicals on Left Hand Side → Free radicals on Right Hand Side</td></tr>
<tr><td>Propagation</td><td>Free Radicals found on both sides of arrow</td></tr>
<tr><td>Termination</td><td>Free radicals on Left Hand Side → No free radicals on Right Hand Side</td></tr>
</table></td></tr>
<tr><td>13a</td><td>  </td><td>Aldehyde groups contain a carbonyl (C=O) group with a hydrogen atom attached. The carbon in the aldehyde group is always carbon number one in any numbering system assigned to an aldehyde when naming the compound.</td></tr>
<tr><td>13b</td><td>  </td><td>Problem Solving Question</td></tr>
</table>