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JABchem

Past Papers Higher Chemistry

2009

Marking Scheme

Grade Awarded	Mark Required (/100)	% candidates achieving grade
A	70+	28.0%
B	57+	23.2%
C	44+	24.6%
D	37+	10.7%
No award	<37	13.6%

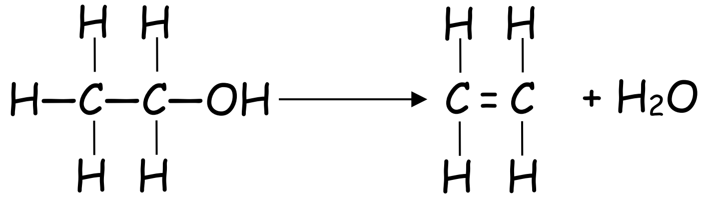
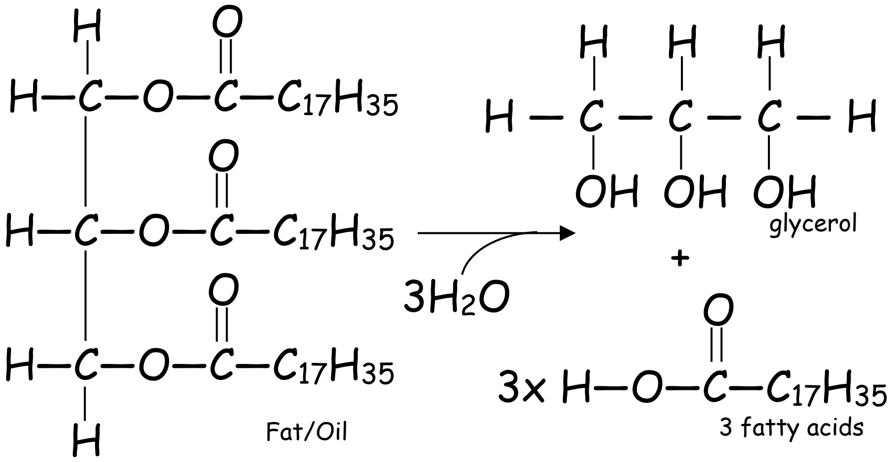
Section:	Multiple Choice	Extended Answer
Average Mark:	24.8 /40	32.4 /60

2009 Higher Chemistry Marking Scheme

MC Qu	Answer	% Pupils Correct	Reasoning
1	D	73	☒A non-metal oxides e.g. carbon dioxide dissolve in water to form acids (pH<7) ☒B copper (II) oxide is insoluble in water (p7 of data booklet) ☒C non-metal oxides e.g. sulphur dioxide dissolve in water to form acids (pH<7) ☑D metal oxides e.g. sodium oxide dissolve in water to form alkalis (pH>7)
2	C	48	☒A iodide ions are negative: $2I^- \rightarrow I_2 + 2e^-$ ☒B Nickel ions are oxidised as they lose electrons: $Ni^{2+} \rightarrow Ni^{3+} + e^-$ ☑C Cobalt ions are reduced as they gain an electron: $Co^{3+} + 2e^- \rightarrow Co^{2+}$ ☒D Sulphate ions are negative: $SO_4^{2-} + 2H^+ + 2e^- \rightarrow SO_3^{2-} + H_2O$
3	C	84	☒A molecular covalent: low boiling point and no conduction as solid ☒B metallic: conducts as a solid ☑C covalent network: very high melting point and no conduction as a solid ☒D molecular covalent: low boiling point and no conduction as solid
4	A	52	$CuCO_3 + 2HCl \rightarrow CuCl_2 + H_2O + CO_2$ (1mol, 2mol, 1mol, 1mol)	$CuCO_3 + H_2SO_4 \rightarrow CuCl_2 + H_2O + CO_2$ (1mol, 1mol, 1mol, 1mol) ☑A different quantities of either acid are left over and the pH will be different ☒B Reactions produce 1mol of carbon dioxide each ∴ equal volumes of gas produced ☒C Reactions produce 1mol of water each ∴ equal masses of water produced ☒D Copper carbonate reacts with acid but is insoluble itself
5	D	66	From Graph: when concentration = 0.50mol l^{-1} then the rate = $0.2s^{-1}$ $\text{time} = \frac{1}{\text{rate}} = \frac{1}{0.2} = 5s$
6	A	58	gfm Mg = 24.3g no. of mol Mg = $\frac{\text{mass}}{\text{gfm}} = \frac{10}{24.3}$ = 0.412mol no. of mol $CuSO_4$ = volume x concentration = 1litres x 1mol l^{-1} = 1mol $Mg + CuSO_4 \longrightarrow MgSO_4 + Cu$ 1mol 1mol 0.412mol 0.412mol (reacted) ∴ All 0.412 mol of Magnesium has reacted (limiting reactant) 0.588mol of $CuSO_4$ unreacted ($CuSO_4$ is in excess)
7	B	79	Forward Reaction: Activation energy E_a is measured from R to top of hill Enthalpy Change ΔH is measured from R to P For Forward Catalysed Reaction: ΔH = 50 – 100 = -50kJ mol^{-1}
8	D	63	☒A Ethanol has a high boiling points due to hydrogen bonding but this has no effect ☒B C_2H_5OH and CH_3OCH_3 are isomers and have same mass due to same formula ☒C C_2H_5OH and CH_3OCH_3 are isomers and burn to form same products ☑D C_2H_5OH and CH_3OCH_3 have different bonds within their molecules so release different amounts of energy during combustion when new bonds are formed.
9	A	77	☑A Electroneg: Cs=0.8 and F=4.0 ∴ diff = 4.0-0.8= 3.2 ∴ greatest ionic character ☒B Electroneg: Cs=0.8 and I=2.6 ∴ diff = 2.6-0.8= 2.8 ☒C Electroneg: Na=0.9 and F=4.0 ∴ diff = 4.0-0.9= 3.1 ☒D Electroneg: Na=0.9 and I=2.6 ∴ diff = 2.6-0.9= 2.7 ∴ least ionic character
10	B	50	see table below

Group 1 Element	Lithium	Sodium	Potassium	Rubidium	Caesium	Francium
Melting point (°C)	181	98	63	39	28	Less than 28°C
1st Ionisation Energy (kJ mol^{-1})	520	496	419	403	376	Less than 382

<table>
<tr><td>11</td><td>C</td><td>81</td><td>☒A 1st Ionisation removes 1 mole of electrons from 1 mol of f ree gaseous atoms (not ions)
☒B 1st Ionisation removes 1 mole of electrons from 1 mol of free gaseous atoms (not ions)
☑C 1st Ionisation involves removing 1 mol of e^- from 1 mol of gaseous atoms
☒D 1st Ionisation removes an electron from free gaseous atoms (not molecules)</td></tr>
<tr><td>12</td><td>C</td><td>58</td><td>☒A hydrogen bonds needs a N or O or F directly attached to a hydrogen atom
☒B bond cannot be polar as electronegativity same at either end of bond (both H)
☑C non-polar covalent bond as same electronegativity at either end of bond
☒D van der Waals' forces are between molecules and not inside the molecule</td></tr>
<tr><td>13</td><td>D</td><td>75</td><td>☒A molecule contains N-H bond so contains Hydrogen bonding
☒B molecule contains O-H bond so contains Hydrogen bonding
☒C molecule contains N-H bond so contains Hydrogen bonding
☑D molecule contains no N-H, O-H or H-F bonds so no Hydrogen bonding present</td></tr>
<tr><td>14</td><td>A</td><td>73</td><td><table><tr><td>Bonding Type</td><td>Covalent</td><td>Hydrogen</td><td>London dispersion forces
(old name: van der Waals')</td></tr><tr><td>Bond Strength</td><td>Strong</td><td>Medium</td><td>Weak</td></tr></table></td></tr>
<tr><td>15</td><td>D</td><td>60</td><td>☒A Ionic lattice needs metal and non-metal atoms joined to be ionic (fullerene in C_{60})
☒B Fullerene is a C_{60} is has no metal atoms to be metallic
☒C Melting point of fullerene not high enough to be a covalent network
☑D Fullerene is a molecular form of carbon C_{60}</td></tr>
<tr><td>16</td><td>C</td><td>64</td><td>☒A ammonia NH_3 is a trigonal pyramidal shaped molecule which is polar
☒B Water H_2O is a angular shaped molecule which is polar
☑C Carbon tetrachloride CCl_4 is tetrahedral which is non-polar due to shape
☒D Hydrogen fluoride HF is a linear molecule which is polar</td></tr>
<tr><td>17</td><td>D</td><td>52</td><td>☒A 1mol NaCl formula units = 2 mol of ions (2 ions per NaCl formula unit)
☒B 1 mol H_2 molecules = 2mol of H atoms (2 H atoms ore H_2 molecule)
☒C 1mol He atoms = 2 mol of electrons (2 electrons per He atom)
☑D 1 mol O_2 molecules = 6.02×10^{23} O_2 molecules</td></tr>
<tr><td>18</td><td>C</td><td>58</td><td>gfm CO = 28g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{7}/_{28}$ = 0.25mol
☒A gfm H_2 = 2g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{1}/_{2}$ = 0.5mol
☒B gfm N_2 = 28g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{3.5}/_{28}$ = 0.125mol
☑C gfm Ar = 40g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{10}/_{39.9}$ = 0.25mol
☒D gfm Cl_2 = 71g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{35.5}/_{71}$ = 0.5mol</td></tr>
<tr><td>19</td><td>B</td><td>39</td><td><table><tr><td colspan="3">$H_2 + \frac{1}{2}O_2 \rightarrow H_2O$</td><td colspan="3">$CO + \frac{1}{2}O_2 \rightarrow CO_2$</td></tr><tr><td>1mol</td><td>0.5mol</td><td>1mol</td><td>1mol</td><td>0.5mol</td><td>1mol</td></tr><tr><td>1vol</td><td>0.5vol</td><td>1vol</td><td>1vol</td><td>0.5vol</td><td>1vol</td></tr><tr><td>3 litres</td><td>1.5 litres</td><td>3 litres</td><td>1 litres</td><td>0.5 litres</td><td>1 litres</td></tr></table>Total oxygen required = 1.5 litres + 0.5 litres = 2 litres</td></tr>
<tr><td>20</td><td>D</td><td>64</td><td>☒A Carbon (soot) is formed in car engines from incomplete combustion
☒B Carbon monoxide is formed in car engines from incomplete combustion
☒C hydrocarbons are released by car engines from incomplete combustion of fuel
☑D Nitrogen dioxide is formed by the sparking of air and not combustion of fuel</td></tr>
<tr><td>21</td><td>A</td><td>46</td><td><table><tr><td>Answer</td><td>A</td><td>B</td><td>C</td><td>D</td></tr><tr><td>Formula</td><td>C_2HCl_3</td><td>$C_2H_4Cl_2$</td><td>C_3H_6</td><td>C_3H_7OH</td></tr><tr><td>Possible structures</td><td>Only
1,1,2-trichloroethene</td><td>1,1-dichloroethane
1,2-dichloroethane</td><td>Propene
Cyclopropane</td><td>Propan-1-ol
Propan-2-ol</td></tr></table></td></tr>
<tr><td>22</td><td>C</td><td>73</td><td><table><tr><td>Answer</td><td>A</td><td>B</td><td>C</td><td>D</td></tr><tr><td>Name</td><td>propanal</td><td>methyl ethanoate</td><td>propanone</td><td>ethanoic acid</td></tr><tr><td>Homologous Series</td><td>aldehyde</td><td>ester</td><td>ketone</td><td>carboxylic acid</td></tr><tr><td>Old Name</td><td>alkanal</td><td>-</td><td>alkanone</td><td>alkanoic Acid</td></tr></table></td></tr>
</table>

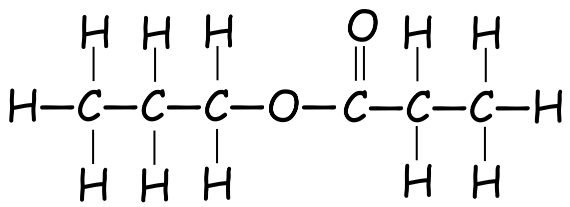
23	B	79	
24	A	83	☑A Steam reforming produces synthesis gas: $CH_4 + H_2O \rightarrow CO + 3H_2$ ☒B Cracking splits larger molecules into smaller molecules: $C_{12}H_{26} \rightarrow C_8H_{18} + C_4H_8$ ☒C Hydration adds water across a C=C double bond: $C_2H_4 + H_2O \rightarrow C_2H_5OH$ ☒D Oxidation increases oxygen : hydrogen ratio(primary alcohol → aldehyde → carboxylic acid)
25	B	36	☒A butan-1-ol oxidises to butanal which would react with Benedict's Solution ☑B butan-2-ol oxidises to butanone which does not react with Benedict's solution ☒C butanone is a ketone which does not oxidise ☒D butanoic acid is a carboxylic acid which does not oxidise
26	B	56	Polymer is made from a 2-carbon monomer ∴ 1st monomer is ethene Polymer is also made from a 4 carbon monomer with C=C double bond between C_1 and C_2 ∴ 2nd monomer is but-1-ene
27	C	52	Structure of amine groups ($-NH_2$) are very similar to ammonia (NH_3)
28	A	56	☑A Hardening of oils is the addition of H_2 molecules across C=C double bonds in oils ☒B Hydrolysis: molecule splits into smaller molecules adding water across break ☒C Dehydration: water is removed from a molecule leaving a C=C double bond ☒D Oxidation: increasing the oxygen : hydrogen ratio in a molecule.
29	C	72	
30	A	85	Enzymes are denatured at temperatures the optimum temperature (37°C). Rate of reactions peaks at optimum temp and falls on either side of the optimum temperature.
31	D	83	A feedstock is a chemical from which other chemical can be extracted. A raw material is a material which is obtained from the earth and used by industry
32	A	80	❶ $H_2 + \frac{1}{2}O_2 \longrightarrow H_2O$ $\Delta H = b$ ❷ $S + O_2 \longrightarrow SO_2$ $\Delta H = c$ ❸x-1 $H_2O + SO_2 \longrightarrow H_2S + 1\frac{1}{2}O_2$ $\Delta H = -d$ add $S + H_2 \longrightarrow H_2S$ $\Delta H = b+c-d$
33	D	88	☒A catalysts increase the rate of both the forward and reverse reactions ☒B catalysts increase the rate of both the forward and reverse reactions ☒C catalysts do not change the final concentrations of the reactants and products ☑D catalysts do not change the final concentrations of the reactants and products
34	B	39	Forward reaction rate is at its highest at start and reduces as reaction proceeds. Reverse reaction is at its slowest at start and increases as reaction proceeds. When at equilibrium, rate of forward reaction = rate of reverse reaction.

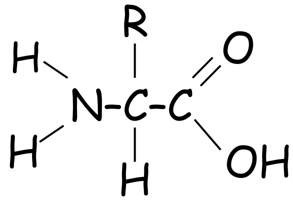
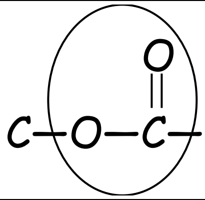
<table>
<tr><td>35</td><td>B</td><td>39</td><td>Hydrogen H^+ ions and sulphite SO_3^{2-} ions join together to form molecules of sulphurous acid H_2SO_3. H^+ ions are removed from the solution but OH^- ions remain and pH is alkaline</td></tr>
<tr><td>36</td><td>D</td><td>50</td><td>☒A sodium ethanoate solution has alkaline pH>7 (weak acid in salt)
☒B sodium sulphate solution has neutral pH=7 (no weak acid or alkalis in salt)
☒C Potassium chloride solution has neutral pH=7 (no weak acid or alkalis in salt)
☑D ammonium nitrate solution has acidic pH<7 (weak alkali in salt)</td></tr>
<tr><td>37</td><td>D</td><td>53</td><td>❶ $2I^- \longrightarrow I_2 + 2e^-$
❷ $MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$

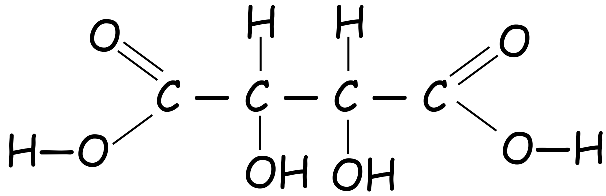
❶x5 $10I^- \longrightarrow 5I_2 + 10e^-$
❷x2 $2MnO_4^- + 16H^+ + 10e^- \longrightarrow 2Mn^{2+} + 8H_2O$

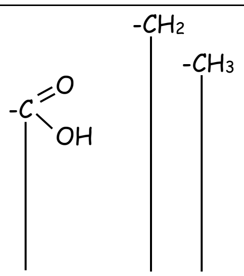
add $2MnO_4^- + 16H^+ + 10I^- \longrightarrow 2Mn^{2+} + 8H_2O + 5I_2$
2mol 10mol
1mol <u>5mol</u></td></tr>
<tr><td>38</td><td>B</td><td>56</td><td>$Mg^{2+} + 2e^- \longrightarrow Mg$
2mol 1mol
2x96500C 1mol
= 193000C</td></tr>
<tr><td>39</td><td>A</td><td>35</td><td><table>
<tr><td>Radiation Type</td><td>Alpha</td><td>Beta</td><td>Gamma</td></tr>
<tr><td>Deflection</td><td>Down to bottom</td><td>Up to top</td><td>Straight through</td></tr>
<tr><td>Size of deflection</td><td>Smaller bend as
Alpha particles are heavier</td><td>Greater bend as
Beta particles are lighter</td><td>(No deflection)</td></tr>
</table></td></tr>
<tr><td>40</td><td>C</td><td>49</td><td>${}^{31}_{15}P + {}^{1}_{0}n \longrightarrow {}^{32}_{15}P$</td></tr>
</table>

2009 Higher Chemistry Marking Scheme

<table>
<tr><th>Long Qu</th><th>Answer</th><th>Reasoning</th></tr>
<tr><td>1a</td><td>Increases across period</td><td>
<table>
<tr><td>Element</td><td>Li</td><td>Be</td><td>B</td><td>C</td><td>N</td><td>O</td><td>F</td></tr>
<tr><td>Electronegativity</td><td>1.0</td><td>1.5</td><td>2.0</td><td>2.5</td><td>3.0</td><td>3.5</td><td>4.0</td></tr>
</table>
</td></tr>
<tr><td>1b</td><td>Electron being removed is breaking a full outer shell</td><td>
<table>
<tr><td>Ionisation Energy</td><td>1st</td><td>2nd</td><td>3rd</td><td>4th</td></tr>
<tr><td>Value (kJ mol^{-1})</td><td>578</td><td>1817</td><td>2745</td><td>11577</td></tr>
</table>
4th Ionisation Energy: $Al^{3+}{}_{(g)} \longrightarrow Al^{4+}{}_{(g)} + e^-$
2,8   2,7
4th ionisation energy is very large as the electron being removed is being taken from the complete outer shell and much energy is required to remove this electron.
</td></tr>
<tr><td>1c</td><td>Greater Van der Waals' attractions in bigger molecules like I_2</td><td>Going down group 7 the atoms with the diatomic halogen molecules get larger. Larger atoms have stronger London dispersion forces so larger halogens are closer together which raises the boiling point.</td></tr>
<tr><td>2a</td><td>x=7 y=8</td><td>Methyl benzene has the formula $C_6H_5CH_3$ ∴ formula = C_7H_8</td></tr>
<tr><td>2b</td><td>No carbon dioxide produced or no greenhouse gases produced</td><td>Hydrogen burns to form water only: $H_2 + \frac{1}{2}O_2 \longrightarrow H_2O$
No carbon dioxide is produced which contributes to the Greenhouse Effect</td></tr>
<tr><td>2c</td><td>Ethanol is a renewable fuel</td><td>Ethanol in petrol reduces amount of petrol being burnt.
As ethanol is a renewable fuel, it can be replaced easily and the amount on non-renewable fuel being used up is reduced.</td></tr>
<tr><td>3a(i)</td><td>H removed from reactant</td><td>
<table>
<tr><td rowspan="3">Oxidation of alcohols</td><td>Primary alcohols → Aldehydes → Carboxylic Acid</td></tr>
<tr><td>Secondary alcohols → Ketones ↛ [No oxidation]</td></tr>
<tr><td>Tertiary alcohols ↛ [No oxidation]</td></tr>
</table>
</td></tr>
<tr><td>3a(ii)</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>Benedict's/Fehling's</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>3b(i)</td><td>Ester smells nice or ester floats on top</td><td>Esters will float on top of sodium hydrogencarbonate solution as they are insoluble in water and are less dense than water. Esters are insoluble in water because the hydrophilic (water-loving) parts of the alkanol and alkanoic acid are removed as they join together to form the ester.</td></tr>
<tr><td>3b(ii)</td><td>Structure of propyl propanoate:</td><td></td></tr>
<tr><td>4a</td><td>Absorbs harmful u.v. light</td><td>Ozone layer in upper atmosphere absorbs harmful ultra-violet (u.v.) radiation from the sun. This u.v. light can cause skin cancer</td></tr>
<tr><td>4b</td><td>Heterogeneous</td><td>
<table>
<tr><th>Type of Catalyst</th><th>Definition</th></tr>
<tr><td>Homogeneous</td><td>Catalyst in same state as reactants</td></tr>
<tr><td>Heterogeneous</td><td>Catalyst in different state from reactants</td></tr>
</table>
</td></tr>
<tr><td>4c</td><td>4.01x10^{23} molecules</td><td>$3O_2 \longrightarrow 2O_3$
3mol   2mol
1mol   0.67mol
1mol O_3 = 6.02x10^{23}molecules
0.67mol O_3 = 6.02x10^{23}molecules x $^{0.67}/_{1}$
=4.01x10^{23}molecules</td></tr>
</table>

5a(i)	Amino acids	Amino acids have the general structure: (where R is different in each amino acid) 
5a(ii)	Molecule splits into two molecules with water added at the break	Hydrolysis reactions are found in • Breakdown of starch into glucose • Breakdown of protein to amino acids • Breakdown of fats/oils to glycerol and 3 fatty acids
5b(i)	Ester	Esters are formed by the condensation reaction between • a hydroxyl –OH group • a carboxyl –COOH group 
5b(ii)	Fibres are linear, resins have cross-links	Fibres are long chains of a polymer but have no strength as they are not cross-linked with other fibres. Cured resins have these cross-links between chains which gives cured resins strength.
6a(i)	Answers include:	Temperature of water at start / Temperature of water at end; Volume/Mass of water
6a(ii)	-333.8 kJ mol^{-1}	1mol CH_3OH = (1x12) + (4x1) + (1x16) = 12 + 4 + 16 = 32g 0.370g methanol ↔ 3.86kJ 32g methanol 3.86kJ x $^{32}/_{0.370}$ = -333.8 kJ mol^{-1}
6b	Complete combustion of methanol	The oxygen atmosphere in the apparatus means that there is no loss of heat by incomplete combustion
7a	Collect gas over water in a water-filled measuring cylinder	Gases can be collected over water in a measuring cylinder to measure the volume of gas. Carbon Dioxide is slightly soluble in water so some is lost as it dissolves in water. Very soluble gases e.g. nitrogen dioxide cannot be collected this way
7b	Loss of mass of flask	The mass of the flask + contents will decrease as gas escapes from the flask. The quicker the mass of the flask decreases, the faster the reaction. Other acceptable answers: pH, concentration of acid and conductivity.
8a	Continuous	Chemicals needed in large quantities e.g. fertiliser have to be made by a continuous process as it is more efficient/profitable in a continuous process rather than a stop/start batch process.
8b(i)	Answer to include:	Higher temperature gives lower yield of ammonia • raising temperature means endothermic reaction will be favoured • Less yield of ammonia means reverse reaction is favoured • Equilibrium moves to the left ∴ reverse reaction is endothermic and forward reaction is exothermic
8b(ii)	Answer to include:	$N_2 + 3H_2 \longrightarrow 2NH_3$ 1mol 3mol 2mol 1vol 3vol 2vol Forward Reaction: 4vol ⟶ 2vol Forward reaction lowers pressure as 4vol ⟶ 2vol High pressure favours the pressure-reducing forward reaction High pressure give higher yield of products by moving equilibrium to right

<table>
<tr><td>8c</td><td>67%</td><td>gfm N_2 = (2x14) = 28g   gfm NH_3= (1x14)+(3x1) = 14+3 = 17g
$N_2 + 3H_2 \longrightarrow 2NH_3$
1mol   2mol
28g   34g
500g   34g x $^{500}/_{28}$
= 607.1g
500kg   607.1kg
$\%yield = \frac{actual}{theoretical} \times 100 = \frac{405}{607.1} \times 100 = 66.7\%$</td></tr>
<tr><td>9a</td><td>Answer to include:</td><td><table><tr><th>Type of Alcohol</th><th>Definition</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>9b</td><td>Addition</td><td>CH_3-MgCl adds across the C=O double bond</td></tr>
<tr><td>9c</td><td>Pentan-3-one</td><td>Final product 3-methylpentan-3-ol
3-methyl group is removed and –OH becomes C=O to form pentan-3-one</td></tr>
<tr><td>10a</td><td>Neutralisation</td><td>acid + carbonate ⟶ salt + water + carbon dioxide</td></tr>
<tr><td>10b</td><td>Diagram showing:</td><td></td></tr>
<tr><td>10c</td><td>0.0164g</td><td>1mol $C_4H_6O_6$ = (4x12) + (6x1) + (6x16) = 48 + 6 + 96 = 150g
$no.\ of\ mol = \frac{Volume}{Molar\ Volume} = \frac{0.105\ litres}{24\ litres\ mol^{-1}} = 0.004375mol$
$2NaHCO_3 + C_4H_6O_6 \longrightarrow Na_2(C_4H_4O_6) + 2H_2O + 2CO_2$
1mol   2mol
0.00219mol   0.00438mol
mass = no. of mol x gfm = 0.00219mol x 150g mol^{-1} = 0.329g
20 sweets = 0.329g   ∴ 1 sweet = 0.0164g</td></tr>
<tr><td>11a</td><td>Answer to include:</td><td>Increasing the temperature results in more particles having energy greater than the activation energy. The activation energy stays the same as temperature rises. More particles have energy greater than the activation energy so reaction rate increases.</td></tr>
<tr><td>11b</td><td>Answer to include:</td><td>Potassium has electron arrangement: 2,8,8,1 Chlorine has electron arrangement: 2,8,7
Potassium has addition electron shell compared to chlorine. Potassium's additional shell is further from nucleus so atomic size increases.</td></tr>
<tr><td>12a</td><td>0.0179 mol l^{-1}</td><td>no. of mol H_2SO_4 = volume x concentration = 0.050 litres x 0.01mol l^{-1} = 0.0005mol
$H_2SO_4 + Ba(OH)_2 \longrightarrow BaSO_4 + 2H_2O$
1mol   1mol
0.0005mol   0.0005mol
$concentration = \frac{no.\ of\ mol}{volume} = \frac{0.0005mol}{0.028\ litres} = 0.0179\ mol\ l^{-1}$</td></tr>
<tr><td>12b</td><td>Answer to include:</td><td>$H_2SO_{4(aq)}$ + $Ba(OH)_{2(aq)}$ ⟶ $BaSO_{4(s)}$ + $2H_2O_{(l)}$
These ions are used up during the reaction
Conductivity decreases as ions are removed
The ions in the solid precipitate are unable to move so do not contribute to conductivity
Molecules of H_2O does not contribute to conductivity
At neutralisation point, there are no reactant ions left and the products have no free ions to conduct</td></tr>
</table>

13a	Add ammeter to measure current Add variable resistor	The current in the circuit needs to be measured to calculate Q = I x t and current is measured on an ammeter. A variable resistor is added to control the current and keep it constant.
13b	0.107g	$Ag^+ + e^- \rightarrow Ag$ 1mol 1mol 96500C 107.9g $^{0.365}/_{107.9}$ x 96500C 0.365g = 326.4C $Cu^{2+} + 2e^- \rightarrow Cu$ 2mol 1mol 2x96500C 63.5g 193000C 63.5g 326.4C 63.5gx$^{326.4}/_{193000}$ = 0.107g
14a	Lower Same	(see table below)
14b(i)	10^{-13} mol l^{-1}	pH = 1.0 ∴ $[H^+] = 10^{-1} = 0.1$mol l^{-1} $[OH^-] = \frac{10^{-14}}{[H^+]} = \frac{10^{-14}}{10^{-1}} = 10^{-13}$ mol l^{-1}
14b(ii)	Answer to include:	Increasing the number of chlorine atoms gives decrease in pH ∴ strength of acid is related to degree of dissociation/conc of H^+ ions ∴ increasing the number of chlorine atoms, the stronger the acid
15a	$Al_4C_3 + 12H_2O$ ↓ $4Al(OH)_3 + 3CH_4$	$Al_4C_3 + 12H_2O \rightarrow 4Al(OH)_3 + 3CH_4$
15b	34	❶ $SiH_4 + 2O_2 \rightarrow SiO_2 + 2H_2O$ ΔH= -1517 kJ ❷ $Si + O_2 \rightarrow SiO_2$ ΔH= -911 kJ ❸ $H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ ΔH= -286 kJ ❶x-1 $SiO_2 + 2H_2O \rightarrow SiH_4 + 2O_2$ ΔH= +1517 kJ ❷ $Si + O_2 \rightarrow SiO_2$ ΔH= -911 kJ ❸x2 $2H_2 + O_2 \rightarrow 2H_2O$ ΔH= -572 kJ add $Si + 2H_2 \rightarrow SiH_4$ ΔH= +34 kJ
16a	Answer to include:	$^{227}_{90}Th \rightarrow ^{223}_{88}Ra + ^{4}_{2}He$
16b	Alpha particles are not very penetrating	Alpha particles are stopped by a piece of paper and are not very penetrating. It is unlikely that a significant amount of alpha particles would leave the body and affect others.
16c	0.48g	(see table below) If 12.5% remaining then 87.5% has decayed 87.5% = 0.42g 100% = 0.42g x $^{100}/_{87.5}$ = 0.48g
17a	neutron : proton 7 : 6 1.17 : 1	$^{13}_{6}C$ No of protons = atomic number = 6 No. of neutrons = mass number – atomic number = 13-6 = 7
17b(i)		Problem Solving Question:

14a:

Acid	Type	Rate of Reaction	Conductivity	Volume to neutralise alkali
Hydrochloric acid	Strong	Faster	High	Same
Ethanoic Acid	Weak	Slower	Low	

16c:

Time (days)	Number of Half-Lives	Percentage Remaining
0	0	100%
19	1	50%
38	2	25%
57	3	12.5%

17b(ii)	but-2-ene	Mass = 54 ∴ hydrocarbon has 4 carbons (weighing 48) ∴ remaining mass = 8 ∴ 8 hydrogens in the hydrocarbon Formula = C_4H_8 could be butene or cyclobutane But hydrocarbon reacts with hydrogen so hydrocarbon must be butene. Hydrocarbon is but-2-ene as only 2 groups on NMR spectrum ($-CH_3$ and C=C)
18a	$2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2e^-$	Redox: $I_2 + 2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2I^-$ Reduction: $I_2 + 2e^- \rightarrow 2I^-$ Oxidation: $2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2e^-$
18b	Starch	Starch indicator turns blue/black in the presence of iodine
18c	0.0126	no. of mol thiosulphate = volume x concentration = 0.0504 litres x 0.1 mol l^{-1} = 0.00504mol $I_2 + 2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2I^-$ 1mol 2mol 0.00252mol 0.00504mol $5CO + I_2O_5 \rightarrow I_2 + 5O_2$ 5mol 1mol 0.0126mol 0.00252mol