Past Papers Higher Chemistry

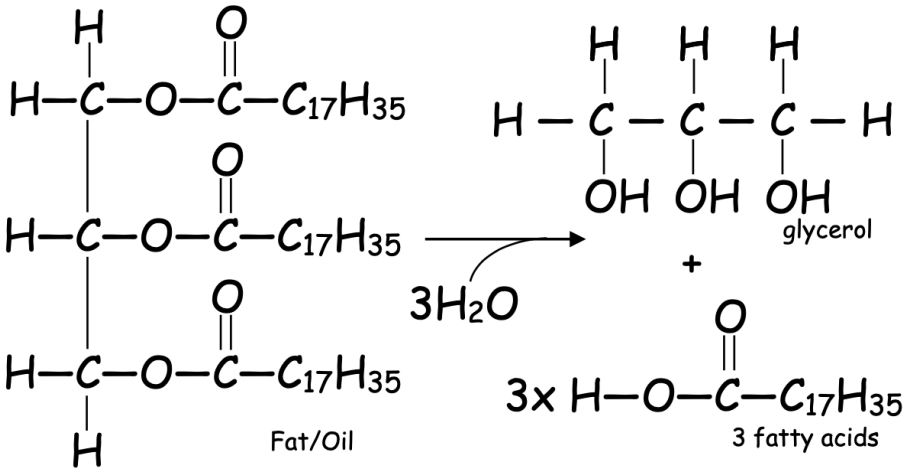
2023

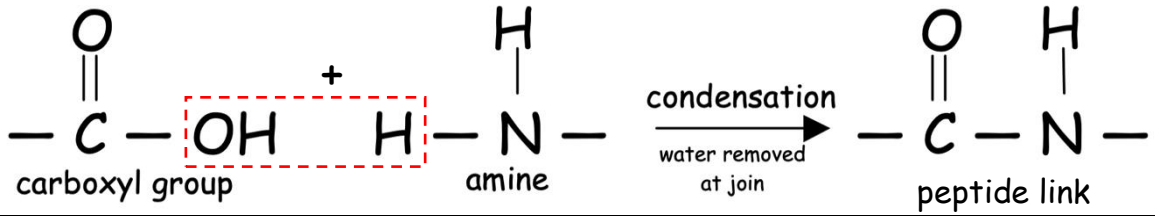
Marking Scheme

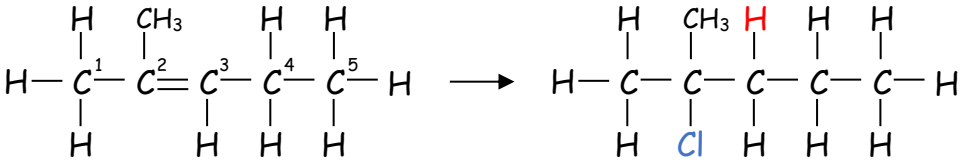
Grade Awarded	Mark Required		% candidates achieving grade
	(/120)	%	
A	80+	66.7%	32.6%
B	65+	54.1%	23.9%
C	50+	41.7%	21.3%
D	35+	29.2%	14.4%
No award	<35	<29.2%	7.8%

Section:	Multiple Choice	Extended Answer	Assignment
Average Mark:	17.6 /25	49.7 /95	No Assignment in 2023

2023 Higher Chemistry Marking Scheme

MC Qu	Answer	% Correct	Reasoning
1	A	71	☑A Electronegativies Na = 0.9 & I = 2.7 ∴ difference = 1.8 (least ionic character) ☒B Electronegativies Na = 0.9 & F = 4.0 ∴ difference = 3.1 ☒C Electronegativies K = 0.8 & I = 2.7 ∴ difference = 1.9 ☒D Electronegativies K = 0.8 & F = 4.0 ∴ difference = 3.2 (greatest ionic character)
2	D	89	☒A N-H bond in structure ∴ hydrogen bonding would occur between molecules ☒B O-H bond in structure ∴ hydrogen bonding would occur between molecules ☒C N-H bond in structure ∴ hydrogen bonding would occur between molecules ☑D No N-H, O-H or H-F bonds in structure ∴ no hydrogen bonding between molecules
3	C	85	
4	A	69	☑A Activation of reverse reaction = 200 – 50 = +150kJ mol^{-1} ☒B Enthalpy change for reverse reaction = 50 – 150 = -100kJ mol^{-1} ☒C Activation of forward reaction = 200 – 150 = 150kJ mol^{-1} ☒D Enthalpy change for forward reaction = 150 – 50 = +100kJ mol^{-1}
5	C	91	time = 10s ∴ rate = $\frac{1}{\text{time}} = \frac{1}{10s}$ 0.1 s^{-1} Extrapolate from graph: when rate = 0.1s^{-1} then concentration = 0.25 mol l^{-1}
6	B	74	☒A catalyst speeds up reaction so dotted line would be steeper initially ☑B dotted line is steeper at start and meets full line at horizontal end of line ☒C catalyst does not change final concentrations so dotted line would meet full line at end ☒D catalyst speeds up reaction so dotted line would be steeper initially
7	B	80	1 mol CH_3OH = -726 kJ mol^{-1} = 32g -145.2 kJmol^{-1} = 32g x $\frac{-145.2}{-726}$ = 6.4g
8	A	83	☑A Sodium Na atom (covalent radius = 160pm) is larger than sodium Na^+ ion (ionic radius = 102pm) ☒B Chloride Cl^- ion (ionic radius = 181pm) is larger than chlorine Cl atom (covalent radius = 100pm) ☒C Magnesium Mg^{2+} ion (ionic radius = 72pm) is smaller than magnesium Mg atom (covalent radius = 140pm) ☒D Oxygen O atom (covalent radius = 64pm) is smaller than oxide O^{2-} ion (ionic radius = 140pm)
9	C	87	☒A Covalent molecular is found in both elements e.g. O_2 and compounds e.g. H_2O ☒B Covalent network is found in both elements e.g. C (diamond) and compounds e.g. SiO_2 ☑C Monoatomic structures are only found in elements ☒D Ionic structures are only found in compounds containing metals and non-metal elements
10	B	72	☒A 2-methylbutanal $C_5H_{10}O$ is <u>not</u> an isomer of hexanal $C_6H_{12}O$ ☑B 3-methylpentan-2-one $C_6H_{12}O$ is an isomer of hexanal $C_6H_{12}O$ (same formula different structure) ☒C 2,2-dimethylbutan-1-ol $C_6H_{14}O$ is <u>not</u> an isomer of hexanal $C_6H_{12}O$ ☒D 3,3-dimethylpentanal $C_7H_{14}O$ is <u>not</u> an isomer of hexanal $C_6H_{12}O$

11	C	83	
12	D	50	☒A Formation of carbon monoxide indicated incomplete combustion not complete combustion ☒B Formation of carbon monoxide indicated incomplete combustion not complete combustion ☒C enthalpy of combustion is the complete combustion of **1 mole** of a substance ☑D The energy change for the complete combustion of 1 mol of a substance
13	D	28	☒A ethyl ethanoate and water in B will react to form ethanol and ethanoic acid and form an equilibrium ☒B ethyl ethanoate and water in B will react to form ethanol and ethanoic acid and form an equilibrium ☒C ethanol and ethanoic acid react to form ethyl ethanoate and water in A and form an equilibrium ethyl ethanoate and water in B will react to form ethanol and ethanoic acid and form an equilibrium ☑D Flask A is the reactants at 100% and Flask B is the products at 100%. They will reach the same equilibrium eventually with ethyl ethanoate, water, ethanol and ethanoic acid present in both flasks at the same cocentrations.
14	C	70	Write Down main species: IO_3^- → I_2 Balance all atoms other than oxygen and hydrogen: $\mathbf{2}IO_3^-$ → I_2 Balance O by adding H_2O to other side: $2IO_3^-$ → I_2 + $\mathbf{6}H_2O$ Balance H by adding H^+ ions to other side: $2IO_3^-$ + $\mathbf{12}H^+$ → I_2 + $6H_2O$ Balance charge by adding e^- to most positive side: $2IO_3^-$ + $12H^+$ + $\mathbf{10}e^-$ → I_2 + $6H_2O$
15	D	78	☒A Condensation: 2 molecules join together with small molecule e.g. water removed at join ☒B Hydration: Addition reaction where H_2O is added across a C=C double bond ☒C Reduction: decrease in oxygen : hydrogen ratio ☑D Oxidation: increase in oxygen : hydrogen ratio ($C_6H_7ON \rightarrow C_6H_5O_2N$) O:H ratio 1:7 → 2:5
16	B	46	☒A 3x -OH group makes A the 2nd most polar molecule and A is the 3rd peak left to right ☑B no -OH groups makes B the least polar molecule and B is the 1st peak left to right (Z) ☒C 2x -OH group makes C the 3rd most polar molecule and C is the 2nd peak left to right ☒D 6x -OH group makes D the most polar molecule and D is the 4th peak left to right
17	C	59	☒A Draft shield would reduce heat loss to the surroundings ☒B the thermometer in the diagram is too close to the flame and might give inaccurate temp ☑C glass beaker would reduce the heat transfer to the water compared to a copper can ☒D Stirring the water would mix the water better and give a more accurate temp
18	B	85	☒A head of soap in ionic and therefore polar ☑B ionic head dissolves in polar water and non-polar tail dissolves in non-polar oil ☒C head of soap in ionic and therefore polar ☒D ionic head is polar and dissolves in polar water rather than non-polar head
19	C	53	☒A unreacted nickel oxide must be removed by filtration before evaporation takes place ☒B the filtration of nickel oxide must be followed by evaporation of water to form salt ☑C the unreacted nickel oxide is filtered to remove it and the evaporation that follows removes the water from the nickel sulfate solution to leave nickel sulphate salt ☒D the unreacted nickel oxide must be filtered before evaporation takes place
20	B	76	☒A ethanal CH_3CHO is an aldehyde and does not react with alkalis ☑B ethanoic acid CH_3COOH is a carboxylic acid and is neutralised by alkalis. ☒C propanone CH_3COCH_3 is a ketone and does not react with alkalis ☒D ethan-1-ol CH_3CH_2OH is a primary alcohol and does not react with alkalis

21	D	94	☒A Secondary alcohol: 2 carbons directly attached to the carbon with -OH group ☒B Secondary alcohol: 2 carbons directly attached to the carbon with -OH group ☒C Tertiary alcohol: 3 carbons directly attached to the carbon with -OH group ☑D Primary alcohol: 1 carbon directly attached to the carbon with -OH group
22	A	68	4-methylpentan-2-one is a ketone which reduces to form the secondary alcohol 4-methylpentan-2-ol. **gfm** 4-methylpentan-2-one $C_6H_{12}O$ = (6x12)+(12x1)+(1x16) = 72+12+16 = 100g **gfm** 4-methylpentan-2-ol $C_6H_{14}O$ = (6x12)+(14x1)+(1x16) = 72+14+16 = 102g 4-methylpentan-2-one → 4-methylpentan-2-ol $C_6H_{12}O$ → $C_6H_{14}O$ 1mol → 1mol 100g → 102g
23	D	42	gfm O_2 = 32g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{16}/_{32}$ = **0.5mol** (same no. of mol = same volume) ☒A gfm CO = 28g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{21}/_{28}$ = 0.75mol ☒B gfm CO_2 = 44g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{44}/_{44}$ = 1.0mol ☒C gfm NO_2 = 46g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{46}/_{46}$ = 1.0mol ☑D gfm N_2O_4 = 92g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{46}/_{92}$ = **0.5mol**
24	A	45	Ionic formula aluminium sulfate = $(Al^{3+})_2(SO_4^{2-})_3$ 1 mol of $Al_2(SO_4)_3$ contains 2 mol of positive Al^{3+} ions 0.25mol → 0.5 mol
25	B	56	**C_2 in C=C double bond has no hydrogens directly attached to it** ∴ Cl of H-Cl attaches to C_2 (major product) **C_3 in C=C double bond has 1 hydrogen directly attached to it** ∴ H of H-Cl attaches to C_3 (major product) 2-methylpent-2-ene → 2-chloro-2-methylpentane  + Cl – H

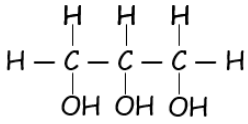
2023 Higher Chemistry Marking Scheme

Long Qu	Answer	Reasoning
1a(i)	Greater no. of protons/ nuclear charge holds electrons more tightly	Across a period, the same electron shell is filling up but there is a greater nuclear charge due to the increase atomic number. The outer shell is held more tightly by the nucleus and an electron is harder to remove from the outer shell.
1a(ii)	b or j	Elements c and k are group 0 elements as they have the highest 1st ionisation energy in their periods. Group 7 elements have the next highest 1st ionisation energy and elements b and j correspond to the 2nd highest ionisation energies.
1a(iii)A	Answer to include:	1st mark: 2nd electron removed from an electron shell closer to nucleus 2nd mark: 2nd electron is less screened/shielded (than 1st electron removed) or 2nd electron is more strongly attracted to the nucleus
1a(iii)B	11472	❶ $Na^{+}_{(g)} \rightarrow Na^{2+}_{(g)} + e^{-}$ $\Delta H = 4562$ kJ mol^{-1} ❷ $Na^{2+}_{(g)} \rightarrow Na^{3+}_{(g)} + e^{-}$ $\Delta H = 6910$ kJ mol^{-1} add $Na^{+}_{(g)} \rightarrow Na^{3+}_{(g)} + 2e^{-}$ $\Delta H = 11472$kJ mol^{-1}
1b(i)	Attraction atom/nucleus has for electrons within a bond	Electronegativity is a measure of the attraction an atom involved in a bond has for the electrons of the bond (shared pair of electrons)
1b(ii)	Answer to include:	1st mark: Increased screening/shielding effect (due to more shells) 2nd mark: Attraction of nucleus/protons for outer electrons decreases
1b(iii)	Strontium (or Barium or Radium)	Strongest reducing agents are found on the top right hand corner of the electrochemical series. First four in top right corner are group 1 elements and Strontium is the first group 2 element.
2a(i)	Answer to Include:	1st mark: (intermolecular) forces increase going down a group 2nd mark: London dispersion forces are forces broken between molecules 3rd mark: The more electrons the stronger the LDFs
2a(ii)	Hydrogen bonding	Hydrogen bonding occurs between molecules containing one of the following bonds: N – H bond | O – H bond | H – F bond
2b(i)	34	Desired equation: $Si + 2H_2 \rightarrow SiH_4$ ❶ $SiH_4 + 2O_2 \rightarrow SiO_2 + 2H_2O$ ΔH=-1517 kJ mol^{-1} ❷ $Si + O_2 \rightarrow SiO_2$ ΔH= -911 kJ mol^{-1} ❸ $H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ ΔH= -286 kJ mol^{-1} ❶x-1 $SiO_2 + 2H_2O \rightarrow SiH_4 + 2O_2$ ΔH=+1517 kJ mol^{-1} ❷ $Si + O_2 \rightarrow SiO_2$ ΔH= -911 kJ mol^{-1} ❸x2 $2H_2 + O_2 \rightarrow 2H_2O$ ΔH= -572 kJ mol^{-1} add $Si + 2H_2 \rightarrow SiH_4$ ΔH= +34 kJ mol^{-1}
2b(ii)	40%	**gfm** Mg_2Si = 76.7g v **n**o. of mol = $\frac{\textbf{mass}}{\textbf{gfm}} = \frac{15.32}{76.7} = 0.200$mol $4HCl + Mg_2Si \rightarrow SiH_4 + 2MgCl_2$ 1mol 0.200mol → 1mol 0.200mol (theoretical) **gfm** SiH_4 = 32.1g **n**o. of mol = $\frac{\textbf{mass}}{\textbf{gfm}} = \frac{2.56}{32.1} = 0.080$mol (actual) % Yield = $\frac{\text{Actual}}{\text{Theoretical}} \times 100 = \frac{0.080}{0.200} \times 100 = 40\%$

2b(iii) — Answer to include:

1st mark:	In SiO_2 covalent bonds are broken
2nd mark:	In SiH_4 { London dispersion forces / Van der Waals' forces / Intermolecular forced } are broken
3rd mark:	Covalent bonds { are stronger / need more energy to break } than { London dispersion forces / Van der Waals' forces / Intermolecular forced }

3a(i)A — propane-1,2,3-triol



glycerol

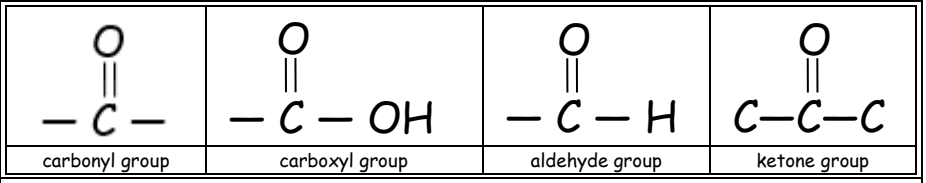
propane-1,2,3-triol

3 carbons | Single bonds between carbons | Functional groups on Carbons 1,2,3 | 3 hydroxyl –OH groups

3a(i)B — condensation

A condensation reaction occurs when two molecules join together with a small molecule removed where they join. The small molecule is usually water.

3a(ii)A — carbonyl

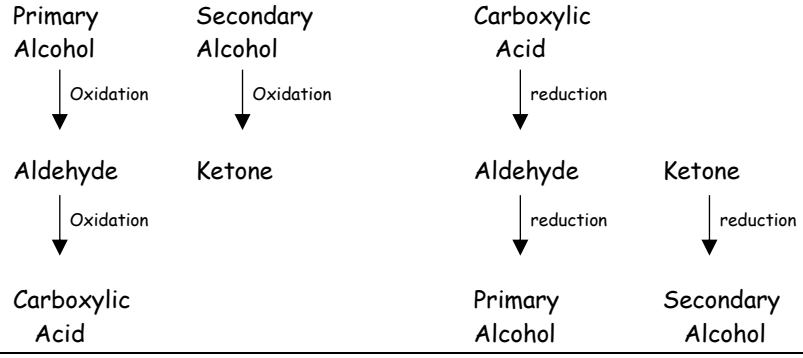


carbonyl group | carboxyl group | aldehyde group | ketone group

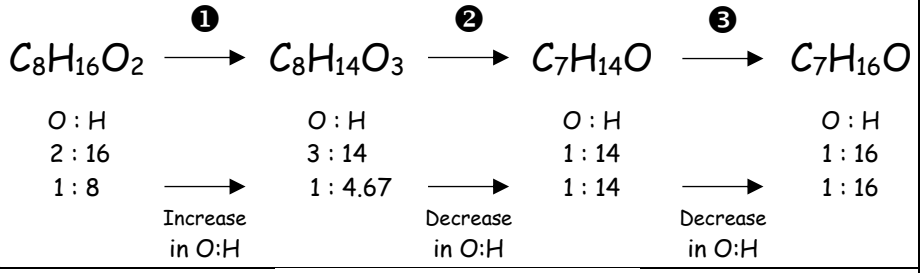
3a(ii)B — heptan-2-one

Seven carbons in main chain. (hept)
Carbonyl functional group between 2 carbons = Ketone (heptanone)
Functional group in C_2 (heptan-2-one)

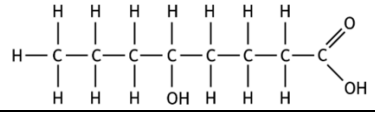
3a(ii)C — reduction



3a(ii)D — Reaction 1



3a(iii) — Structure drawn of 5-hydroxyoctanoic acid



3a(iv)A — 12-13 minutes

Problem Solving: Interpreting multiple graphs

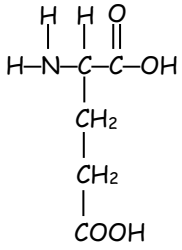
3a(iv)B — Dilute the sample or use less sample

When the concentration of the sample is too large the top of the peak is cut off and this prevent the area under the peak from being calculated.

3b(i) — essential

Essential amino acids are amino acids which must be obtained through the diet as the body cannot make these amino acids themselves

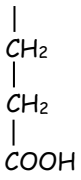
3b(ii)



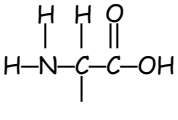
There are 2 amino acids that appear twice in the portion of protein

- glutamic acid
- leucine

Only one of those sidegroups have a carboxyl group to make the sidegroup an acid



Sidegroup is attached to basic structure of an amino acid to form glutamic acid

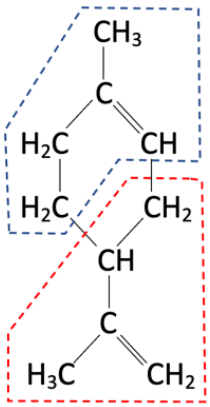
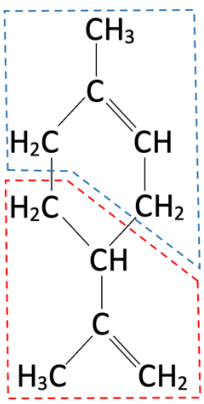
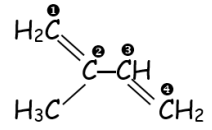
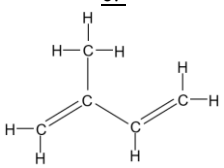


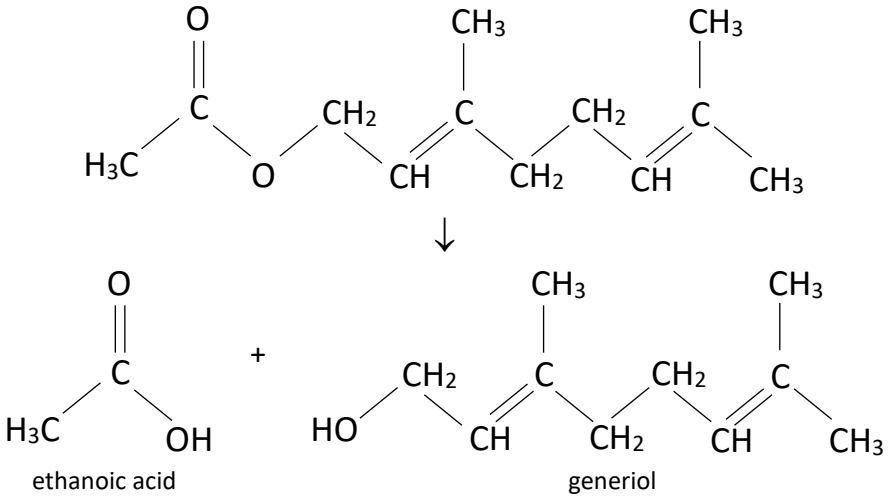
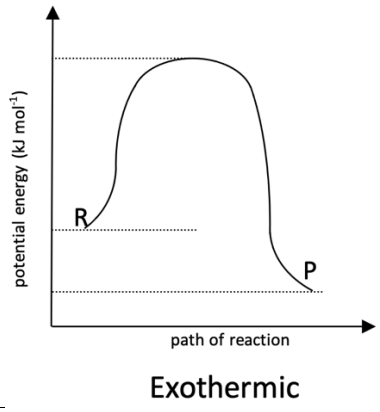
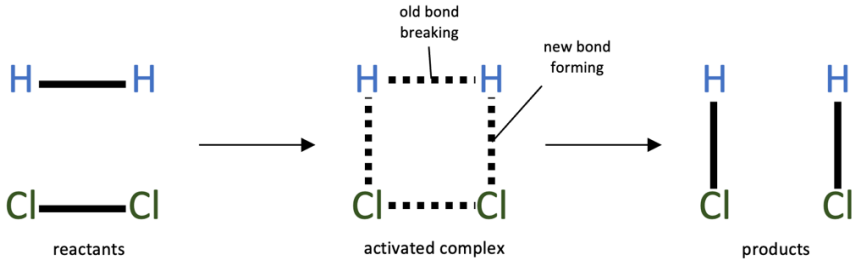
<table>
<tr><td>3b(iii)</td><td>denaturing</td><td>When a protein changes shape by a change like heating, the protein changes shape as hydrogen bonds are broken to alter the shape of the protein e.g. spirals of protein unravel.</td></tr>
<tr><td>3c</td><td>To prevent non-polar and polar liquids separating (into layers)</td><td>Emulsifiers had hydrophilic polar. Heads and hydrophobic non-polar tails.
The hydrophobic tails stick into non-polar oil/grease droplets and hydrophilic heads stay outside the oil/grease droplets in the polar water.
The oil/grease droplets cannot join together are form an oil/grease layer which spoils the appearance of the food.</td></tr>
<tr><td>3d</td><td>Calcium propanoate</td><td>$Ca^{2+}(CH_3CH_2COO^-)_2$ is the salt formed by the neutralisation of propanoic acid (CH_3CH_2COOH) with a calcium-containing base e.g. calcium hydroxide</td></tr>
<tr><td>4</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>5a(i)A</td><td>494</td><td>0.05litres glucose solution contains 5.79g glucose
16litres glucose solution contains 5.79g glucose x $^{16}/_{0.05}$
= 1852.8g glucose

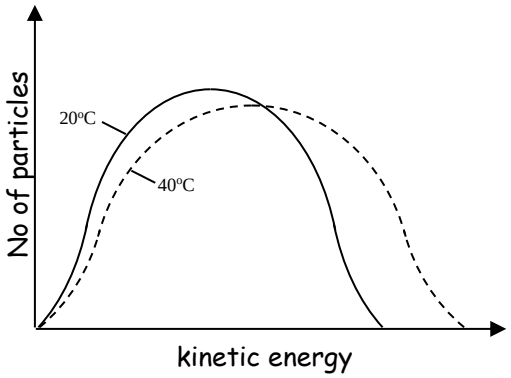
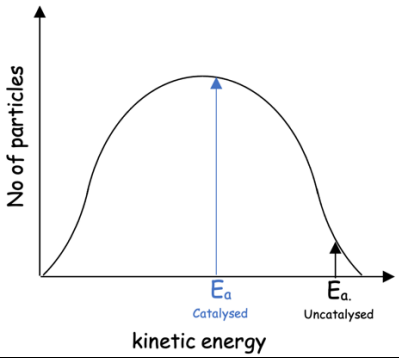
gfm $C_6H_{12}O_6$ = 180g

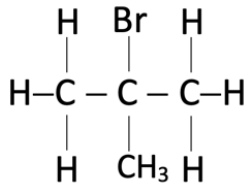
$\textbf{no. of mol} = \frac{\textbf{mass}}{\textbf{gfm}} = \frac{1852.8}{180} = 10.3\text{mol}$

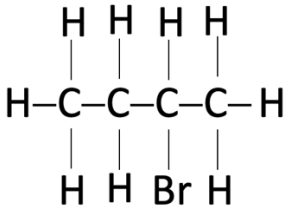
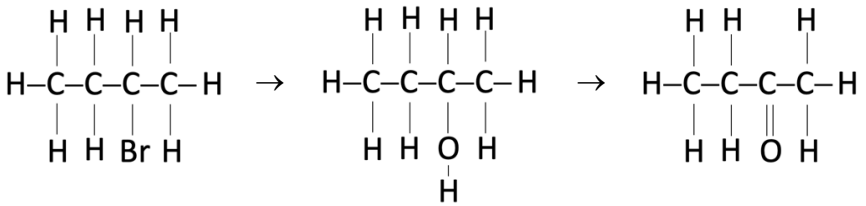
$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$
1mol 2mol 2mol
10.3mol 20.6mol

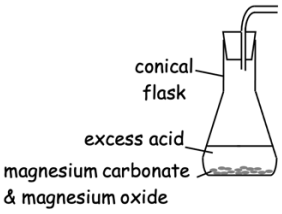
Volume = no. of mol x Molar Volume = 20.6mol x 24litres mol^{-1} = 494litres</td></tr>
<tr><td>5a(i)B</td><td>51.1</td><td>atom economy = $\frac{\text{Mass of useful produce}}{\text{Mass of reactants}}$ x100 = $\frac{2\text{x}46}{1\text{x}180}$ x100 = $\frac{92}{180}$ x100 =51.1%</td></tr>
<tr><td>5a(ii)</td><td>12.2</td><td>% alcohol by volume = $\frac{\text{Change in specific gravity}}{0.7362}$ x100 = $\frac{1.075 - 0.985}{0.7362}$ x100 = 12.2%</td></tr>
<tr><td>5b(i)</td><td>Answer to include one from:</td><td>
<table>
<tr><td>Acidified dichromate would turn orange to green with methanol
<u>and</u> no colour change with propan-2-one.</td><td>Hot copper (II) oxide would turn black to brown with methanol
<u>and</u> no colour change with propan-2-one</td></tr>
</table>
The oxidising agents Fehling's solution and Tollen's reagent would not react with methanol or propan-2-one</td></tr>
<tr><td>5b(ii)A</td><td>terpenes</td><td>Terpenes are formed when isoprene C_5H_8 units join together. The terpenes formed have a carbon number with is a multiple of 5, depending in how many isoprenes joined together.</td></tr>
<tr><td>5b(ii)B</td><td>C_5H_8
unit circled
as shown opposite:</td><td>
<table>
<tr><td>  </td><td>  </td><td>Circled area should resemble a five carbon isoprene unit shown below
 
<u>or</u>
 
• C=C double bonds alter as units join together
• start at one end of terpene to find a C_5H_8 unit</td></tr>
</table>
</td></tr>
</table>

5b(ii)C	ethanoic acid	
5c	2100mg or 2.1g (1 mark for mass and 1 mark for unit)	For 8 hours: 1kg body weight = 10.0mg quinine 70kg body weight = 10.0mg quinine x $^{70}/_{1}$ = 700mg quinine For 24 hours: = 700mg x $^{24}/_{8}$ = 2100mg (=2.1g)
6a(i)A	Curve finishes below reactants	
6a(i)B	Activated Complex	
6a(ii)	Calculation showing:	no. of mol HNO_3 =volume x concentration = 1316litres x 9.5mol l^{-1} = 12502mol no. of mol NH_3 = $\frac{\text{mass}}{\text{gfm}}$ = $\frac{220000}{17}$ = 12941mol (available) $HNO_3 + NH_3 \longrightarrow NH_4NO_3$ 1mol 1mol 12502mol 12502mol(required) More NH_3 available (12941mol) than is required (12502mol) to react all HNO_3 ∴ **NH_3 is in excess** and HNO_3 is the limiting reactant
6a(iii)	100% atom economy	As there is only one product then all reactants end up in the useful product.
6b(i)A	Total number of particles/molecules	The area under the curve is the total number of particles in the sample.

6b(i)B	Graph moves to right	
6b(ii)	Line to the left of dotted line diagram	
6c(i)	rate of forward reaction equals rate of reverse reaction	At equilibrium: rate of forward reaction = rate of reverse reaction (and concentration of reactants and products are *constant*)
6c(ii)A	Answer to include:	1st mark: equilibrium shifts to right hand side **or** increases yield of ammonia 2nd mark: decreases the rate of reverse reaction **or** rate of forward reaction is then greater than rate of reverse reaction
6c(ii)B	One answer from:	recycling of unused gases/reactants; air is a low cost or free resource; uses a catalyst (to reduce energy costs)
6d(i)	$4NH_3+3O_2 \downarrow 2N_2+6H_2O$	❶ $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$ ❷ $2NH_3 + 6OH^- \rightarrow N_2 + 6H_2O + 6e^-$ ❶x3 $3O_2 + 6H_2O + 12e^- \rightarrow 12OH^-$ ❷x2 $4NH_3 + 12OH^- \rightarrow 2N_2 + 12H_2O + 12e^-$ add $3O_2 + \cancel{6H_2O} + \cancel{12e^-} \rightarrow \cancel{12OH^-} + 2N_2 + \cancel{12}\,6\,H_2O + \cancel{12e^-}$ (cancelling $4NH_3 + \cancel{12OH^-}$) $3O_2 + 4NH_3 \rightarrow 2N_2 + 6H_2O$
6d(ii)	ammonia or NH_3	Reducing Agent: reduced something else and is oxidised itself. NH_3 is oxidised and loses electrons: $2NH_3 + 6OH^- \rightarrow N_2 + 6H_2O + 6e^-$
7a(i)	hard water	Hard water contains large quantities of (usually) calcium Ca^{2+} ions. These ions react with soap to form an insoluble precipitate known as scum.
7a(ii)	hydrophilic	hydrophilic: The ionic head of a detergent molecule is hydrophilic as it is polar and dissolved in water hydrophobic: The hydrocarbon tail of a detergent molecule is hydrophobic as it is non-polar and will not mix with water. The hydrocarbon tail will stick into non-polar oil/grease instead
7a(iii)	8.37×10^{-4} or 0.000837	**n**o. of mol EDTA = **v**olume x **c**oncentration = $0.0093_{litres} \times 0.0045_{mol\ l^{-1}} = 4.185\times10^{-5}mol$ $Ca^{2+} + C_{10}H_{12}N_2O_8^{4-} \longrightarrow [Ca(C_{10}H_{12}N_2O_4)]^{2-}$ 1mol $4.185\times10^{-5}mol$; 1mol $4.185\times10^{-5}mol$ **c**oncentration = $\frac{\text{**n**o. of mol}}{\text{**v**olume}} = \frac{4.185\times10^{-5}_{mol}}{0.05_{litres}} = 8.37\times10^{-4}mol$

<table>
<tr><td>7b</td><td>4.4 to 5.4</td><td>Draw a best fit straight line on graph ignoring the rogue point at 4mg l^{-1}.
Draw a line horizontally from Absorbance = 0.08 to the best fit straight line and then vertically go down to x-axis to read the concentration.</td></tr>
<tr><td>7c(i)</td><td>Answer to include:</td><td><table><tr><td>1st Mark:</td><td>Trichloromethane is polar.
and Tetrachloromethane is non-polar.</td></tr><tr><td>2nd Mark:</td><td>Trichloromethane has a permanent dipole.
and Tetrachloromethane has no permanent dipole.</td></tr></table></td></tr>
<tr><td>7c(ii)</td><td>-14</td><td><table><tr><td colspan="2">Bond Breaking Steps (endothermic)</td><td colspan="2">Bond Forming Steps (exothermic)</td></tr><tr><td>1xC-H bond
3x C-Cl bonds
2xH-F bond</td><td>1x 412kJ = 412kJ
3x 338kJ = 1014kJ
2x 570kJ = 1140kJ</td><td>1xC-H bond
2xC-F bonds
1xC-Cl bonds
2xH-Cl bond</td><td>1x 412kJ = 412kJ
2x 484kJ = 968kJ
1x 338kJ = 338kJ
2x 431kJ = 862kJ</td></tr><tr><td>Total bond breaking</td><td>= 2566kJ</td><td>Total bond forming</td><td>= 2580kJ</td></tr></table>Enthalpy change = ∑Bond Breaking Steps – ∑Bond forming steps = 2566 - 2580 = -14kJ mol^{-1}</td></tr>
<tr><td>8</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>9a(i)</td><td>1 mark each:</td><td><table><tr><td>1st Mark:</td><td>Longer the carbon chain the higher the boiling point</td></tr><tr><td>2nd Mark:</td><td>Further Down group 7 the halogen is the higher the boiling point</td></tr></table></td></tr>
<tr><td>9a(ii)</td><td>Permanent dipole to permanent dipole attractions.</td><td>The carbon – halogen C-X bond is a polar bond due to the difference in electronegativities between the two elements. Permanent dipoles are formed when the electrons in the bond are shared unequally. The element with the higher electronegativity has a slightly negatively charge (δ-). The halogen in the C=X bond will carry the δ- charge. Permanent dipole to permanent dipole attractions bring the molecules closer together and raise the boiling point as a result.</td></tr>
<tr><td>9b(i)</td><td>One answer from:</td><td><table><tr><td>2 carbons attached to the carbon with the halogen attached.</td></tr><tr><td>1 hydrogen attached to the carbon with the halogen attached.</td></tr></table></td></tr>
<tr><td>9b(ii)</td><td>  </td><td>To be an isomer of 2-bromobutane then must have formula C_4H_9Br.

To be a tertiary haloalkane, structure must have three carbons/no hydrogens attached to the carbon with the bromine attached.</td></tr>
<tr><td>9c(i)</td><td>Ultraviolet light
or u.v.</td><td>Ultraviolet light is required to provide the energy required to split the covalent bond in halogen in the initiation step.</td></tr>
<tr><td>9c(ii)</td><td>One answer from:</td><td><table><tr><td>$2Br^{\bullet} \rightarrow Br_2$ or
$Br^{\bullet} + Br^{\bullet} \rightarrow Br_2$</td><td>$Br^{\bullet} + {}^{\bullet}CH_3 \rightarrow CH_3Br$</td><td>$2{}^{\bullet}CH_3 \rightarrow C_2H_6$ or
${}^{\bullet}CH_3 + {}^{\bullet}CH_3 \rightarrow C_2H_6$</td></tr></table></td></tr>
<tr><td>9d</td><td>  </td><td>Tollen's Reagent and Fehling's solution will react with aldehydes only.
• R C_4H_8O must be an ketone if it does not react with Tollens and Fehling's.
• Q C_4H_9OH must be a secondary alcohol if it is oxidised into ketone R
Haloalkane P → Alcohol Q → Ketone R
$C_4H_9Br \rightarrow C_4H_9OH \rightarrow C_4H_8O$
  </td></tr>
<tr><td>9e</td><td>Answer shown:</td><td>2-bromo-3-chloro-1,1,1-trifluoropentane</td></tr>
</table>

<table>
<tr><td>10a</td><td>Answer to include:</td><td>
<table>
<tr><th>Mark</th><th>Version 1</th><th>Version 2</th><th>Version 3</th></tr>
<tr><td>1st Mark</td><td>Tare the balance with the crucible</td><td>Tare a weighing boat, transfer the 1.5 g onto the weighing boat. Record mass. Transfer into the crucible.</td><td>Weigh mixture and weighing boat, record the mass. Transfer mixture into the crucible.</td></tr>
<tr><td>2nd Mark</td><td>Transfer 1·5 g (into the crucible)</td><td>Reweigh the weighing boat and record the mass/calculate the difference</td><td>Reweigh the weighing boat and record the mass/calculate the difference</td></tr>
</table>
</td></tr>
<tr><td>10b(i)</td><td>to allow gas/CO_2 to escape</td><td>The gas formed in the reaction will build up in the crucible under the lid. Lifting the lid will prevent. Pressure building up that could dislodge the lid.</td></tr>
<tr><td>10b(ii)</td><td>reactants/products are not flammable</td><td>Bunsen burners should be replaced with non-flammable heating methods like hot plates and heating mantles when the reactants or products are flammable.</td></tr>
<tr><td>10c</td><td>0.582</td><td>**m**ass of crucible before heating = 1.598g **m**ass of crucible after heating = 1.294g
mass of CO_2 released = 1.598g – 1.294g = 0.304g
gfm CO_2 = 44g
$\text{no. of mol} = \frac{\textbf{mass}}{\textbf{gfm}} = \frac{0.304}{44} = 0.00691\text{mol}$
$MgCO_3 \longrightarrow MgO + CO_2$
1mol 1mol
0.00691mol 0.00691mol
gfm $MgCO_3$ = 84.3g
mass = **n**o. of mol x **gfm** = 0.00691 x 84.3 = 0.582g</td></tr>
<tr><td>10d(i)</td><td> 
</td><td></td></tr>
<tr><td>10d(ii)</td><td>carbon dioxide has low solubility in water</td><td>Only gases that are insoluble or have low solubility in water should be collect over water this water. There is some loss of gas during the process. The best way to collect CO_2 in a gas syringe so there is no loss of any gas by dissolving in water.</td></tr>
</table>