JABchem

Past Papers Higher Chemistry

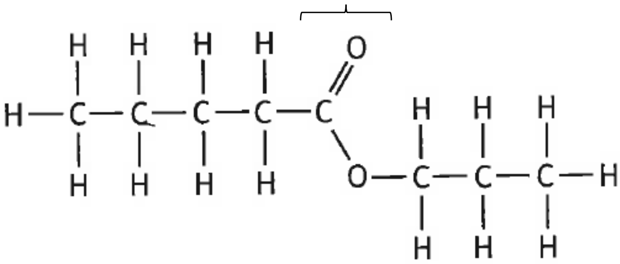
2022

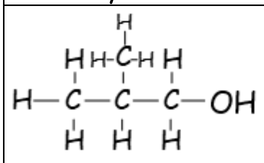
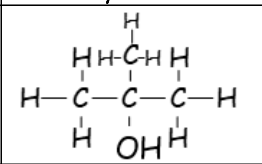
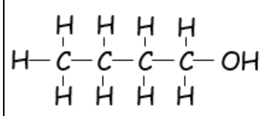
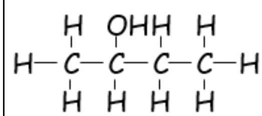
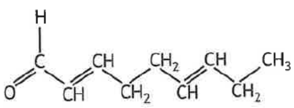
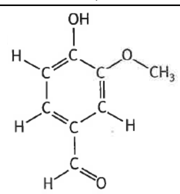
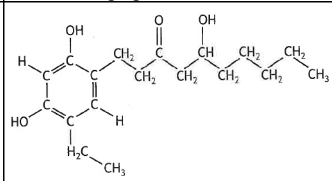
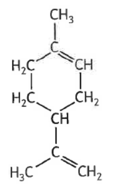
Marking Scheme

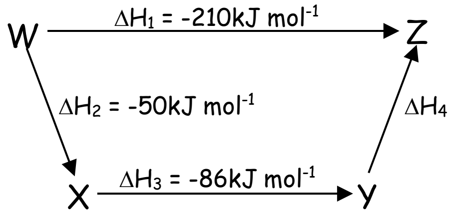
Grade Awarded	Mark Required (/120)	%	% candidates achieving grade
A	84+	70.0%	34.9%
B	68+	56.7%	24.1%
C	53+	44.2%	19.3%
D	37+	30.1%	12.9%
No award	<37	<30.1%	8.8%

Section:	Multiple Choice	Extended Answer	Assignment
Average Mark:	16.4 /25	55.1 /95	No Assignment in 2022

2022 Higher Chemistry Marking Scheme

<table>
<tr><th>MC Qu</th><th>Answer</th><th>Reasoning</th></tr>
<tr><td>1</td><td>D</td><td>☒A Boron is a covalent network due to its high melting point
☒B Neon is monatomic in Group 0 due to its full pouter shell
☒C Sodium is a metal and contains metallic bonding
☑D Sulphur has a covalent S_8 structure and has LdF between molecules</td></tr>
<tr><td>2</td><td>A</td><td>☑A Forming a 2+ ion creates a full outer shell and a low 2nd ionisation energy
☒B Forming a 3+ ion creates a full outer shell and a low 3rd ionisation energy
☒C ionisation energy removes electrons and forms positive ions
☒D ionisation energy removes electrons and forms positive ions</td></tr>
<tr><td>3</td><td>C</td><td>☒A Intermolecular forces decide the boiling point not the covalent bonds inside
☒B Intermolecular forces decide the boiling point not the covalent bonds inside
☑C Permanent dipole to permanent dipole attractions between polar covalent HCl molecules are stronger than London dispersion forces between H_2 molecules
☒D Van der Waals' forces are never stronger than covalent bonds</td></tr>
<tr><td>4</td><td>B</td><td>
<table>
<tr><th>Agent</th><th>Reducing Agent</th><th>Oxidising Agent</th></tr>
<tr><td>Action of Agent on Another Species</td><td>reduces another species</td><td>oxidises another species</td></tr>
<tr><td>Action on Agent Itself</td><td>agent is oxidised</td><td>agent is reduced</td></tr>
<tr><td>Effect on Electrons in Agent</td><td>loss of electrons</td><td>gain of electrons</td></tr>
<tr><td>Likely Electronegativity of Agent</td><td>low</td><td>high</td></tr>
<tr><td>Position in Electrochemical series</td><td>top right</td><td>bottom Left</td></tr>
</table>
</td></tr>
<tr><td>5</td><td>D</td><td>Redox: $Cr_2O_7^{2-} + 14H^+ + 6Fe^{2+} \rightarrow 2Cr^{3+} + 7H_2O + 6Fe^{3+}$
Oxidation: $6Fe^{2+} \rightarrow 6e^- + 6Fe^{3+}$
Reduction: $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$</td></tr>
<tr><td>6</td><td>A</td><td>
<table>
<tr><th>Formula:</th><th>$MgBr_2$</th><th>$MgSO_4$</th></tr>
<tr><td>Mole ratio:</td><td>1mol : 2mol</td><td>1mol : 1mol</td></tr>
<tr><td>4mol Br^- ions</td><td>2mol : 4mol</td><td></td></tr>
<tr><td>3mol Mg^{2+} ions</td><td>2mol</td><td>1mol</td></tr>
<tr><td>1mol SO_4^{2-} ions</td><td></td><td>1mol : 1mol</td></tr>
</table>
</td></tr>
<tr><td>7</td><td>D</td><td>Ester Link

C_5 carboxyl side ∴Ends in Pentanoate
C_3 alcohol side ∴Starts with Propyl</td></tr>
<tr><td>8</td><td>C</td><td>Structure shown has formula $C_8H_{16}O$
☒A octan-4-one has formula $C_8H_{16}O$
☒B 2-ethylhexanal has formula $C_8H_{16}O$
☑C 2-ethylhexan-1-ol has formula $C_8H_{18}O$
☒D 5-methylheptan-3-one has formula $C_8H_{16}O$</td></tr>
<tr><td>9</td><td>A</td><td>
<table>
<tr><th>Name</th><th>Hydroxyl</th><th>Carboxyl</th><th>Amine</th><th>Carbonyl</th></tr>
<tr><td>Functional Group</td><td>—OH</td><td>—C(=O)—OH</td><td>H—N(H)—</td><td>—C(=O)—</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><td>10</td><td>C</td><td>☒A C=C double bond in prenol molecule would decolourise bromine solution quickly
☒B C=C double bond in prenol molecule would decolourise bromine solution quickly
☑C Prenol would decolourise bromine solution and react with hot copper (II) oxide
☒D Prenol is a primary alcohol and would react with hot copper (II) oxide</td></tr>
<tr><td>11</td><td>B</td><td>Palm oil has iodine number of 48 ∴ 48g of Iodine reacts with 100g of palm oil
Olive oil has iodine number of 84 ∴ 84g of Iodine reacts with 100g of olive oil
• palm oil must contain less C=C double bonds than olive oil as less iodine is required by palm oil to saturate the molecules completely.
• palm oil must be more saturated than olive oil if it contains less C=C bonds
• more saturated palm oil molecules fit together better would meaning palm oil molecules are closer together and raises melting point of palm oil.</td></tr>
<tr><td>12</td><td>B</td><td>☒A head section is polar making it hydrophilic.
☑B hydrophilic head dissolves in water and hydrophobic tail dissolves in oil
☒C head section is polar would dissolve in water making it hydrophilic.
☒D head section is polar would dissolve in water.</td></tr>
<tr><td>13</td><td>D</td><td><table>
<tr><td>2-methylbutan-1-ol</td><td>2-methylbutan-2-ol</td><td>butan-1-ol</td><td>butan-2-ol</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td><u>Primary Alcohol</u>
1 carbon directly attached to the carbon with the -OH group</td><td><u>Tertiary Alcohol</u>
3 carbons directly attached to the carbon with the -OH group</td><td><u>Primary Alcohol</u>
1 carbon directly attached to the carbon with the -OH group</td><td><u>Secondary Alcohol</u>
2 carbons directly attached to the carbon with the -OH group</td></tr>
</table></td></tr>
<tr><td>14</td><td>C</td><td><table>
<tr><td>A</td><td>B</td><td>C</td><td>D</td></tr>
<tr><td>cucumber flavour</td><td>vanilla flavour</td><td>ginger flavour</td><td>Orange flavour</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>mainly non-polar molecule
(C=O carbonyl molecule only slightly polar)
∴oil soluble</td><td>Polar Molecule
due to -OH group
∴water soluble</td><td>Polar Molecule
due to 3x -OH groups
∴water soluble</td><td>Non-polar molecule
∴oil soluble</td></tr>
</table></td></tr>
<tr><td>15</td><td>B</td><td>☒A Carbonyl group would be numbered C_2 to give functional group lowest numbering system
☑B Secondary alcohol 4-methylpentan2-ol oxidises to form the ketone 4-methylpentan-2-one
☒C Molecule is secondary alcohol and would oxidise to form a ketone not aldehyde
☒D Molecule is secondary alcohol and would oxidise to form a ketone not aldehyde</td></tr>
<tr><td>16</td><td>C</td><td>☒A the bottom of the meniscus should be used to measure the volumes in a burette
☒B rinsing the burette with deionised water will result in the dilution of the next solution in burette
☑C small volume of the reactant in the burette should be used to rinse the burette before use, the bottom of the meniscus should be used to measure volumes and draining a small volume of acid will remove any air bubble below the tap in the burette.
☒D the bottom of the meniscus should be used to measure the volumes in a burette</td></tr>
<tr><td>17</td><td>B</td><td>☒A polar ethanol would not be a solvent to dissolve non-polar lycopene & beta-carotene
☑B pentane is non-polar and would be a good solvent for non-polar lycopene & beta-carotene
☒C polar propanoic acid would not be a solvent to dissolve non-polar lycopene & beta-carotene
☒D polar water would not be a solvent to dissolve non-polar lycopene & beta-carotene</td></tr>
<tr><td>18</td><td>D</td><td>$\text{rate} = \frac{1}{\text{time}} = \frac{1}{0.004} = 250\text{s}$</td></tr>
<tr><td>19</td><td>A</td><td>$$\underbrace{\underset{\substack{1\text{mol}\\1\text{vol}\\100\text{cm}^3}}{C_4H_{8(g)}} + \underset{\substack{6\text{mol}\\6\text{vol}\\600\text{cm}^3}}{6O_{2(g)}}}_{700\text{cm}^3 \text{ used up}} \longrightarrow \underbrace{\underset{\substack{4\text{mol}\\4\text{vol}\\400\text{cm}^3}}{4CO_{2(g)}} + \underset{\substack{4\text{mol}\\4\text{vol}\\400\text{cm}^3}}{4H_2O_{(g)}}}_{800\text{cm}^3 \text{ produced}}$$</td></tr>
</table>

<table>
<tr><td>20</td><td>C</td><td>☒A No effect as neither Na^+ or Cl^- ions is a reactant or product and don't react with a reactant/product
☒B H^+ ions in $HCl_{(aq)}$ increases concentration of a product ∴equilibrium shifts to left
☑C OH^- ions in $NaOH_{(aq)}$ neutralises H^+ in products ∴equilibrium shifts to right to replace H^+ ions
☒D CH_3COO^- ions in $CH_3COONa_{(aq)}$ increases concentration of product ∴equilibrium shifts to left</td></tr>
<tr><td>21</td><td>D</td><td><table>
<tr><th>Quantity</th><th>Measured</th><th>A</th><th>B</th><th>C</th><th>D</th></tr>
<tr><td>Enthalpy of Reactants ($kJ\ mol^{-1}$)</td><td>Where R starts on y-axis</td><td>30</td><td>30</td><td>30</td><td>30</td></tr>
<tr><td>Activation Energy of Forward Reaction ($kJ\ mol^{-1}$)</td><td>Difference between R and top of hill</td><td>80-30
= 50</td><td>110-30
= 80</td><td>110-30
= 80</td><td>140-30
= 110</td></tr>
<tr><td>Activation Energy of Reverse Reaction ($kJ\ mol^{-1}$)</td><td>Difference between P and top of hill</td><td>80-40
= 40</td><td>110-40
= 70</td><td>110-70
= 40</td><td>140-70
= 70</td></tr>
</table></td></tr>
<tr><td>22</td><td>B</td><td>$\Delta H_1 = \Delta H_2 + \Delta H_3 + \Delta H_4$
$\Delta H_4 = \Delta H_1 - \Delta H_2 - \Delta H_3$
$\Delta H_4 = -210 - (-50) - (-86)$
$\Delta H_4 = -74kJ\ mol^{-1}$
But ΔH for Z to Y = $+74kJ\ mol^{-1}$
</td></tr>
<tr><td>23</td><td>A</td><td>$50cm^3$ diluted in a $250cm^3$ standard/volumetric flask gives 1 in 5 dilution.
$0.100mol\ l^{-1}$ given 1 in 5 dilution results in solution becoming $0.02mol\ l^{-1}$ (or $2.0\times10^{-2}\ mol\ l^{-1}$)</td></tr>
<tr><td>24</td><td>B</td><td>☒A gfm AgF = 107.9 ∴ $n = {}^{m}/_{gfm} = {}^{2.868}/_{107.9} = 0.0266mol$
☑B gfm AgCl = 143.4 ∴ $n = {}^{m}/_{gfm} = {}^{2.868}/_{143.4} = 0.0200mol$
☒C gfm AgBr = 187.8 ∴ $n = {}^{m}/_{gfm} = {}^{2.868}/_{187.8} = 0.0153mol$
☒D gfm AgI = 234.8 ∴ $n = {}^{m}/_{gfm} = {}^{2.868}/_{234.8} = 0.0122mol$</td></tr>
<tr><td>25</td><td>A</td><td>☑A $10cm^3$ of water is better measured in a measuring cylinder and titration carried out in conical flask
☒B beakers are not as accurate as measuring cylinders for measuring volumes
☒C Volumetric/standard flasks are used to make up solutions of accurately known concentration
☒D Volumetric/standard flasks are used to make up solutions of accurately known concentration</td></tr>
</table>

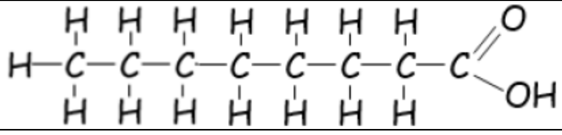
2022 Higher Chemistry Marking Scheme

Long Qu	Answer	Reasoning
1a(i)	one answer from:	atoms/nuclei have the same attraction for the bonding electrons / same electronegativity/ electronegativity values given / Bonding electrons shared equally (between the atoms).
1a(ii)	greater nuclear charge	Across a period, **the number of protons increases** giving a **greater nuclear charge**. The greater nuclear charge pulls the outer electron shell further which reduces the size of the atom.
1b(i)	Answer to include:	The energy required to remove 1 mole of electrons from one mole of atoms in the gaseous state.
1b(ii)	One answer from:	More shells so increased screening/shielding covalent radius increases / atom size increases / more shells so attraction of nucleus / protons for outer electrons **decreases**
1c(i)	Answer to include:	Hydrogen bonding (1 mark) 1 mark for either: Hydrogen bonding occurs between hydrogen bonded to N, O or F *(all 3 elements needed)* The attraction between δ+ end on a permanent dipole is strongly attracted to the δ– end of a neighbouring permanent dipole in molecules with hydrogen and a atom with high electronegativity
1c(ii)	Answer to include:	1st Mark: London dispersion forces become stronger (moving from HCl to HI) 2nd Mark: Number of electrons increases (moving from HCl to HI)
2a	$3KClO_4 + 8Al$ ↓ $3KCl + 4Al_2O_3$	$3KClO_4 + 8Al \longrightarrow 3KCl + 4Al_2O_3$
2b(i)	1.35	**gfm** $KClO_4$ = 122.6g **no.** of mol = $\frac{\text{mass}}{\text{gfm}} = \frac{4.6}{122.6}$ = 0.0375mol $2KlClO_3 \longrightarrow 3O_2 + 2KCl$ 2mol → 3mol 0.0375mol → 0.0563mol **Volume** = **no.** of mol x **Molar Volume** = 0.0563mol x 24litres mol^{-1} = 1.35litres
2b(ii)	no effect	Catalysts speed up chemical reaction but do not get used up in that chemical reaction. The enthalpy change is the same for the catalysed and the non-catalysed route due to Hess's Law.
2b(iii)	2595.6	5.5g ⟷ 103kJ 1mol = 138.6g ⟷ 103kJ x $^{138.6}/_{5.5}$ = 2595.6kJ
2b(iv)	Answer to include:	1st Mark: Increases the number of particles with energy 2 equal to or greater than the activation energy or Increases the number of particles with (sufficient) energy to form an activated complex/to react 2nd Mark: More successful collisions
2c	Sodium	Peak B at 590nm. Sodium gives a flame colour at 589nm.
3	Open Question Answer to Include:	**3 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. **2 mark answer**: Demonstrates a **reasonable understanding** of the chemistry involved, making some statement(s) which are relevant to the situation, showing that the problem is understood. **1 mark answer**: 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.

4a(i) | Ester link

—O—H	$-\overset{\displaystyle O}{\overset{\|}{C}}-OH$	$-\overset{\displaystyle O}{\overset{\|}{C}}-O-$	$-\overset{\displaystyle O}{\overset{\|}{C}}-$
hydroxyl group	carboxyl group	ester link	carbonyl group

4a(ii) | Diagram showing:



4a(iii) | Structure of Heptan-1-ol or other C_7 alcohol listed:

Propyl octanoate has a total of 11 carbons. For the isomer of propyl octanoate to be an ester with butanoic acid being released during hydrolysis, the alcohol released by this hydrolysis must have seven carbons. There are 38 possible seven carbon alcohols. (I think!)

heptan-1-ol	heptan-2-ol	heptan-3-ol	heptan-4-ol
2-methylhexan-1-ol	3-methylhexan-1-ol	4-methylhexan-1-ol	5-methylhexan-1-ol
2-methylhexan-2-ol	3-methylhexan-2-ol	4-methylhexan-2-ol	5-methyl-hexan-2-ol
2-methylhexan-3-ol	3-methylhexan-3-ol	4-methylhexan-3-ol	5-methylhexan-3-ol
2,2-dimethylpentan-1-ol	2,3-dimethylpentan-1-ol	2,4-dimethylpentan-1-ol	3,3-dimethylpentan-1-ol
3,4-dimethylpentan-1-ol	4,4-dimethylpentan-1-ol	2,3-dimethylpentan-2-ol	2,4-dimethylpentan-2-ol
3,3-dimethylpentan-2-ol	3,4-dimethylpentan-2-ol	4,4-dimethylpentan-2-ol	2,2-dimethylpentan-3-ol
2,3-dimethylpentan-3-ol	2,4-dimethylpentan-3-ol	2,2,3-trimethylbutan-1-ol	2,3,3-trimethylbutan-1-ol
2,3,3-trimethylbutan-2-ol	3-ethylpentan-1-ol	3-ethylpentan-2-ol	3-ethylpentan-3-ol
2-ethyl-2-methylbutan-1-ol	2-ethyl-3-methylbutan-1-ol		

4b(i) | 35-45

Triglyceride	Glyceryl trilinoleate	Glyceryl tricaprate	Difference
Number of Carbons	57 carbons	33 carbons	24 carbons
Absorbance Units	19.3	16.1	3.2

3.2 difference in absorbance units = 24 carbons

Glyceryl trilaurate = 17.5 absorbance units (1.4 units above Glyceryl tricaprate)

1.4 difference in absorbance units = $24 \times {}^{1.4}/_{3.2}$ = 10.5 carbons

∴ Estimate of number of carbons in glyceryl trilaurate = 24 + 11 = 35

4b(ii) | glyceryl trilinoleate

The lower the melting point, the higher the number of C=C double bonds in molecule.
Oil molecules do not fit as close together due to the change of direction in the carbon chain after a C=C double bond. The further apart the molecules are, the lower the melting point as less energy is needed to separate the molecules into a liquid as there are weaker van der Waals' between oil molecules.

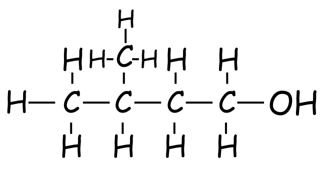
4c(i) | by react with glycerol

Fatty acids from edible oils <u>react</u> with glycerol by condensation reaction. One or two fatty acids react with glycerol to form an emulsifier. This will leave at least one polar -OH group on the glycerol part of the molecule needed to form the hydrophilic head on the emulsifier.

4c(ii) | Answer to include:

1st Mark:	Correctly identifying that the 2 emulsifier has two parts with different polarities or two parts that are hydrophobic/hydrophilic.
2nd Mark:	Hydrophobic part / hydrocarbon chain / fatty acid chain / non-polar part } dissolves in non-polar liquids hydrophilic part / hydroxyl groups / polar part } dissolves in polar liquids

5a | 3-methylbutan-1-ol



3-methylbutan-1-ol

$\underbrace{\text{3-methyl}}_{\text{methyl -CH}_3\text{ on C}_3\text{ of main chain}}\underbrace{\text{butan}}_{\text{four carbons on main chain}}\underbrace{\text{-1-ol}}_{\text{-OH group on C}_1}$

5b(i) | $C_3H_7OH \rightarrow C_3H_6O + 2H^+ + 2e^-$

<u>Step 1</u>: Write down main species in reaction

$C_3H_7OH \rightarrow C_3H_6O$

<u>Step 2</u>: Balance all atoms other than O or H (no change in this example)

$C_3H_7OH \rightarrow C_3H_6O$

<u>Step 3</u>: Balance O atoms by adding H_2O to the other side (no change in this example)

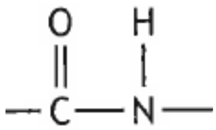
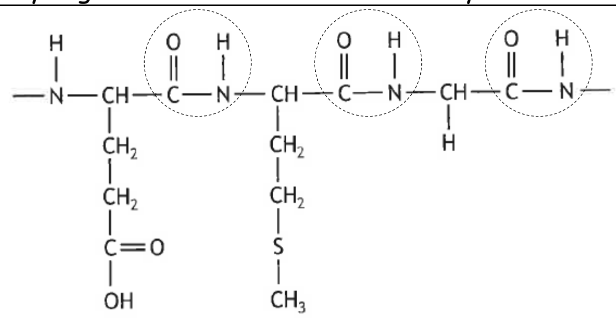
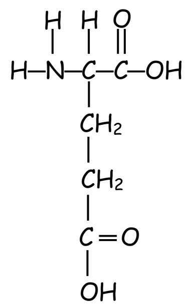
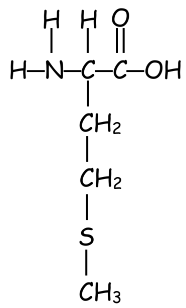
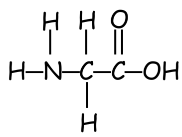
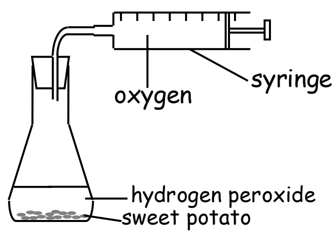
$C_3H_7OH \rightarrow C_3H_6O$

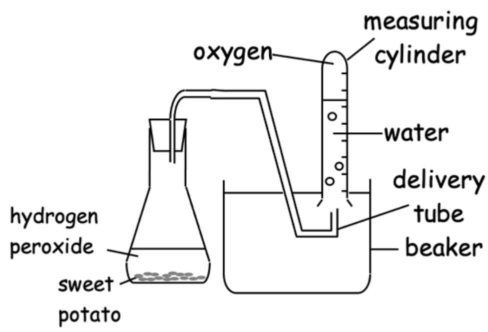
<u>Step 4</u>: Balance H atoms by adding H^+ to the other side

$C_3H_7OH \rightarrow C_3H_6O + 2H^+$

<u>Step 5</u>: Balance charge by adding electrons to the most positive side

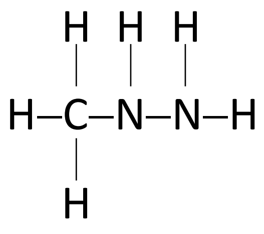
$C_3H_7OH \rightarrow C_3H_6O + 2H^+ + 2e^-$

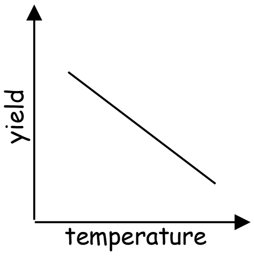
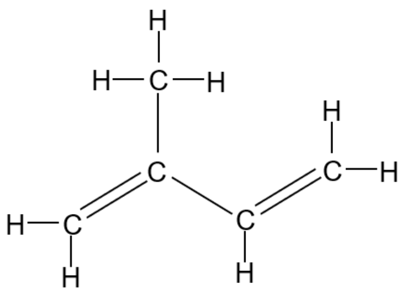
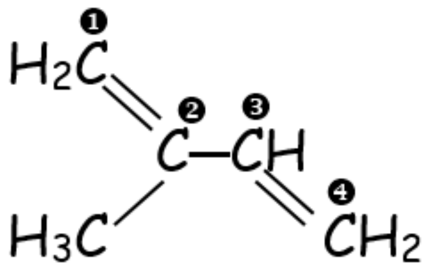
<table>
<tr><td>5b(ii)</td><td>To provide H^+ ions</td><td>H^+ ions are a reactant on the left hand side of the equation. If the reactants are not acidified than one of the reactants will be absent and the chemical reaction will not proceed.</td></tr>
<tr><td>5b(iii)</td><td>orange → green</td><td>
<table>
<tr><th>Oxidising Agent</th><th>Start Colour</th><th>End Colour</th></tr>
<tr><td>Acidified Dichromate</td><td>Orange</td><td>Green</td></tr>
<tr><td>Fehling's Solution</td><td>Blue</td><td>Brick Red (orange)</td></tr>
<tr><td>Hot copper (II) oxide</td><td>Black</td><td>Brown</td></tr>
<tr><td>Tollen's Reagent</td><td>(Colourless)</td><td>Silver mirror produced</td></tr>
</table>
</td></tr>
<tr><td>5b(iv)</td><td>Tollen's Reagent</td><td>
<table>
<tr><th>Oxidising Agent</th><th>Reactant(s)</th><th></th><th>Product(s)</th></tr>
<tr><td>Acidified Dichromate</td><td>$Cr_2O_7^{2-} + 14H^+ + 6e^-$</td><td>→</td><td>$2Cr^{3+} + 7H_2O$</td></tr>
<tr><td>Fehling's Solution</td><td>$Cu^{2+} + e^-$</td><td>→</td><td>Cu^+</td></tr>
<tr><td>Hot copper (II) oxide</td><td>$Cu^{2+} + 2e^-$</td><td>→</td><td>Cu</td></tr>
<tr><td>Tollen's Reagent</td><td>$Ag^+ + e^-$</td><td>→</td><td>Ag</td></tr>
</table>
</td></tr>
<tr><td>5b(v)</td><td>tertiary alcohols
(do not oxidise)</td><td>
<table>
<tr><td rowspan="3">Oxidation of Alcohols</td><td>Primary alcohol → Aldehyde → Carboxylic acid</td></tr>
<tr><td>Secondary alcohol → Ketone $\not\rightarrow$ [No oxidation]</td></tr>
<tr><td>Tertiary alcohol $\not\rightarrow$ [No oxidation]</td></tr>
</table>
</td></tr>
<tr><td>5b(vi)</td><td>1 : 10
1 : 8</td><td>
<table>
<tr><th>Chemical</th><th>Formula</th><th>No. of O</th><th>No. of H</th><th>Oxygen : Hydrogen ratio</th></tr>
<tr><td>butan-1-ol</td><td>C_4H_9OH</td><td>1</td><td>10</td><td>1:10</td></tr>
<tr><td>butanal</td><td>C_4H_8O</td><td>1</td><td>8</td><td>1:8</td></tr>
</table>
</td></tr>
<tr><td>6a(i)</td><td>biological catalyst</td><td>An enzyme is a specially-shaped protein which acts as a biological catalyst, catalysing chemical reactions in the body at 37°C.</td></tr>
<tr><td>6a(ii)A</td><td>one peptide link circled:
</td><td></td></tr>
<tr><td>6a(ii)B</td><td>one amino acid structure from:</td><td> or  or </td></tr>
<tr><td>6a(ii)C</td><td>amino acid which must be obtained through diet</td><td>Essential amino acids are amino acids which must be obtained from your diet for a healthy diet to be obtained. These amino acids cannot be made by the body.</td></tr>
<tr><td>6a(ii)D</td><td>condensation</td><td>A condensation reaction occurs when two molecules join together to form a bigger molecule and water is removed at the join.
Other small molecules can also be removed instead of water.</td></tr>
<tr><td>6a(iii)</td><td>Answer to include:</td><td>
<table>
<tr><td>1st Mark:</td><td>enzyme becomes denatured/enzyme changes shape</td></tr>
<tr><td>2nd Mark:</td><td>Intermolecular/hydrogen bonds are broken</td></tr>
</table>
</td></tr>
<tr><td>6a(iv)</td><td>Answer to include one of:</td><td>

or

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

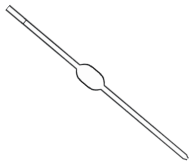
<table>
<tr><td>6b(i)</td><td>one answer from:</td><td>
<table><tr><td>To prevent unwanted oxidation</td><td>to oxidise in place of the compounds they have been added to protect</td><td>to stop (oxidation of edible oils) food acquiring a rancid flavour.</td></tr></table>
</td></tr>
<tr><td>6b(ii)</td><td>answer to include:</td><td>
<table>
<tr><td>1st Mark:</td><td>Vitamin C molecule is polar due to its hydroxyl groups or Vitamin C can form hydrogen bonds due to its hydroxyl groups</td></tr>
<tr><td>2nd Mark:</td><td>Vitamin C is soluble in water because of interactions of polar -OH groups in Vitamin C with polar -OH groups in water.</td></tr>
</table>
</td></tr>
<tr><td>6c</td><td>975g
2 marks for mass
1 mark for units</td><td>1kg body weight ↔ 3mg solanine
65kg body weight ↔ 3mg solanine x $^{65}/_{1}$
=195g solanine
0.2mg solanine ↔ 1g of potato
195mg solanine ↔ 1g of potato x $^{195}/_{0.2}$
= 975g of potato</td></tr>
<tr><td>7a</td><td>0.203g</td><td>Heat Energy = Specific Heat Capacity x Mass x Change In Temperature
$E_h = c \times m \times \Delta T$
$E_h = 4.18\ kJ\ kg^{-1}\ {}^oC^{-1} \times 0.1kg \times 27^oC$
$E_h = 11.3\ kJ$
gfm Heptane CH_4 = (1x12) + (4x1) = 12 + 4 = 16g
1 mol CH_4 = 891 kJ ⟷ 16g
11.3 kJ ⟷ 16g x $^{11.3}/_{891}$
= 0.203g</td></tr>
<tr><td>7b</td><td>-816</td><td>
<table>
<tr><td colspan="2">Bond Breaking Steps (endothermic)</td><td colspan="2">Bond Forming Steps (exothermic)</td></tr>
<tr><td>4xC-H bonds
2xO=O bond</td><td>4x 412kJ = 1648kJ
2x 498kJ = 996kJ</td><td>2xC=O bonds
4xO-H bonds</td><td>2x 804kJ = 1608kJ
4x 463kJ = 1852kJ</td></tr>
<tr><td>Total bond breaking</td><td>= 2644kJ</td><td>Total bond Forming</td><td>= 3460kJ</td></tr>
<tr><td colspan="4">Enthalpy change = ∑Bond Breaking Steps – ∑Bond forming steps = 2644 - 3460 = -816kJ mol^{-1}</td></tr>
</table>
</td></tr>
<tr><td>7c</td><td>17.6%</td><td>atom economy = $\frac{\text{mass of useful products}}{\text{total mass of reactants}}$ x100 = $\frac{(3x2)}{(1x16) + (1x18)}$ x100 = 17.6%</td></tr>
<tr><td>7d</td><td><table><tr><td>High</td></tr><tr><td>Low</td></tr></table></td><td>
<table>
<tr><td>Change in Temperature</td><td>Change In Pressure</td></tr>
<tr><td>Maximising Yield of NO_2 = more reverse reaction
• reverse reaction is endothermic
• Increasing temperature favours the endothermic reaction
• HIGH temperature increases reverse reaction
• HIGH temperature increases yield of NO_2</td><td>Maximising Yield of NO_2 = more reverse reaction
• reverse reaction increases pressure (1vol→2vol)
• Decreasing pressure favours the pressure-increasing reaction
• LOW pressure increases reverse reaction
• LOW pressure increases yield of NO_2</td></tr>
</table>
</td></tr>
<tr><td>7e(i)</td><td>-4632</td><td>
❶ $C_{(s)} + 3H_{2(g)} + N_{2(g)} \rightarrow CH_3NHNH_{2(l)}$ ΔH=+54 kJ mol^{-1}
❷ $N_{2(g)} + 2O_{2(g)} \rightarrow N_2O_{4(g)}$ ΔH=-20 kJ mol^{-1}
❸ $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$ ΔH=-394 kJ mol^{-1}
❹ $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}$ ΔH=-286 kJ mol^{-1}
❺ $H_2O_{(l)} \rightarrow H_2O_{(g)}$ ΔH=+41 kJ mol^{-1}

❶x-4 $4CH_3NHNH_{2(l)} \rightarrow \cancel{4C_{(s)}} + \cancel{12H_{2(g)}} + 4N_{2(g)}$ ΔH=-216 kJ mol^{-1}
❷x-5 $5N_2O_{4(g)} \rightarrow 5N_{2(g)} + \cancel{10O_{2(g)}}$ ΔH=+100 kJ mol^{-1}
❸x4 $\cancel{4C_{(s)}} + \cancel{4O_{2(g)}} \rightarrow 4CO_{2(g)}$ ΔH=-1576 kJ mol^{-1}
❹x12 $\cancel{12H_{2(g)}} + \cancel{6O_{2(g)}} \rightarrow \cancel{12H_2O_{(l)}}$ ΔH=-3432 kJ mol^{-1}
❺x12 $\cancel{12H_2O_{(l)}} \rightarrow 12H_2O_{(g)}$ ΔH=+492 kJ mol^{-1}

add $5N_2O_{4(g)} + 4CH_3NHNH_{2(l)} \rightarrow 4CO_{2(g)} + 12H_2O_{(g)} + 9N_{2(g}$ ΔH=-4632 kJ mol^{-1}
</td></tr>
<tr><td>7e(ii)</td><td></td><td>
<table>
<tr><td>Element</td><td>Valency</td><td>No of Bonds made by element</td></tr>
<tr><td>C</td><td>4</td><td>4</td></tr>
<tr><td>N</td><td>3</td><td>3</td></tr>
<tr><td>H</td><td>1</td><td>1</td></tr>
</table>
</td></tr>
</table>

8a(i)	increase increase no effect	A catalyst increases the rate of both the forward and reverse reactions by lowering the activation energies of both the forward and reverse reactions. The position of equilibrium is not changed but the time to get to equilibrium is shortened.
8a(ii)		The forward reaction in the water-gas shift reaction is exothermic. • Increasing the temperature favours the endothermic reaction • Reverse reaction is endothermic • Reverse reaction is favoured by increasing the temperature • Less products formed as temperature increase • Graph has decreasing slope as yield decreases as temperature increases
8b	Calculation showing:	**gfm** sorbic acid $C_6H_8O_2$ = (6x12)+(8x1)+(2x16) = 72 + 8 + 32 = 112 no. of mol = $\frac{\text{mass}}{\text{gfm}} = \frac{7}{112}$ = 0.0625mol (**available**) **n** KOH = **v**olume x **c**oncentration = 0.25litres x 0.5mol l^{-1} = 0.125mol $C_6H_8O_2 + KOH \longrightarrow H_2O + C_6H_7O_2$ 1mol 0.125mol (**required**) Less **no.** of mol of sorbic acid **available** than is **required** ∴ Sorbic acid is limiting reactant and KOH is in excess
8c	2.52×10^{-5} or 0.0000252	1% = 1g per 100cm^3 0.002% = 0.002g per 100cm^3 100cm^3 = 0.002g 330cm^3 = 0.002g x $^{330}/_{100}$ = 0.0066g **gfm** = 261.8g no. of mol = $\frac{\text{mass}}{\text{gfm}} = \frac{0.0066}{261.8}$ = 2.52×10^{-5} mol
8d(i)A	non-water soluble or volatile or aroma	Essential oils are concentrated extracts of volatile, non-water soluble aroma compounds from plants • mixtures of many different compounds. • widely used in perfumes | cosmetic products | cleaning products | flavourings in foods
8d(i)B Part I	terpene	Terpenes are key components in most essential oils. Terpenes are unsaturated compounds formed by joining together isoprene (2-methylbuta-1,3-diene) units.
8d(i)B Part II	correct structure drawn of 2-methylbut-1,3-diene	 or 
8d(i)B Part III	3	Formula of zingiberene: $C_{15}H_{24}$ Formula of isoprene: C_5H_8 ∴ 3 isoprene units join together
8d(ii)A	water or H_2O	The difference between the two molecules is the a C=C double bond is formed in the product and an H atom was removed on one side where the C=C double bond formed and a OH group was removed from the other side of where the C=C double bond formed.

8d(ii)B	Hydroxyl group and Carbonyl Group	—O—H : hydroxyl group O=C—OH (— C — OH with =O) : carboxyl group O=C (—C— with =O) : carbonyl group
9	Open Question Answer to Include:	**3 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. **2 mark answer**: Demonstrates a **reasonable understanding** of the chemistry involved, making some statement(s) which are relevant to the situation, showing that the problem is understood. **1 mark answer**: 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)	One from:	Higher the number of chlorine atoms the higher the ODP Lower the number of chlorine atoms the lower the ODP Lower the number of fluorine atoms the higher the ODP Higher the number of fluorine atoms the lower the ODP
10a(ii)	1+5	Refrigerant Compound 1 has 2 carbons, 4 fluorines and 2 bromines Refrigerant Compound 1 has 2 carbons, 4 fluorines and 2 chlorines
10a(iii)	Carbon dioxide and ammonia do not contain halogens or Carbon dioxide and ammonia do not damage the ozone layer	CO_2 and NH_3 lack group 7 elements (halogen) atoms in their structure. All refrigerant compounds in table have halogen atoms in their structure.
10b(i)	Species (atoms/molecules/particles) with unpaired electron	Free radicals are atoms or molecules that are highly reactive due to the presence of an unpaired electron.
10b(ii)A	Initiation	Step: Reactants (before Arrow) ⟶ Products (after Arrow) Initiation: No free radicals on Reactant Side ⟶ Free radicals on Product Side Propagation: Free Radicals found on both sides of arrow Termination: Free radicals on Reactant Side ⟶ No free radicals on Product Side
10b(ii)B	One from:	$CH_3F + F^{\bullet} \longrightarrow {}^{\bullet}CH_2F + HF$ ${}^{\bullet}CH_2F + F_2 \longrightarrow CH_2F_2 + F^{\bullet}$ $F_2 + {}^{\bullet}CH_3 \longrightarrow CH_3F + F^{\bullet}$ ${}^{\bullet}CH_2F + HF \longrightarrow CH_2F_2 + H^{\bullet}$
10c	0.208	0.05kg ⟶ 0.025kg difluoromethane 0.05kg ⟶ 0.025kg pentafluoroethane no. of mol = $\frac{\text{mass}}{\text{gfm}} = \frac{25\text{g}}{120\text{ g mol}^{-1}}$ = 0.208 mol
11a(i)	water and carbon dioxide	copper (II) carbonate + ethanoic acid ⟶ copper (II) ethanoate + water + carbon dioxide metal carbonate + acid ⟶ salt + water + carbon dioxide
11a(ii)	$Cu^{2+}(CH_3COO^-)_2$	Copper (II) has a valency of 2 and forms Cu^{2+} ions Ethanoate ions has a formula of CH_3COO^- and valency of 1. Formula of copper (II) ethanoate is $Cu(CH_3COO)$. Ionic formula of copper (II) ethanoate is $Cu^{2+}(CH_3COO^-)_2$

11b	Answer to include:	1 mark: Dissolve oxalic acid (in a small volume of deionised water) 1mark: Transfer quantitatively oxalic acid solution to standard/volumetric flask including rinsings/washings 1mark: Fill volumetric/standard flask up to mark (with deionised water)
11c(i)		Volumetric bulb pipette to be drawn showing: • volumetric mark/line • end of pipette must narrow to a point A graduated pipette would also be acceptable.
11c(ii)	pink → colourless	Colour in conical flask at start: pink as sodium hydroxide solution is in conical flask at start and phenolphthalein is pink in alkaline conditions Colour in conical flask at end: colourless as sodium hydroxide in conical flask has been neutralised by the addition of oxalic acid from the burette. Phenolphthalein is colourless in acidic/neutral conditions
11c(iii)	concordant	Results in a titration are described as concordant when the individual titres are within $0.2 cm^3$ of each other. This ignores the rough titre and any rogue results.
11d	0.27	Oxalic acid no. of mol = volume x concentration = 0.02675_{litres} x $0.126_{mol\ l^{-1}}$ = 0.00337mol $H_2C_2O_4 + 2NaOH \longrightarrow Na_2C_2O_4 + 2H_2O$ 1mol 2mol 0.00337mol 0.00674mol concentration = $\frac{\text{no. of mol}}{\text{volume}} = \frac{0.00674_{mol}}{0.025_{litres}}$ = 0.270 mol l^{-1}