JABchem

Past Papers Higher Chemistry

2010

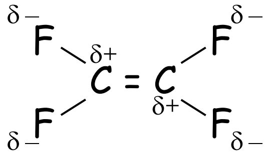
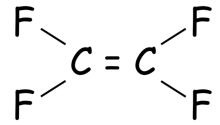
Marking Scheme

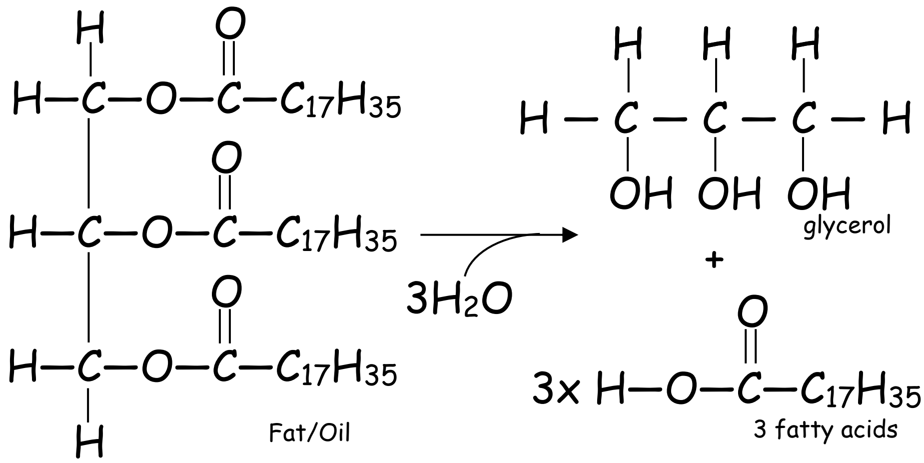
Grade Awarded	Mark Required (/100)	% candidates achieving grade
A	70+	28.2%
B	57+	24.3%
C	44+	23.6%
D	37+	10.6%
No award	<37	13.3%

Section:	Multiple Choice	Extended Answer
Average Mark:	25.5 /40	32.1 /60

2010 Higher Chemistry Marking Scheme

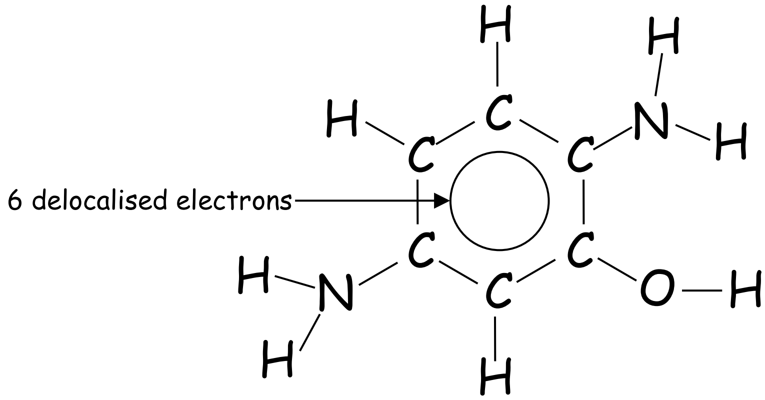
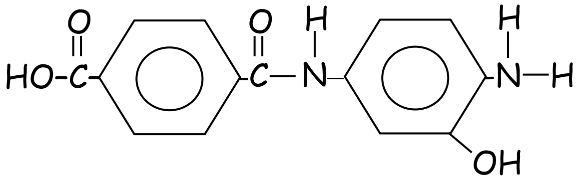
MC Qu	Answer	% Pupils Correct	Reasoning
1	B	80	☒A HBr would dissolve to form hydrobromic acid solution with pH<7 ☑B NH_3 would dissolve to form ammonium hydroxide solution with pH>7 ☒C CO_2 would dissolve to form carbonic acid solution with pH<7 ☒D CH_4 is a non-polar hydrocarbon and does not dissolve.
2	C	74	☒A No precipitate as magnesium chloride or sodium nitrate are both soluble ☒B No precipitate as magnesium sulphate or sodium nitrate are both soluble ☑C Precipitate formed: Silver chloride is insoluble and forms a precipitate ☒D No precipitate as silver sulphate or sodium nitrate are both soluble
3	C	35	1mol of $CuCl_2$ formula units ↔ 1mol Cu^{2+} ions 1mol of $CuSO_4$ formula units ↔ 1mol Cu^{2+} ions ∴ 0.5mol $CuCl_2$ f.u. ↔ **0.5mol** Cu^{2+} ions ∴ 0.5mol $CuSO_4$ f.u. ↔ **0.5mol** Cu^{2+} ions Total number of Cu^{2+} ions = **0.5mol** + **0.5mol** = 1mol concentration = $\frac{\text{no. of mol}}{\text{volume}} = \frac{1\text{ mol}}{0.5\text{ litres}} = 2\text{ mol l}^{-1}$
4	B	67	☒A Temperature is a measure of the kinetic energy of all particles not just the ones which react ☑B Temperature is a measure of the kinetic energy of all particles not just the ones which react ☒C The activation energy is the minimum energy required for a successful collision ☒D The activation energy is the minimum energy required for a successful collision
5	B	43	0.8mol of H_2 remaining ∴ 0.2mol of H_2 has reacted $H_2 + I_2 \longrightarrow 2HI$ 1mol 2mol 0.2mol 0.4mol
6	D	26	☒A Increasing the concentration would increase the final volume of gas produced ☒B H_2SO_4 has $2 \times H^+$ ions per formula unit so final volume of gas produced would increase ☒C Ethanoic acid is a weak acid so initial gradient would be less steep ☑D Magnesium is more reactive than zinc so initial gradient of line is steeper
7	C	59	☒A True: a catalyst provides an alternative route to the products ☒B True: a catalyst lowers the energy needed for successful collisions (activation energy) ☑C False: a catalyst does not provide any energy to a reaction ☒D False: reactant molecules adsorb to the catalyst but do not form strong bonds
8	B	62	The activation energy (E_a) is the minimum energy required for a successful collision and the formation of products. The value of the activation energy is always endothermic (positive) as it represents the bond breaking processes. The enthalpy change (ΔH) cannot be higher than the activation energy because it represents both endothermic bond breaking steps and exothermic bond forming steps.
9	A	82	☑A the boiling point increases down group 7 (data booklet p4) ☒B the density increases down group 7 (data booklet p3) ☒C the 1st ionisation decreases down group 7 (data booklet p10) ☒D the atomic size increases down group 7 (data booklet p5)
10	D	39	2nd ionisation energy: ❶ $Al^+(g) \rightarrow Al^{2+}(g) + e^-$ $\Delta H = +1830\text{kJ mol}^{-1}$ 3rd ionisation energy: ❷ $Al^{2+}(g) \rightarrow Al^{3+}(g) + e^-$ $\Delta H = +2760\text{kJ mol}^{-1}$ ❶x-1 $Al^{2+}(g) + e^- \rightarrow Al^+(g)$ $\Delta H = -1830\text{kJ mol}^{-1}$ ❷x-1 $Al^{3+}(g) + e^- \rightarrow Al^{2+}(g)$ $\Delta H = -2760\text{kJ mol}^{-1}$ ❶'+❷' $Al^{3+}(g) + 2e^- \rightarrow Al^+(g)$ $\Delta H = -4590\text{kJ mol}^{-1}$
11	B	79	☒A atoms of similar size can have different electronegativities affecting polarity ☑B atoms with same electronegativity form non-polar covalent bonds ☒C 1st ionisation energy has no effect on polarity of a bond ☒D atoms with different number of outer electrons can form non-polar covalent bonds
12	A	72	☑A CH_3COOH has an O-H bond ∴ ethanoic acid contains hydrogen bonding ☒B Ethyl ethanoate ($C_2H_5COOCH_3$) does not have a N,O or F atom bonded to a hydrogen ☒C Hexane C_6H_{14} does not have a N,O or F atom bonded to a hydrogen atom ☒D Hex-1-ene C_6H_{12} does not have a N,O or F atom bonded to a hydrogen atom

13	B	54	The C-F bond is **POLAR** due to electronegativity difference of 1.5 $\delta+$ $\delta-$ C — F Tetrafluoroethene has a planar (flat) arrangement of atoms and polarity of bonds should look like:  To be a polar molecule, molecule must have a positive end and a negative end. This molecule would only have negative ends so polarity cancels out and the molecule is **NON-POLAR** 
14	D	67	☒A magnesium oxide is ionic and is a solid at room temperature ☒B silicon dioxide is covalent network and is a solid at room temperature ☒C nitrogen is a gas at room temperature ☑D sulphur is a solid at room temp, doesn't conduct as a solid and forms $SO_{2(g)}$
15	D	62	☒A gfm O_2 molecules = 32g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{16}/_{32}$ = 0.5mol O_2 molecules ☒B no. of mol = v x c = 1 x 1 = 1mol ∴ 1mol Na^+Cl^- formula units ∴ 2 mol of ions ☒C gfm C atoms = 12g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{24}/_{12}$ = 2mol C atoms ☑D gfm H_2 molecules = 2g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{2}/_{2}$ = 1mol H_2 molecules
16	C	34	☒A ^1H does not have any neutrons ☒B 1mol ^{12}C = 12g ∴ 1g = $^1/_{12}$mol but 6 neutrons per ^{12}C ∴ $^6/_{12}$mol neutrons = 0.5mol ☑C 1mol ^{24}Mg = 24g ∴ 2g = $^2/_{24}$mol but 12 neutrons per ^{24}Mg ∴ $^{24}/_{24}$mol neutrons = 1mol ☒D 1mol ^{22}Ne = 22g ∴ 2g = $^2/_{22}$mol but 12 neutrons per ^{22}Ne ∴ $^{24}/_{22}$mol neutrons = 1.09mol
17	D	48	$3CuO_{(s)} + 2NH_{3(g)} \longrightarrow 3Cu_{(s)} + 3H_2O_{(g)} + N_{2(g)}$ 3mol, 2mol → 3mol, 3mol, 1mol negligible vol, 2vol → negligible vol, 3vol, 1vol 20cm^3 → 30cm^3, 10cm^3
18	A	84	Biological material breaks down by anaerobic respiration in a landfill rubbish dump when there is no oxygen available for aerobic respiration by bacteria. Biogas contains mainly methane gas as this small carbon molecule is produced instead of carbon dioxide.
19	A	89	☑A 2 carbons on the alcohol side (ethanol) and 4 carbons on the C=O side (butanoic acid) ☒B The C=O side of the ester contains 4 carbons ∴ ester made from butanoic acid ☒C The C=O side of the ester contains 4 carbons ∴ ester made from butanoic acid ☒D The C=O side of the ester contains 4 carbons ∴ ester made from butanoic acid
20	B	87	☒A Primary: 1 carbon directly attached to the carbon with the –OH group ☑B Tertiary: 3 carbons directly attached to the carbon with the –OH group ☒C Secondary: 2 carbons directly attached to the carbon with the –OH group ☒D Secondary: 2 carbons directly attached to the carbon with the –OH group
21	C	84	☒A chlorines add onto adjacent carbons not onto the same carbon ☒B chlorines add onto adjacent carbons not onto the same carbon ☑C ethyne + chlorine → 1,2-dichloroethene ☒D 1mol of chlorine will react C≡C triple bond in ethyne to become C=C double bond
22	C	67	Reaction X: Propanal (aldehyde) → Propan-1-ol (primary alcohol) Reduction Reaction Y: Propan-1-ol (alcohol) → Propene (alkene) Dehydration
23	A	69	☑A ozone absorbs ultraviolet (u.v.) radiation ☒B ozone is broken down by CFCs ☒C ozone absorbs ultraviolet (u.v.) radiation ☒D ozone is broken down by CFCs
24	C	75	Synthesis Gas is a mixture of carbon monoxide and hydrogen. Steam Reforming of methane: $CH_{4(g)} + H_2O_{(g)} \rightarrow CO_{(g)} + 3H_{2(g)}$ Steam Reforming of coal: $C_{(g)} + H_2O_{(g)} \rightarrow CO_{(g)} + H_{2(g)}$
25	A	61	☑A Cracking: large molecules break into smaller, more useful molecules with C=C bonds ☒B Addition: molecules add across a C=C double bond ☒C Oxidation: increase in the oxygen : hydrogen ratio e.g. primary alcohol → aldehyde ☒D Hydrogenation: addition of hydrogen across a C=C double bond

<table>
<tr><td>26</td><td>D</td><td>81</td><td><table><tr><td>Type of Polyester</td><td>Fibre</td><td>Cured Resin</td></tr><tr><td>Structure</td><td>linear</td><td>cross-linked</td></tr></table></td></tr>
<tr><td>27</td><td>D</td><td>69</td><td>☒A monomer has two carboxyl functional groups which keep on joining up to extend the polymer
☒B monomer has two hydroxyl functional groups which keep on joining up to extend the polymer
☒C monomer has two different functional groups which keep on joining up to extend the polymer
☑D monomer has one hydroxyl functional groups which prevents the polymer from extending</td></tr>
<tr><td>28</td><td>C</td><td>80</td><td>A saturated fatty acid will have the general formula $C_nH_{2n+1}COOH$<table><tr><td>Formula</td><td>$C_{19}H_{39}COOH$</td><td>$C_{21}H_{43}COOH$</td><td>$C_{17}H_{31}COOH$</td><td>$C_{13}H_{27}COOH$</td></tr><tr><td>Calculation C_nH_{2n+1}</td><td>n=19 ∴ 2n+1=39</td><td>n=21 ∴ 2n+1=43</td><td>n=17 ∴ 2n+1=35</td><td>n=13 ∴ 2n+1=27</td></tr><tr><td>Saturation</td><td>Saturated</td><td>Saturated</td><td>Unsaturated</td><td>saturated</td></tr></table></td></tr>
<tr><td>29</td><td>D</td><td>76</td><td>Butter contains fats and oils:
</td></tr>
<tr><td>30</td><td>D</td><td>57</td><td>☒A Hydration: addition reaction with water added across a C=C double bond
☒B Hydrolysis: Large molecule splits into smaller molecules with water added at break
☒C Hydrogenation: addition reaction with hydrogen added across a C=C double bond
☑D Condensation: small molecules join together with water removed at the join</td></tr>
<tr><td>31</td><td>B</td><td>52</td><td>☒A Ammonia is made by the Haber Process and is not a raw material
☑B Calcium carbonate is chalk/marble and is a raw material
☒C Hexane is not a raw material but can be collected by distillation of crude oil
☒D Nitric Acid is made by the Ostwald Process and is not a raw material</td></tr>
<tr><td>32</td><td>A</td><td>71</td><td>❶ $Mg + 2H^+ \rightarrow Mg^{2+} + H_2$ $\Delta H = a$
❷ $Zn + 2H^+ \rightarrow Zn^{2+} + H_2$ $\Delta H = b$
❶ $Mg + 2H^+ \rightarrow Mg^{2+} + H_2$ $\Delta H = a$
❷x-1 $Zn^{2+} + H_2 \rightarrow Zn + 2H^+$ $\Delta H = -b$
Add ❶+❷' $Mg + Zn^{2+} \rightarrow Mg^{2+} + Zn$ $\Delta H = a-b = c$</td></tr>
<tr><td>33</td><td>B</td><td>58</td><td>☒A Equation: 2vol→2vol ∴ change in pressure has no effect on equilibrium
☑B Equation: 2vol→4vol ∴ increase in pressure shifts equilibrium to left to decrease pressure
☒C Equation: 3vol→3vol ∴ change in pressure has no effect on equilibrium
☒D Equation: 4vol→2vol ∴ increase in pressure shifts equilibrium to right to decrease pressure</td></tr>
<tr><td>34</td><td>C</td><td>44</td><td>☒A OH^- removed by neutralisation ∴ equilibrium moves to left and lowers intensity of blue
☒B OH^- removed by neutralisation with acid ∴ equilibrium moves to left to replace OH^- ions
☑C OH^- removed by neutralisation ∴ equilibrium moves to left and produces more Cu^{2+} ions
☒D OH^- removed by neutralisation with acid ∴ equilibrium moves to left to replace OH^- ions</td></tr>
<tr><td>35</td><td>B</td><td>82</td><td><table><tr><td>Acid</td><td>Concentration</td><td>Type of Acid</td></tr><tr><td>1mol l^{-1} hydrochloric acid</td><td>concentrated</td><td>strong</td></tr><tr><td>0.1mol l^{-1} hydrochloric acid</td><td>dilute</td><td>strong</td></tr><tr><td>1mol l^{-1} ethanoic acid</td><td>concentrated</td><td>weak</td></tr><tr><td>0.1mol l^{-1} ethanoic acid</td><td>dilute</td><td>weak</td></tr></table></td></tr>
</table>

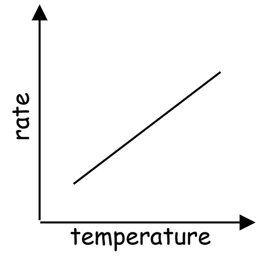
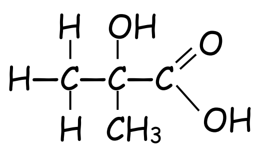
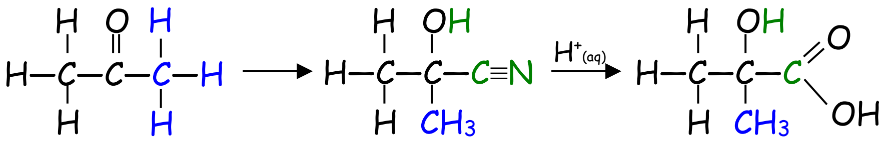
36	C	67	☒A a solution with a pH below zero is acidic ∴ solution will not neutralise H^+ ions ☒B all solutions (acidic, neutral or alkaline) contain some OH^- ions ☑C a solution with pH below zero is very acidic & has a high concentration of H^+ ions ☒D all solutions (acidic, neutral or alkaline) contain some H^+ ions and OH^- ions
37	B	52	☒A Ethanoic acid is acidic ∴ pH increases to 7 when it is diluted ☑B Sodium chloride solution is neutral pH=7 ∴ adding water does not change its pH ☒C Sodium hydroxide is alkaline ∴ pH increases to 7 when it is diluted ☒D Nitric acid is acidic ∴ pH increases to 7 when it is diluted
38	D	56	☒A Nitric acid HNO_3 contains one H^+ ion per formula unit ☒B Hydrochloric acid HCl contains one H^+ ion per formula unit ☒C Ethanoic acid is a weak acid and contains few H^+ ions. ☑D Sulphuric acid H_2SO_4 contains two H^+ ions per formula unit
39	D	28	☒A Hydrogen reduces $Cu^{2+}O^{2-}$ to Cu metal ∴ H_2 acting as reducing agent ☒B Addition Reaction and not a redox equation ∴ cannot be acting as an oxidising agent ☒C $H_2 \rightarrow 2H^+ + 2e^-$: hydrogen loses electrons ∴ H_2 is oxidised and acts as reducing agent ☑D $H_2 + 2e^- \rightarrow 2H^-$: hydrogen gains electrons ∴ H_2 is reduced and acts as oxidising agent
40	A	85	${}^{211}_{83}Bi \rightarrow {}^{207}_{81}Tl + {}^{4}_{2}He$ ${}^{207}_{81}Tl \rightarrow {}^{207}_{82}Pb + {}^{0}_{-1}e$

2010 Higher Chemistry Marking Scheme

<table>
<tr><th>Long Qu</th><th>Answer</th><th>Reasoning</th></tr>
<tr><td>1</td><td><table><tr><td>metallic</td><td></td></tr><tr><td>covalent</td><td>network</td></tr><tr><td></td><td>molecular
(or discrete)</td></tr></table></td><td><table><tr><td>Lithium is a metal and contains metallic bonding which is a lattice of positive ions with delocalised outer electrons</td><td>Boron is a non-metal and forms a covalent network (m.pt.= 2300°C)</td><td>Nitrogen is a diatomic element with formula N_2. As N_2 is a non-polar molecule, there are only Van der Waals forces between N_2 molecules.</td></tr></table></td></tr>
<tr><td>2a(i)</td><td>8</td><td>
</td></tr>
<tr><td>2a(ii)</td><td>Answer showing:</td><td></td></tr>
<tr><td>2b</td><td>Soluble in water</td><td><table><tr><td>Polymer</td><td>Kevlar</td><td>Poly(ethenol)</td><td>Poly(ethyne)</td><td>Biopol</td></tr><tr><td>Property</td><td>Very strong</td><td>Soluble in water</td><td>Electrical conductor</td><td>Biodegradable polymer</td></tr></table></td></tr>
<tr><td>3a(i)</td><td>Concentrations of reactants and products are constant
or
Rate of forward reaction = Rate of reverse reaction</td><td>At equilibrium:
The concentration of reactants and products are constant (not equal!)

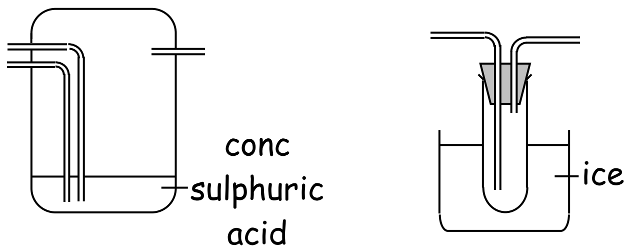
In a system at equilibrium:
the rate of the forward reaction = the rate of the reverse reaction</td></tr>
<tr><td>3a(ii)</td><td>Dissolved O_2 returns to atmosphere</td><td>Increase in temperature favours the endothermic reaction.
Reverse reaction is endothermic.
Dissolved $O_{2(aq)}$ becomes $O_{2(g)}$ in the atmosphere.</td></tr>
<tr><td>3b</td><td>0.0003125</td><td>1mol O_2 = 32g = 6.02×10^{23} molecules
1mol $O_2 \times {}^{0.01}/_{32}$ = 0.010g
= 0.0003125mol</td></tr>
<tr><td>4a</td><td>Carbon electrode may react to form CO_2</td><td>At the temperature of molten aluminium oxide (above 2072°C) the carbon electrodes may react with any oxygen around.</td></tr>
<tr><td>4b</td><td>5596g</td><td>Q = I x t
= 50 000 x (20x60)
= 60 000 000 C

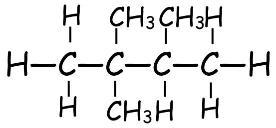
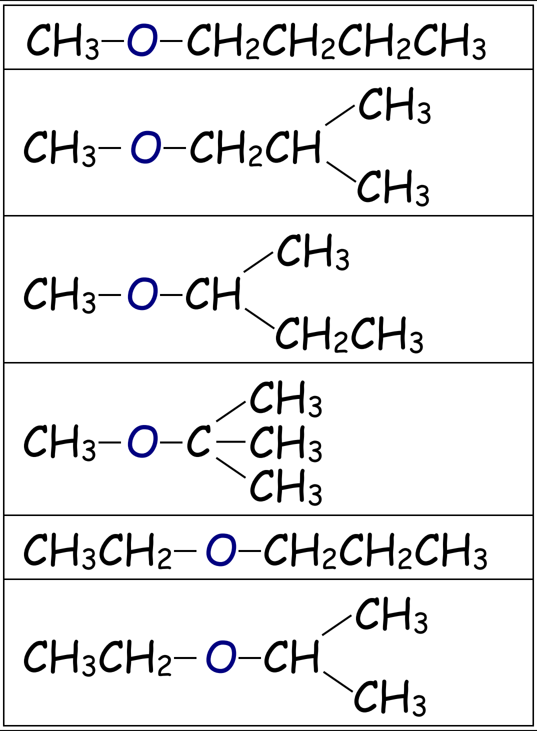
$Al^{3+} + 3e^- \longrightarrow Al$
3mol → 1mol
3x96500C → 27g
60 000 000C → $27g \times {}^{60\,000\,000}/_{(3\times96500)}$
= 5596g</td></tr>
<tr><td>5a(i)</td><td>Volume of reactant(s)
Concentration of reactant(s)</td><td>PPA 1.2 Question</td></tr>
</table>

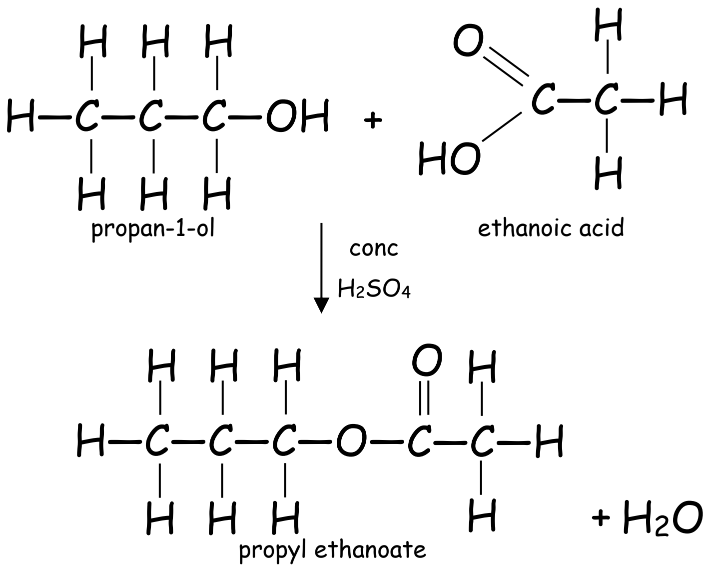
5a(ii)	Colour change is too gradual at room temp	PPA 1.2 Question
5b		The rate of a reaction increases with increasing temperature
6a	Equation showing:	$^{11}_{6}C \longrightarrow {}^{11}_{5}B + {}^{0}_{+1}e$
6b	20	Rate: 640, 320, 160, 80 No of $t_{\frac{1}{2}}$: 0, 1, 2, 3 $3\times t_{\frac{1}{2}} = 60$ min $\therefore t_{\frac{1}{2}} = {}^{60}/_{3} = 20$min
6c	Pure ^{11}C contains more ^{11}C nuclei than same mass of glucose containing ^{11}C atoms	The half life of ^{11}C is the same regardless of temperature and chemical form (element, compound or ion). The half-life of the ^{11}C nucleus is constant. The intensity of the radiation depends on the number of ^{11}C nuclei present. Pure ^{11}C contains more nuclei than the same mass of a compound containing ^{11}C nuclei.
7a	Answer to include:	C≡N bond has electronegativity difference of 0.5 Electrons between C and N are unequally shared between atoms Permanent dipoles (δ+ and δ-) are set up Molecules closer together due to electrostatic attraction between δ+ and δ-
7b		
8a(i)	Chemical used to make another chemical	A feedstock is a chemical used to make another chemical. A raw material is a substance found naturally on Earth needed by the chemical industry for a particular chemical reaction.
8a(ii)	Addition	An addition reaction has taken place as Cl-OH has been added across the C=C double bond
8a(iii)	Sodium chloride	Sodium Na^+ from NaOH transfers into the salt Chlorine from molecule transfer into the salt as chloride Cl^- ion
8a(iv)	Fats/Oils are a renewable resource	Fats and Oils are a renewable resource as they are made using CO_2 recently converted into biomolecules like fats and oils. Propene is made from fossil fuels therefore the glycerol would effectively be made from CO_2 from millions of years ago. When this glycerol is returned to CO_2, the CO_2 contributes to the greenhouse effect as it is additional CO_2.
8b	$2C_3H_8O_3$ ↓ $3CO_2 + 3CH_4 + 2H_2$	$2C_3H_8O_3 \longrightarrow 3CO_2 + 3CH_4 + 2H_2$

<table>
<tr><td>8c</td><td>-672</td><td>❶ $C + O_2 \longrightarrow CO_2$ ΔH= -394 kJ
❷ $H_2 + \frac{1}{2}O_2 \longrightarrow H_2O$ ΔH= -286 kJ
❸ $C_3H_8O_3 + 3\frac{1}{2}O_2 \longrightarrow 3CO_2 + 4H_2O$ ΔH= -1654 kJ

❶x3 $3C + 3O_2 \longrightarrow 3CO_2$ ΔH= -1182kJ
❷x4 $4H_2 + 2O_2 \longrightarrow 4H_2O$ ΔH= -1144 kJ
❸x-1 $3CO_2 + 4H_2O \longrightarrow C_3H_8O_3 + 3\frac{1}{2}O_2$ ΔH=+1654 kJ

add $3C + 4H_2 + \frac{1}{2}O_2 \longrightarrow C_3H_8O_3$ ΔH= -672 kJ mol^{-1}</td></tr>
<tr><td>9a</td><td>Carbon, hydrogen, oxygen and nitrogen</td><td><table>
<tr><td>Element</td><td>Carbon</td><td>Hydrogen</td><td>Oxygen</td><td>Nitrogen</td></tr>
<tr><td>Carbohydrate</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>Fats</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>Proteins</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
</table></td></tr>
<tr><td>9b</td><td>Count number of bubbles produced in 3 minute period</td><td>PPA 2.3 Technique Question</td></tr>
<tr><td>9c</td><td>Enzymes denature and stop working at high temperatures</td><td>Enzymes are biological catalysts which work best at an optimum temperature and pH. At temperatures exceeding body temperature, enzymes quickly change shape, denature and stop working.</td></tr>
<tr><td>10a</td><td>Diagrams showing:</td><td>
</td></tr>
<tr><td>10b</td><td>67.5%</td><td>$2SO_2 + O_2 \longrightarrow 2SO_3$
2mol → 2mol
1mol → 1mol
64.1g → 80.1g
64.1tonnes → 80.1tonnes
51.2tonnes → 80.1 tonnes x $^{51.2}/_{64.1}$
= 63.98tonnes (theoretical)
$\%yield = \frac{actual}{theoretical} \times 100 = \frac{43.2}{63.98} \times 100 = 67.5\%$</td></tr>
<tr><td>11a(i)</td><td>Outer electrons further away from nucleus
Shielding effect of inner electron shells on outer electrons</td><td>The outer electron shell of elements gets further away as you go down a group because an additional electron shell is added each time.
The complete inner electron shells have a screening effect so that the nucleus has less of a hold on the outer electrons.</td></tr>
<tr><td>11a(ii)</td><td>2371.88</td><td>3.94×10^{-21} kJ x 6.02×10^{23} mol^{-1} = 2371.88 kJ mol^{-1}</td></tr>
<tr><td>11b</td><td>$Cl_{(g)} + e^- \rightarrow Cl^-_{(g)}$</td><td>$Cl_{(g)} + e^- \rightarrow Cl^-_{(g)}$</td></tr>
<tr><td>12a</td><td>0.02</td><td>no. of mol LiOH = volume x concentration = 0.4litres x 0.10 mol l^{-1} = 0.04mol
no. of mol CO_2 = $\frac{Volume}{Molar\ Volume} = \frac{0.24\ litres}{24\ litres\ mol^{-1}}$ = 0.01mol
$2LiOH + CO_2 \longrightarrow Li_2CO_3 + H_2O$
2mol 1mol
0.02mol 0.01mol
0.02 mol of LiOH used up (but 0.04mol of LiOH available)
∴ 0.04mol – 0.02mol = 0.02mol of LiOH still available</td></tr>
</table>

12b	13	$[OH^-] = 0.1 = 10^{-1}$ $\therefore [H^+] = \frac{10^{-14}}{[OH^-]} = \frac{10^{-14}}{10^{-1}} = 10^{-13} \therefore pH=13$
12c	Answer to include:	Carbonate ions pair up with H^+ ions in the water to form molecules of carbonic acid $2H^+ + CO_3^{2-} \rightleftharpoons H_2CO_3$ H^+ ions removed so water equilibrium shifts to right to replace H^+ ions $H_2O \rightleftharpoons H^+ + OH^-$ Additional OH^- ions produced: $[OH^-] > [H^+] \therefore pH>7$
13a(i)		**2,2,3-trimethylbutane** 2,2,3: position of sidegroups trimethyl: 3x $-CH_3$ sidegroups but: 4 carbons in main chain ane: all C-C single bonds
13a(ii)	Branches keep molecules apart to prevent auto-ignition	Branched and ring hydrocarbons are used in unleaded petrol because the shape of the molecules prevents them getting too close together. If the molecules get too close together then they will auto-ignite before the spark and cause pinking/knocking in the engine.
13b(i)	To reduce the amount of non-renewable fossil fuels being used.	Fossil fuels are non-renewable fuels which contribute to the greenhouse effect. By mixing with renewable oxygenates, the actual amount of fossil fuels burned will reduce.
13b(ii)	1 diagram from:	
13c	Cyclohexane	The hydrocarbon produced must have the formula C_6H_{12} $\therefore$ alkene or cycloalkane The hydrocarbon does not decolourise bromine solution $\therefore$ a cycloalkane Possible cycloalkanes formed with formula C_6H_{12} include: cyclohexane; 1,1-dimethylcyclobutane; 1,2-dimethylcyclobutane; 1,3-dimethylcyclobutane methylcyclopentane; ethylcyclobutane; 1-ethyl-2-methylcyclopropane; propylcyclopropane
14a(i)	Answers showing:	2. Measure the temperature of water 4. Measure the maximum temperature of the solution during dissolving
14a(ii)	Good insulator of heat to reduce heat loss	A polystyrene cup is used to reduce the amount of heat loss from the experiment. Polystyrene is a plastic with a high specific heat capacity.

14a(iii)	50.4kJ mol^{-1}	1 mol KOH = (1x39) + (1x16) + (1x1) = 39+16+1 = 56g 1.2g ↔ 1.08kJ 56g ↔ $1.08 \times \frac{56}{1.2}$ = 50.4kJ
14b	Answer to include:	The HCl reaction with KOH produces 1 mole of water from 1 mole of KOH The H_2SO_4 reaction with KOH produces 2 moles of water from 2 moles of KOH ∴ The same mass of KOH produces the mass of H_2O
15a	X: O–H Y: C–H	X – O–H – Peak at 3500 – 2500 cm^{-1} – C-H stretch Y – C–H – Peak at 2962 – 2853 cm^{-1} – O-H stretch in -COOH
15b(i)	Condensation or Esterification	
15b(ii)	Adsorptions peaks at 2962 – 2853 cm^{-1} and 1750 – 1735 cm^{-1}	ester – Peak at 1750 – 1735 cm^{-1} – C=O stretch in ester group C–H – Peak at 2962 – 2853 cm^{-1} – O-H stretch in -COOH