JABchem

Past Papers Higher Chemistry

2015

Marking Scheme

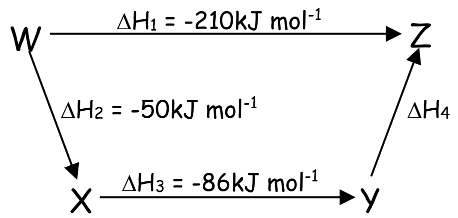
Grade Awarded	Mark Required (/100)	% candidates achieving grade
A	71+	30.6%
B	59+	22.9%
C	47+	21.1%
D	41+	9.2%
No award	<41	16.1%

Section:	Multiple Choice	Extended Answer
Average Mark:	26.7 /40	32.7 /60

2015 Higher Chemistry Marking Scheme

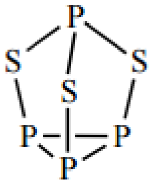
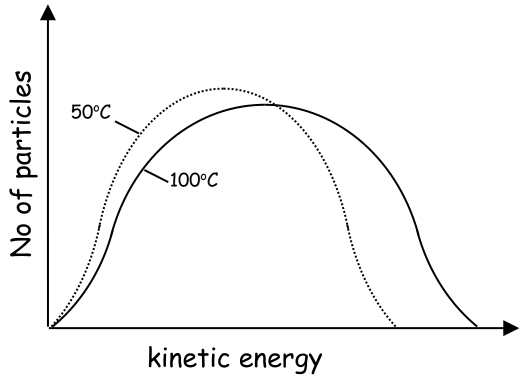
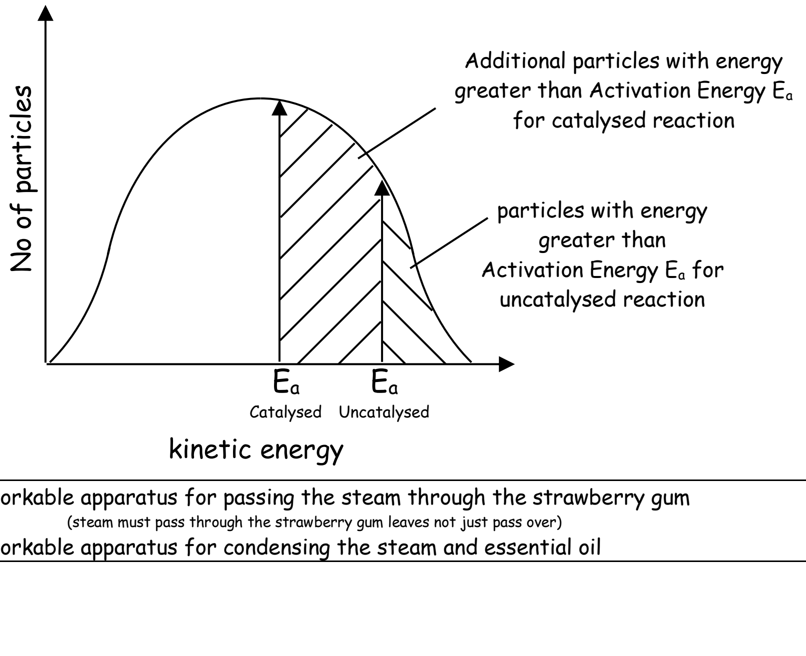
MC Qu	Answer	% Pupils Correct	Reasoning
1	C	73	☒A isotopes have the same number of protons ∴ have the same number of electrons ☒B isotopes have different mass numbers and have different masses ☑C isotopes have the same atomic number and have the same number of protons ☒D isotopes have the same number of protons so have the same nuclear charge
2	B	60	☒A Iodine is a non-metal element with no electrical conductivity ☑B potassium is a metal with a low melting point (63°C) and high electrical conductivity ☒C silicon dioxide is a covalent network and has no electrical conductivity ☒D potassium fluoride is ionic and has no electrical conductivity as a solid
3	C	71	☒A rate of reaction increases as temperature increases (but graph shows rate decreasing) ☒B The graph shows the rate of reaction when an enzyme is involved in the reaction ☑C rate of reaction increases (exponentially) as temperature increases ☒D The graph is typical of the effect of temperature on radioactive half-life
4	B	55	$Mg + 2H^+ \longrightarrow Mg^{2+} + H_2$ 1mol 2mol 0.1mol 0.2mol $\text{volume} = \frac{\text{no. of mol}}{\text{concentration}} = \frac{0.2\text{ mol}}{4\text{ mol l}^{-1}} = 0.05_{\text{litres}} = 50\text{cm}^3$
5	D	65	☒A displacement: higher up metal displaces a lower down metal ion from compound ☒B neutralisation: H^+ ions in acids react with bases/alkali to form water ☒C oxidation: increase in the oxygen : hydrogen ratio in carbon compounds ☑D precipitation: two ions meet and form insoluble precipitate which falls to the bottom
6	C	54	☒A nail Q is protected from corrosion by sacrificial protection by higher up metal zinc ☒B nail P corrodes to protect copper by sacrificial protection and Fe^{2+} cause blue colour ☑C nail P corrodes to protect copper by sacrificial protection and Fe^{2+} cause blue colour ☒D nail Q is protected from corrosion by sacrificial protection by higher up metal zinc
7	B	82	$\text{Rate} = \frac{\Delta\text{quantity}}{\Delta\text{time}} = \frac{0.035 - 0.025}{20 - 10} = \frac{0.01}{10} = 0.001\text{ mol l}^{-1}\text{ s}^{-1}$
8	A	80	☑A 1st ionisation energy decreases down a group as outer electrons easier to remove ☒B atomic size increases down a group as additional shells of electrons are added ☒C electronegativity decreases down a group ☒D melting point of group elements decreases going down group 1
9	C	85 newH=89	☒A First ionisation energy forms a 1+ ion from the element in the gaseous state ☒B First ionisation energy forms a 1+ ion from the element in the gaseous state ☑C 1st ionisation energy: removal of one mole of electron from one mole of atoms in the gaseous state. ☒D Element must be single atoms in the gaseous state before ionisation
10	B	81	Group 3 elements have a low 3rd ionisation energy and a very high 4th ionisation energy • removal of the 3rd electron creates a full outer shell • removal of the 4th electron breaks into a full outer shell
11	A	75	☑A 1st Electron Affinity: one mole of atoms gains one mole of electrons in the gaseous state ☒B Element must be single atoms in the gaseous state before gaining electron ☒C Element must be single atoms in the gaseous state before gaining electron ☒D Electron affinity forms negative ions as it *combines* with electrons
12	A	74 newH=62	☑A X-Y: activation energy (E_a) for the forward reaction ☒B Y-X: would give a negative value but activation energy (E_a) must be endothermic ☒C Y-Z: would be the enthalpy change (ΔH) for the reverse reaction ☒D Z-Y: would be the enthalpy change (ΔH) for the forward reaction

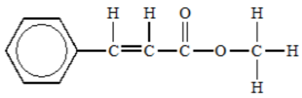
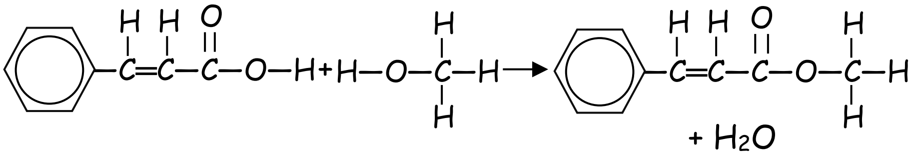
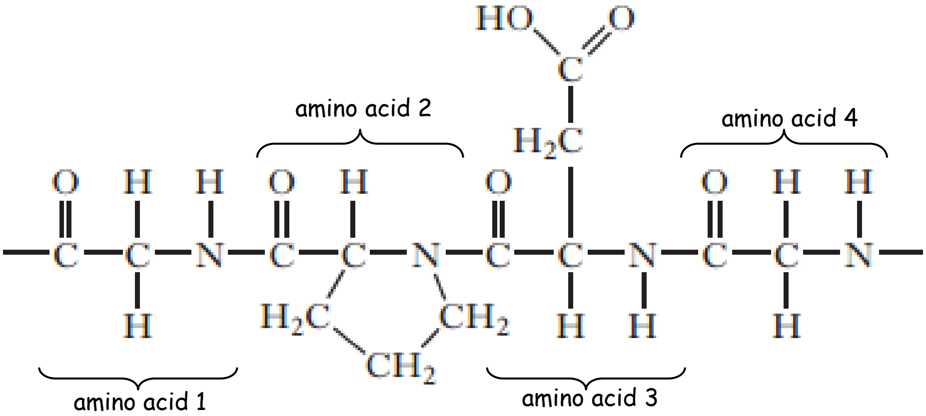
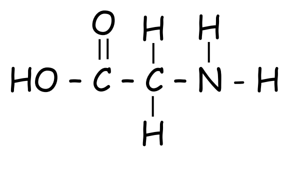
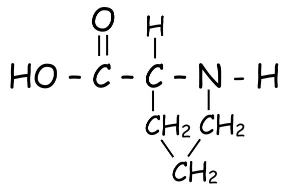
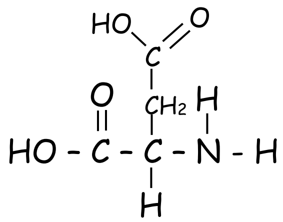
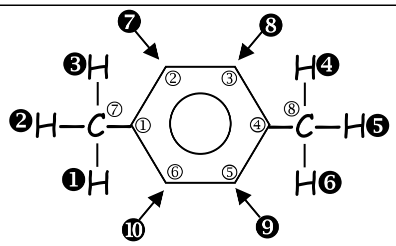
13	B	84	Enthalpy of Neutralisation: The energy change when one mole of water is formed in the neutralisation of an acid
14	D	58	☒A 1mol Na^+Cl^- but 2 ions per f.u. ∴ 2mol of ions ☒B 1mol H_2 molecules but 2 atoms per molecule ∴ 2mol of atoms ☒C 1mol of He atoms but 2 electrons per atom ∴ 2mol of electrons ☑D 1mol of O_2 molecules
15	D	72	☒A 1mol O_2 molecules = 2mol of O atoms but 1mol of CO molecules = 1mol of O atoms ☒B 1mol O_2 molecules = 2mol of O atoms but 0.5 mol CO_2 molecules = 1 mol of O atoms ☒C 0.5mol O_2 molecules = 1mol of O atoms but 1 mol CO_2 molecules = 2 mol of O atoms ☑D 1mol O_2 molecules = **2 mol** of O atoms and 1 mol CO_2 molecules = **2 mol** of O atoms
16	D	51	☒A not all gases are made of molecules as Noble gases are gases made of atoms ☒B number of electrons will vary depending on the elements inside the gas ☒C some gases are made of molecules of varying number of atoms inside ∴no. of atoms will vary ☑D equal of volumes of gas (at same pressure and temp) will have the same number of moles of gas
17	D	51 revH=54	☒A 1mol gas → 2mol gas: products have greater volume than reactants ☒B 1mol gas → 1mol gas: products have same volume than reactants ☒C zero mol of gas → 1mol gas: products have greater volume than reactants ☑D 2mol gas → zero mol of gas: products have less volume than reactants
18	C	26	**gfm** Na = 23g mol^{-1} mass = 4.6g **M**olar Volume = 24 litres mol^{-1} Volume = 4.8litres no. of mol = $\frac{\text{mass}}{\text{gfm}} = \frac{4.6g}{23g\ mol^{-1}}$ = 0.2mol no. of mol = $\frac{\text{Volume}}{\text{Molar Volume}} = \frac{4.8\ litres}{23\ litres\ mol^{-1}}$ = 0.2mol $4Na + O_2 \longrightarrow 2Na_2O$ 4mol 1mol 2mol 0.2mol 0.05mol 0.05mol of O_2 reacts with 0.2mol of Na ∴ 0.15mol of O_2 (out of 0.2mol) is unreacted
19	C	75	☒A fractional distillation of crude oil must be the first step ☒B fractional distillation of crude oil must be the first step ☑C fractionating into fractions before reforming into branched chains before blending ☒D straight chains must be reformed into branched chains before blending
20	B	78	2,2-dimethylpentan-1-ol has the molecular formula $C_7H_{15}OH$ ☒A $CH_3CH_2CH_2CH(CH_3)CH_2OH$ has the molecular formula of $C_6H_{13}OH$ ☑B $(CH_3)_3CCH(CH_3)CH_2OH$ has the molecular formula of $C_7H_{15}OH$ ∴ isomer ☒C $CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2OH$ has the molecular formula of $C_8H_{17}OH$ ☒D $(CH_3)_2CHC(CH_3)_2CH_2CH_2OH$ has the molecular formula of $C_8H_{17}OH$
21	B	67	☒A Hydrogen can be made from water or natural gas ☑B Methane (biogas) can be made from anaerobic fermentation of biological material ☒C Methanol is made from synthesis gas: $CO + 2H_2 \rightarrow CH_3OH$ ☒D Petrol is made by reforming the naphtha fraction of crude oil
22	D	54	$nCO + (2n+1)H_2 \rightarrow nH_2O$ + hydrocarbon **Multiply out brackets** $nCO + 2nH_2 + H_2 \rightarrow nH_2O$ + hydrocarbon **Separate out H_2 which forms H_2O** nC~~O~~ + ~~nH_2~~ + $nH_2 + H_2 \rightarrow$ ~~nH_2O~~ + hydrocarbon **Cancel out water** $nC + nH_2 + H_2 \rightarrow$ hydrocarbon **Build hydrocarbon into general formula** $C_nH_{2n} + H_2 \rightarrow$ Hydrocarbon C_nH_{2n+2} = Hydrocarbon
23	C	70	Reaction X is hydration as water is added across a C=C double bond Reaction Y is oxidation as a secondary alcohol is converted into a ketone

<table>
<tr><td>24</td><td>B</td><td>68</td><td>Diacid monomer must have 2 carboxyl groups to be a diacid and they should be on carbons C_1 and C_3 of benzene ring</td></tr>
<tr><td>25</td><td>A</td><td>80</td><td>☑A ozone absorbs harmful u.v. light which can cause skin cancer
☒B ozone absorbs u.v. light not reflect
☒C chlorofluorocarbons break down ozone
☒D chlorofluorocarbons were used as a refrigerant gas (and in aerosols in the past)</td></tr>
<tr><td>26</td><td>D</td><td>68</td><td>Polyester can be a fibre or a resin. The correct answers for both types are:
<table>
<tr><td>Use</td><td>Property</td><td>Structure</td></tr>
<tr><td>Resin</td><td>Rigid</td><td>Cross-linked</td></tr>
<tr><td>Fibre</td><td>Flexible</td><td>Linear</td></tr>
</table></td></tr>
<tr><td>27</td><td>A</td><td>68</td><td>Nylon is former by condensation polymerisation. During a condensation reaction, two molecules join together and a small molecule is removed from where the two molecules join together. This small molecule is usually, but not always, water.
In this example, a Cl atom is removed from the first monomer and an H atom is removed from the second monomer to form HCl.</td></tr>
<tr><td>28</td><td>D</td><td>68</td><td>The polymer shown is poly(ethyne). The third bond in the triple bond takes part in the addition reaction as the ethyne monomer units polymerise together to make the long polymer chain leaving a double bond.
This double bond is later altered to allow poly(ethyne) to be able to conduct electricity.</td></tr>
<tr><td>29</td><td>B</td><td>80</td><td>☒A dehydrogenation is the removal of hydrogen but this reaction adds hydrogen atoms
☑B this reaction is a hydrogenation reaction as hydrogen is added across C=C bonds
☒C hydrolysis reactions split the molecule into smaller units adding water at the break
☒D hydration reactions add water across a C=C double bond. 2mol H_2 are added not H_2O</td></tr>
<tr><td>30</td><td>C</td><td>63</td><td>☒A This molecules has no C=C double bonds to react with bromine.
☒B This molecules is not a primary alcohol. Primary alcohols oxidise to an aldehyde.
☑C This molecule is a secondary alcohol and will oxidise to a ketone
☒D There are no C=C double bonds to allow addition polymerisation</td></tr>
<tr><td>31</td><td>A</td><td>60</td><td>☑A Full scale production is not a stage is new product development
☒B Pilot studies show whether a new product can be produced by the method profitably
☒C Research is an essential stage in the development of a new product
☒D Scaling up is necessary to develop a new product in the large quantities necessary</td></tr>
<tr><td>32</td><td>D</td><td>70
newH=62
revH=73</td><td>☒A $2I_{(g)} + 2e^- \longrightarrow 2I^-_{(g)}$ should have ΔH = 2x-349kJ = -698kJ
☒B $2I_{(g)} + 2e^- \longrightarrow 2I^-_{(g)}$ should have ΔH = 2x-349kJ = -698kJ
☒C $I_{2(g)} \longrightarrow 2I_{(g)}$ should have ΔH = +243kJ
☑D all steps have the correct enthalpy changes:
Enthalpy of sublimation $I_{2(s)} \longrightarrow I_{2(g)}$ ΔH = +60kJ
Bond dissociation of I_2 $I_{2(g)} \longrightarrow 2I_{(g)}$ ΔH = +243kJ
2xelectron affinity of iodine $2I_{(g)} + 2e^- \longrightarrow 2I^-_{(g)}$ ΔH =-698kJ</td></tr>
<tr><td>33</td><td>A</td><td>64
newH=58
revH=69</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>34</td><td>A</td><td>87
newH=89
revH=88</td><td>☑A at equilibrium rate of the forward reaction = rate of reverse reaction
☒B at equilibrium the concentration of reactants and products are constant not equal
☒C at equilibrium both forward and reverse reactions continue at equal rate
☒D catalysts do not change the position of equilibrium</td></tr>
<tr><td>35</td><td>B</td><td>83
revH=84</td><td>☒A Forward reaction: 2mol gas → 1mol gas ∴forward reaction decreases pressure
☑B Forward reaction: 2mol gas → 2mol gas ∴no change in pressure
☒C Forward reaction: 3mol gas → 2mol gas ∴forward reaction decreases pressure
☒D Forward reaction: 4mol gas → 2mol gas ∴forward reaction decreases pressure</td></tr>
</table>

36	C	40 revH=33	The red colour will fade as equilibrium shifts to right. ☒A Equilibrium shifts to left as product (H^+) is added to equilibrium ☒B Equilibrium shifts to left as product (Br^-) is added to equilibrium ☑C Equilibrium shifts to right as product (Br^-) is removed by $Ag^+Br^-_{(s)}$ precipitation ☒D Equilibrium shifts to left as product (OBr^-) is added to equilibrium
37	D	56	☒A [OH^-] decreases as sodium hydroxide solution is diluted with water ☒B [OH^-] decreases as sodium hydroxide solution is diluted with water ☒C Conductivity decreases as solution is diluted as there are less ions to conduct ☑D Dilution of an alkali decreases [OH^-], increases [H^+] and decreases conductivity
38	A	54	Lemon Juice: pH= 3 $\therefore$[H^+] = 10^{-3} mol l^{-1} Apple Juice: pH= 5 $\therefore$[H^+] = 10^{-5} mol l^{-1} pH=3 → pH=5 is a decrease in concentration of H^+ by a factor of 100 Lemon Juice : Apple Juice 100 : 1
39	B	57	$Cu^{2+} + 2e^- \longrightarrow Cu$ — 2mol : 1mol; 193000C : 63.5g; $^{0.127}/_{63.5}$ x 193000C = 386C : 0.127g $2Cl^- \longrightarrow Cl_2 + 2e^-$ — 1mol : 2mol; 24litres : 193000C; $^{386}/_{193000}$ x 24litres = 0.048litres : 286C
40	A	61	☑A radioactive calcium will have a different mass number from non-radioactive calcium ☒B All calcium atoms have same chemical properties (as they have 2,8,8,2 arrangement) ☒C All calcium atoms have an atomic number if 20 ☒D All calcium atoms have 20 electrons and an arrangement of 2,8,8,2

2015 Higher Chemistry Marking Scheme

Long Qu	Answer	Reasoning
1a	London dispersion forces covalent bonds	The covalent bonds inside the S_8 rings do not break as the sulphur melts. When sulphur S_8 melts, London dispersion forces between the S_8 rings must be overcome but as these are weak then sulphur has a lower melting point. Silicon dioxide is a covalent network. Covalent bonds must be broken before a covalent network will melt into a liquid resulting in a high melting point.
1b(i)		Any structure for P_4S_3 that obeys the following valency rules: • 3 bonds per P atoms • 2 bonds per S atom
1b(ii)	Increased nuclear attraction/charge or more protons in sulphur nucleus	Sulphur and phosphorus are in the same period of the periodic table and the same shell is being filled with electrons. Sulphur has 16 protons which pull in the outer shell of the sulphur atom further than the 15 protons in a phosphorus nucleus would do. Electrons closer to the nucleus are harder to remove.
1b(iii)	Greater number of London dispersion forces between S_8 molecules than P_4 molecules	Both P_4 and S_8 contain non-polar molecules. Both substances are solid at room temperature due to the number of London dispersion forces between the molecules which bring the molecules close enough to be a solid. Sulphur has a higher melting point than phosphorus due to greater numbers of London dispersion forces between molecules of 8 atoms than phosphorus atoms with only 4 atoms inside the molecule.
2a	45-46	From graph: rate = 0.0022 s^{-1} $\text{Rate} = \frac{1}{\text{time}} \therefore \text{time} = \frac{1}{\text{rate}} = \frac{1}{0.022} = 45\text{s}$
2b(i)	Curve and peak drawn to left of original curve	
2b(ii)	Line drawn to the left of the E_a line.	
3a	Diagram showing:	1mark: workable apparatus for passing the steam through the strawberry gum (steam must pass through the strawberry gum leaves not just pass over) 1mark: workable apparatus for condensing the steam and essential oil

3b		 Methyl cinnamate is the ester formed from cinnamic acid and methanol
3c	52%	Cinnamic acid + methanol → methyl cinnamate + water 1mol … 1mol 148g … 162g 6.5g … $162g \times {}^{6.5}/_{148}$ $= 7.1g$ (theoretical) $\%\ yield = \frac{actual}{theoretical} \times 100 = \frac{3.7}{7.1} \times 100 = 52\%$
4a	Energy or vitamins	A balanced diet will contain the appropriate mix of carbohydrates, fats/oils, protein, fibre, vitamins and minerals
4b	Esters	Triglycerides are formed in the condensation reaction of three fatty acid molecules with glycerol. The fatty acid molecules have carboxyl groups which join to a hydroxyl group on glycerol. Water is removed as they join.
4c	hydrolysis	Hydrolysis is the breaking of fats/oils into three fatty acids and a glycerol molecule with three molecules of water added at the breaks.
5a	4	
5b	One from:	 amino acid 1&4 —  amino acid 2 —  amino acid 3
6a(i)	More branched or ringed/aromatic molecules formed	Reforming of straight chain molecules in petrol into branched chain or ring/aromatic hydrocarbons keeps the molecules far enough apart when they are compressed so that they do not auto-ignite before the spark.
6a(ii)	C_8H_{10}	
6b(i)	Prevent loss by evaporation	Alcohol is a volatile liquid which evaporates quickly. Placing the lid on the spirit burner reduces evaporation of alcohol. Alcohol which evaporates does not release energy and makes the answer more inaccurate.

<table>
<tr><td>6b(ii)</td><td>-1015</td><td>

E_h	=	c	×	m	×	ΔT
Energy	=	specific heat capacity	×	mass	×	change in temperature
E_h	=	4.18	×	0.1	×	21
E_h	=	8.78 kJ				

1mol C_4H_9OH = (4x12)+(10x1)+(1x16) = 48+10+16 = 74g

0.64g ↔ 8.78kJ
74g ↔ 8.78kJ x $^{74}/_{0.64}$
= -1015 kJ mol^{-1}

</td></tr>
<tr><td>6c</td><td>Answer between -3325 to -3340</td><td>

Alcohol	Ethanol	Propan-1-ol	Butan-1-ol	Pentan-1-ol
Enthalpy of Combustion (kJ mol^{-1})	-1367	-2020	-2676	-
Difference (kJ mol^{-1})	653	656	(659)	
Prediction (kJ mol^{-1})	-	-	-	-3335

</td></tr>
<tr><td>7a</td><td>Maintain steady current</td><td>The variable resistor allows the experiment to be carried out at a constant current. The current flowing in the circuit may change as the temperature changes or the concentration of the reactants changes.</td></tr>
<tr><td>7b</td><td>18996</td><td>

1cm^2 leaf requires 0.030A ∴ 24cm^2 leaf requires 0.030A x $^{24}/_1$ = 0.72A

$Cu^{2+} + 2e^- \longrightarrow Cu$

2mol → 1mol
2x96500C → 63.5g
193000C x $^{4.5}/_{63.5}$ → 4.5g
= 13677C

$t = \frac{Q}{I} = \frac{13677}{0.72} = 18996s$

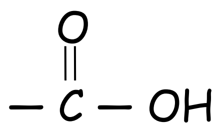
</td></tr>
<tr><td>8a</td><td>Equation showing:</td><td>

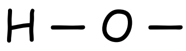
$${}^{60}_{27}Co \longrightarrow {}^{60}_{28}Ni + {}^{0}_{-1}e$$

</td></tr>
<tr><td>8b</td><td>Gamma is high energy or very penetrating</td><td>Gamma radiation is high energy electromagnetic radiation. It needs a thick layer of lead metal to stop it and will penetrate the packaging and kill the bacteria inside to sterilise the insides of the package until it is opened.</td></tr>
<tr><td>8c(i)</td><td>21.08</td><td>

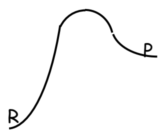
Radioactivity	Number of Half-lives	Time (years)
1	0	0
$^1/_2$	1	1x5.27 = 5.27
$^1/_4$	2	2x5.27 = 10.54
$^1/_8$	3	3x5.27 = 15.81
$^1/_{16}$	4	4x5.27 = 21.08

</td></tr>
<tr><td>8c(ii)</td><td>No change</td><td>The half-life of a radioisotope is determined by the ratio of protons to neutrons. Changes in temperature, concentration, physical state and chemical state do not alter the half-life of the radioisotope.</td></tr>
<tr><td>9a(i)</td><td>Hydroxyl and carboxyl groups</td><td>

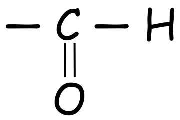
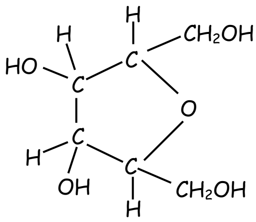

carboxyl group


hydroxyl group

</td></tr>
<tr><td>9a(ii)</td><td>forms hydrogen bonds with water</td><td>Hydrogen bonding is formed when N—H, O—H or H—F bonds interact with water molecules. These bonds are highly polar allowing the compounds containing these bonds to be soluble in a polar solvent like water.</td></tr>
<tr><td>9b</td><td>H^+ ions are not produced until dissolved in water</td><td>Acidity and alkalinity are water-based systems and no pH can be measured if water is absent. When water is added to solid citric acid, H^+ ions will dissociate from carboxyl group and can then react with hydrogencarbonate ions.</td></tr>
</table>

9c		Endothermic reactions take energy from the surroundings and lower the temperature in those surroundings. On a potential energy diagram the products are higher than the reactants. Exothermic reactions give heat to the surroundings and raise the temperature of the surroundings. On a potential energy diagram the products are lower than the reactants.
9d	4.29 litres	**gfm** $NaHCO_3$ = 84g **n**o. of mol = $\frac{\textbf{mass}}{\textbf{gfm}}$ = $\frac{15g}{84g}$ = 0.179mol $C_6H_8O_7 + 3NaHCO_3 \longrightarrow C_6H_5O_7Na_3 + 3H_2O + 3CO_2$ $NaHCO_3$: 3mol, 1mol, 0.179mol; CO_2: 3mol, 1mol, 0.179mol **gfm** CO_2 = (1x12) + (2x16) = 12 + 32 = 44g **V**olume = no. of mol x **M**olar **V**olume = 0.179mol x 24 litres mol^{-1} = 4.29 litres
10a	Acid which partially ionises/dissociates	Strong acids fully dissociate into ions e.g. hydrochloric acid, sulphuric acid Weak acids only partially dissociate with only a small percentage of the possible H^+ ions dissociated e.g. ethanoic acid, sulphurous acid
10b	pH greater than 7	Sodium cyanide is made from sodium hydroxide (strong alkali) & hydrocyanic acid (weak acid) • Salts made from strong acids and strong alkalis have pH=7 • Salts made from weak acids and strong alkalis have pH>7 • Salts made from strong acids and weak alkalis have pH<7
10c(i)	Equation showing:	$4Au + 8NaCN + O_2 + 2H_2O \longrightarrow 4NaAu(CN)_2 + 4NaOH$
10c(ii)	10^{-4} mol l^{-1}	(see table below)

pH	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
$[H^+]$ (mol l^{-1})	1	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}	10^{-10}	10^{-11}	10^{-12}	10^{-13}	10^{-14}
$[OH^-]$ (mol l^{-1})	10^{-14}	10^{-13}	10^{-12}	10^{-11}	10^{-10}	10^{-9}	10^{-8}	10^{-7}	10^{-6}	10^{-5}	10^{-4}	10^{-3}	10^{-2}	10^{-1}	1

11a(i)		Aldehyde groups contain a carbonyl (C=O) group with a hydrogen atom attached. The carbon in the aldehyde group is always carbon number one in any numbering system assigned to an aldehyde when naming the compound.
11a(ii)	Glucose/Fehling's mixture is heated	Fehling's solution and Benedict's solution both react with aldehyde groups giving a blue to brick red colour change. The reaction must be heated to speed up the reaction/colour change.
11a(iii)	Blue to brick red	Colour change must be described as blue at start but the following colours are acceptable as the end colour: orange, (brick) red, yellow, brown, green
11b		Problem Solving Question
11c	Condensation	Condensation Polymerisation: small molecules (e.g. glucose) joining up to make a larger molecule (e.g. starch) with a small molecule (e.g. water) removed at the joins.
11d	Answer to include:	Amylopectin molecules are unable to pack closely together due to shape and can separate more easily. (It has more readily accessible –OH groups.) Amylose molecules pack closer together and more difficult to separate.
12a(i)	Flow chart complete with:	1st Mark: calcium carbonate; ammonia; carbon dioxide; calcium oxide 2nd Mark: sodium hydrogencarbonate; ammonium chloride; water; sodium carbonate

12a(ii)	Calcium chloride/ byproducts can be sold	The calcium chloride can be sold for profit even though it is not the main product of the Solvay Process. If the calcium chloride is not sold for profit then it would have to be disposed of responsibly at a cost.
12b	Adding Na^+ shifts equilibrium to right	Brine contains Na^+ ions. Na^+ ions are a reactant in the reaction. When a reactant is added to a reaction at equilibrium, the equilibrium shifts to the right to make additional products and remove the additional Na^+ ions.
12c	+20 kJ mol^{-1}	$CaCO_3 + 2NaCl \rightarrow Na_2CO_3 + CaCl_2$ ❶ $CaCO_3 \rightarrow CO_2 + CaO$ $\Delta H=+178kJ$ ❷ $CaO + H_2O \rightarrow Ca(OH)_2$ $\Delta H=-65kJ$ ❸ $NaCl + NH_3 + CO_2 + H_2O \rightarrow NaHCO_3 + NH_4Cl$ $\Delta H=-79kJ$ ❹ $2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$ $\Delta H=+85kJ$ ❺ $Ca(OH)_2 + 2NH_4Cl \rightarrow CaCl_2 + 2H_2O + 2NH_3$ $\Delta H=-20kJ$ ❶ $CaCO_3 \rightarrow$ ~~CO_2~~ + ~~CaO~~ $\Delta H=+178kJ$ ❷ ~~CaO~~ + ~~H_2O~~ $\rightarrow$ ~~$Ca(OH)_2$~~ $\Delta H=-65kJ$ ❸x2 $2NaCl$ + ~~$2NH_3$~~ + ~~$2CO_2$~~ + ~~$2H_2O$~~ $\rightarrow$ ~~$2NaHCO_3$~~ + ~~$2NH_4Cl$~~ $\Delta H=-158kJ$ ❹ ~~$2NaHCO_3$~~ $\rightarrow Na_2CO_3$ + ~~H_2O~~ + ~~CO_2~~ $\Delta H=+85kJ$ ❺ ~~$Ca(OH)_2$~~ + ~~$2NH_4Cl$~~ $\rightarrow CaCl_2$ + ~~$2H_2O$~~ + ~~$2NH_3$~~ $\Delta H=-20kJ$ add $CaCO_3 + 2NaCl \rightarrow Na_2CO_3 + CaCl_2$ $\Delta H=+20kJ$
13a	Answer to include:	1st mark: ammonia is polar and trichloramine is non-polar 2nd mark: electronegativity difference is bigger in N-H bond than N-Cl bond ∴ NH_3 is polar and NCl is non-polar
13b(i)	$2I^- \rightarrow I_2 + 2e^-$	Redox equation: $NaOCl + 2I^- + 2H^+ \rightarrow I_2 + NaCl + H_2O$ Oxidation step: $2I^- \rightarrow I_2 + 2e^-$ Reduction step: $NaOCl + 2H^+ + 2e^- \rightarrow NaCl + H_2O$
13b(ii)	Starch acts as an indicator	Starch solution acts as indicator in this reaction. Starch turns blue/black in the presence of iodine and is colourless when there is no iodine present. The end point of a reaction is detected when all the iodine has reacted with the thiosulphate ions by the colour change blue/black to colourless.
13b(iii)	6.20×10^{-5} mol l^{-1}	$S_2O_3^{2-}$ **n**o. of mol = **c**oncentration x **v**olume = 0.00100litres x 0.0124 mol l^{-1} = 1.24×10^{-5} mol $I_2 + 2Na_2S_2O_3 \rightarrow 2NaI + Na_2S_4O_6$ 1mol 2mol 6.20×10^{-6}mol 1.24×10^{-5}mol $NaOCl + 2I^- + 2H^+ \rightarrow I_2 + NaCl + H_2O$ 1mol 1mol 6.20×10^{-6}mol 6.20×10^{-6}mol 100cm^3 of swimming pool water contains 6.20×10^{-6} mol NaOCl 1000cm^3 of swimming pool water contains 6.20×10^{-6} mol x $^{1000}/_{100}$ $=6.20\times10^{-5}$ mol l^{-1}