JABchem

Past Papers Higher Chemistry

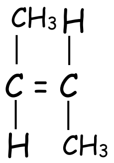
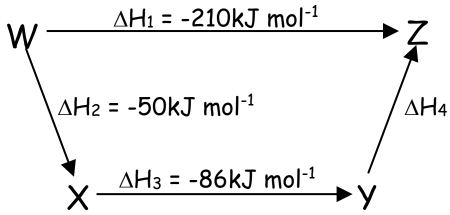
2002

Marking Scheme

Grade Awarded	Mark Required (/100)
A	77+
B	62+
C	47+
D	?
No award	?

2002 Higher Chemistry Marking Scheme

MC Qu	Answer	% Pupils Correct	Reasoning
1	D	81	☒A $HCl \rightarrow H^+ + Cl^-$ ☒B not soluble in water so has no pH ☒C $SO_2 + H_2O \rightarrow H_2SO_3$ (sulphurous acid) $\rightarrow 2H^+ + SO_3^{2-}$ ☑D $NH_3 + H_2O \rightarrow NH_4^+ + OH^-$
2	C	52	$Cu + 2Ag^+NO_3^- \rightarrow 2\mathbf{Ag} + Cu^{2+}(NO_3^-)_2$ (Displacement Reaction) $Cu + Zn(NO_3) \rightarrow$ no reaction as copper is below zinc in reactivity series
3	B	52	$Mg + 2HCl \rightarrow MgCl_2 + H_2$ 1mol 2mol 0.1mol 0.2mol volume = $\frac{\text{no. of mol}}{\text{concentration}} = \frac{0.2\text{mol}}{4\text{mol l}^{-1}}$ = 0.05mol = 50cm^3
4	A	74	☑A As mass of zinc is same and acid is in excess – same volume of gas produced and same mass lost ☒B concentrations different ∴ speed of reaction is different (2mol l^{-1} would finish first) ☒C 2mol l^{-1} acid would react faster initially than 1 mol l^{-1} ☒D Different initial speed of reactions would give different average rate of reaction
5	D	55	Activation energy is unaffected by changing temperature. Lower temperature reduces the energy of the collisions so less particles have enough energy to successfully collide and react.
6	A	64	ΔH measured from reactants to products (-227 – 134 = -361kJ mol^{-1}) NB Downhill overall so exothermic with negative sign.
7	C	74	☒A Very little ionic bonding in water or ice ☒B polar covalent bonds inside molecules are unchanged during melting ☑C hydrogen bonding is much greater in ice than in water (hence ice has bigger volume) ☒D Water is a polar covalent substance due to electronegativity in the O-H bond
8	C	68	☒A H-Cl is polar due to electronegativity difference (Δneg=3.0-2.2=0.8) ☒B H_2O is polar due to electronegativity difference (Δneg=3.5-2.2=1.3) ☑C CO_2 is non-polar due to linear shape despite electronegativity difference ☒D $CHCl_3$ (chloroform) is polar as C-H bond has Δneg =3.0-2.5=0.5
9	A	67	Metal produced will be a solid as metal produced melts at 843°C and the temperature of the process is likely to be just above 772°C (the mpt of the metal chloride). Metal produced is less dense than the molten metal chloride so will float to the surface of the molten metal chloride.
10	A	60	☑A 1mol of H_2 = 2g ∴ no. of mol H_2 = $^{mass}/_{gfm}$ = $^{0.1}/_{2}$ = 0.05mol ☒B 1mol of NH_3 = 17g ∴ no. of mol H_2 = $^{mass}/_{gfm}$ = $^{0.17}/_{17}$ = 0.01mol ☒C 1mol of CH_4 = 16g ∴ no. of mol H_2 = $^{mass}/_{gfm}$ = $^{0.32}/_{16}$ = 0.02mol ☒D 1mol of Cl_2 = 71g ∴ no. of mol H_2 = $^{mass}/_{gfm}$ = $^{0.35}/_{71}$ = 0.005mol
11	C	41	$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$ 1mol 5mol 3mol 4mol 1vol 5vol 3vol – (NB Liquids have negligible volume compared to liquids) 50cm^3 250cm^3 150cm^3 - Resulting Volume = vol of CO_2 produced + vol of oxygen leftover = 150cm^3 CO_2 + 250cm^3 leftover O_2 = 400cm^3
12	C	58	1mol ^{12}C = 12g = 6.02x10^{23} ^{12}C atoms 1g = 6.02x10^{23} ^{12}C atoms x $^1/_{12}$ = 5.02 x10^{22} ^{12}C atoms But 12 protons/neutrons per ^{12}C atom → 5.02 x10^{22} x 12 = 6.02x10^{23} p+n But 3 quarks per proton/neutron → 6.02x10^{23} x 3 = 1.80x10^{24} quarks
13	A	61	☑A nitrogen dioxide is formed by the sparking of nitrogen & oxygen in an engine ☒B hydrocarbons are formed by incomplete combustion of fuel ☒C carbon (soot) is formed by incomplete combustion of fuel ☒D carbon monoxide is formed by incomplete combustion of fuel
14	B	60	☒A Cracking: Larger molecules broken into smaller molecules, some with C=C bonds ☑B Reforming: Straight chain molecules turned into branched chained or rings ☒C Dehydration: water removed from molecules leaving a C=C double bond ☒D Addition Polymerisation: monomers with C=C bonds joining up to make polymer

15	B	61	Hexanal has structure $CH_3CH_2CH_2CH_2CH_2CHO$ ∴ $C_6H_{12}O$ ☒A 2-methylbutanal has structure $CH_3CH_2CH(CH_3)CHO$ ∴ $C_5H_{10}O$ ☑B 3-methylpentan-2-one has structure $CH_3CH_2CH(CH_3)COCH_3$ ∴ $C_6H_{12}O$ ☒C 2,2-dimethylbutan-1-ol has structure $CH_3CH_2C(CH_3)_2CH_2OH$ ∴ $C_6H_{14}O$ ☒D 3-ethylpentanal has structure $CH_3CH_2CH(C_2H_5)CH_2CHO$ ∴ $C_7H_{14}O$
16	A	80	☑A This is the ester produced from methanoic acid and ethanol ☒B This ester is methylethanoate made from ethanoic acid and methanol ☒C This is not an ester (it is an ether – see Advanced Higher) ☒D This is not an ester (it is the carboxylic acid called propanoic acid)
17	C	61	☒A Benzene C_6H_6 and cyclohexane C_6H_{14} have different formulae ☒B Benzene has no C=C double bonds to react with bromine ☑C Benzene C_6H_6 and ethyne C_2H_2 have the same C:H ratio (ie 1:1) ☒D Benzene has no C=C double bonds to undergo addition reactions
18	C	61	☒A Oxidation: ethanol (primary alcohol) → ethanoic acid (carboxylic acid) ☒B Oxidation: propan-2-ol (secondary alcohol) → propanone (ketone) ☑C Reduction: butanone (ketone) → butan-2-ol (secondary alcohol) [reverse of oxidation] ☒D Oxidation: propanal (aldehyde) → propanoic acid (carboxylic acid)
19	A	69	 This monomer is but-2-ene
20	D	73	Synthesis gas is a mixture of carbon monoxide and hydrogen
21	B	71	☒A poly(ethyne) is a polymer which is an electrical conductor ☑B poly(ethenol) is a polymer which is soluble ☒C Biopol is a polymer which is a biodegradable polymer ☒D Kevlar is a very strong polymer used in bullet-proof vests
22	C	82	Peptides are formed when the -H from an amino group ($-NH_2$) of one amino acid and the –OH from a carboxylic acid group (-COOH) of a second amino acid are removed to form water as the molecules join together.
23	A	44	$\Delta H_1 = \Delta H_2 + \Delta H_3 + \Delta H_4$ $\Delta H_4 = \Delta H_1 - \Delta H_2 - \Delta H_3$ $\Delta H_4 = -210 - (-50) - (-86)$ $\Delta H_4 = -74 kJ\ mol^{-1}$ But ΔH for Z to Y = $+74 kJ\ mol^{-1}$ 
24	D	75	Catalyst does not affect the position of equilibrium Value of ΔH is unchanged by addition of a catalyst.
25	D	55	☒A Hydrogen in position A → Aldehyde ∴ neutral ☒B Hydrogen in position B → Alcohol ∴ neutral ☒C Hydrogen in position C → Alkyl group ∴ neutral ☑D Hydrogen in position D → Carboxylic acid ∴ acidic
26	A	91	☑A pH of acids increase to 7 when diluted ☒B electrical conductivity decreases as acid is diluted ☒C diluted acids react slower with chalk ☒D the volume of alkali neutralised will not increase when an acid is diluted
27	B	56	☒A This is a neutralisation reaction (acid + metal hydroxide → salt + water) ☑B Redox: $Zn \rightarrow Zn^{2+} + 2e^-$ (oxidation) and $2H^+ + 2e^- \rightarrow H_2$ (reduction) ☒C This is a neutralisation reaction (acid + metal oxide → salt + water) ☒D This is a neutralisation reaction (acid + metal carbonate → salt + water + CO_2)
28	B	53	☒A $\frac{1}{2}$mol of each metal produced but 1mol of Cu and 1mol of Ni have different masses ☑B $\frac{1}{2}$mol of each metal produced ∴ same number of atoms of each metal produced ☒C Metal ions are positive so will be deposited on the negative electrode ☒D $\frac{1}{2}$mol of each metal produced as both metals have a two positive charge

29	D	46	Strontium has atomic number of 38 (date booklet) ∴ 38 protons. Number of neutrons = mass number – atomic number = 90 – 38 = 52 neutrons ∴ratio of neutrons:protons = 52:38 = 1.37:1
30	B	71	☒A Electron/β-particle capture ☑B Fusion: Small nuclei join up to make a larger nucleus ☒C Fission: larger nucleus splits to form two smaller nuclei ☒D neutron capture followed by proton emission

Q31→35 are Grid Questions which are a style no longer used in Higher Chemistry. However the content of the questions can still come up in future exams. (If the question suggests there is more than 1 answer then there are 2 answers)		
31a	E	☒A aluminium is metallic ☒B boron forms a covalent network (high melting point) ☒C chlorine has discrete covalent Cl_2 molecules which are a gas at room temperature ☒D hydrogen has discrete covalent H_2 molecules which are a gas at room temperature ☑E Phosphorus forms discrete covalent P_4 molecules which is a solid at room temp ☒F Silicon forms a covalent network (high melting point)
31b	D+E (both for 1 mark)	Most covalent character ∴ elements with closest electronegativity Phosphorus and hydrogen both have electronegativity of 2.2
32a	D	☒A ammonium nitrate is ionic as it contains metals and non-metals in compound. ☒B barium sulphate is ionic as it contains metals and non-metals in compound. ☒C sodium carbonate is ionic as it contains metals and non-metals in compound. ☑D SiO_2 is covalent and is covalent network due to its high melting point (1713°C) ☒E potassium oxide is ionic as it contains metals and non-metals in compound. ☒F phosphorus oxide is covalent molecular due to its low melting point (-98°C)
32b	C	☒A acidic (made from strong acid and weak alkali) ☒B neutral (made from strong acid and strong alkali) ☑C alkaline (made from weak acid and strong alkali) ☒D SiO_2 is insoluble in water (e.g. sand) ☒E K_2O is not a salt! Salts are made by neutralising an acid with a base. ☒F non-metal oxides dissolve in water to make acids (e.g. CO_2, SO_2, NO_2 and P_2O_5)
33	C+D (1 mark each)	☒A 1mol S atoms = 32.1g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{64.2}/_{32.1}$ = 2 mol S atoms ☒B 1mol O molecules = 32g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{16}/_{32}$ = 0.5 mol O molecules ☑C 1mol H_2O molecules = 18g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{6}/_{18}$ = ⅓ mol H_2O molecules ∴1mol atoms ☑D 1mol H_2 molecules = 2g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{1}/_{2}$ = ½ mol H_2 molecules ∴ 1mol protons ☒E no. of mol = ∴ no. of mol = $^{mass}/_{gfm}$ = 2 x 0.5 = 1mol H_2SO_4 formula units ∴2mol H^+ ions ☒F no. of mol = ∴ no. of mol = $^{mass}/_{gfm}$ = 1 x 1 = 1mol $Ba(OH)_2$ formula units ∴2mol OH^- ions
34	C+E (1 mark each)	☒A Fats are a more concentrated source of energy than carbohydrates (not proteins) ☒B Proteins are made by condensation polymerisation ☑C Denaturing changes the shape/structure of the protein ☒D Fibrous proteins are structural proteins. (globular proteins are shaped proteins like enzymes) ☑E Proteins always contain Carbon, Hydrogen, Oxygen and Nitrogen ☒F Both animals and proteins make protein from amino acids
35	B+F (1 mark each)	☒A HCl (strong acid) will give red colour but CH_3COOH (weak acid) will give yellow colour ☑B strong and weak acids both have a pH below 7 ☒C HCl conducts better as it is fully ionised (more ions ∴ higher conductivity) ☒D HCl (strong acid) has higher H^+ ion concentration than CH_3COOH (weak acid) ☒E HCl (strong acid) reacts faster with Mg than CH_3COOH (weak acid) ☑F Same no of mol of H^+ ions in HCl and CH_3COOH ∴ same no. of mol of OH^- ions neutralised

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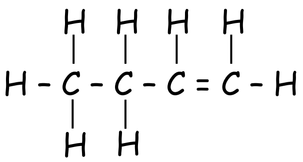
Long Qu	Answer	Reasoning
1a	Electronegativity	Electronegativity is defined as the measure of the attraction an atom has for the shared electrons in a bond
1b	Increases	The 1st ionisation energy across a period increases due to the smaller atomic size across a period and the increasing nuclear charge holding those electrons.
1c	1st ionisation energy creates a stable outer shell. 2nd ionisation energy breaks a stable outer shell	1st Ionisation energy Equation: $\underset{2,8,1}{Na} \rightarrow \underset{2,8}{Na^+} + e^-$ 2nd Ionisation energy Equation $\underset{2,8}{Na^+} \rightarrow \underset{2,7}{Na^{2+}} + e^-$
2a	5800 years	when Radioactive Count Rate = 72 then time = 0 years when Radioactive Count Rate = 36 then time = 5800 years Time for radioactive count to half (half-life) = 5800 - 0 years = 5800 years
2b	${}^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e$	β-emission: neutron splits into proton (stays in nucleus) and electron (emitted from nucleus) β-emission: atomic increases by 1 and mass number is unchanged
2c	Fossil fuels take millions of years to form not thousands	Too many half lives of ^{14}C will have passed over the millions of years needed to form coal for accurate measurement of the radioactivity (not much ^{14}C is left!)
3a(i)	Heterogeneous	Nickel is a solid catalyst and the olive oil reactant is a liquid Homogeneous catalyst: reactants and catalyst in same state Heterogeneous catalyst: reactants and catalyst in different states
3a(ii)	Fat molecules are saturated (no C=C bonds)	Fat molecules are solids because they fit closely together as they are straight-chain molecules due to saturated carbon chains. Oils are liquids at room temp as they contain unsaturated carbon chains contain C=C bonds. These are bent in shape and prevent the oil molecules being close enough together to be a solid.
3b(i)	Glycerol (or propane-1,2,3-triol)	Fats & Oils are made of glycerol and 3 fatty acids joined together by condensation polymerisation. In this reaction, hydrolysis of fats & oils releases glycerol and 3 fatty acids and then the fatty acids react with the alkali NaOH.
3b(ii)	soaps/detergents	Sodium salts of fatty acids are used as soaps/detergents as they are soluble in both fats and water
4a(i)	$FeS + 2HCl \rightarrow FeCl_2 + H_2S$	iron (II) sulphide + hydrochloric acid → iron (II) chloride + hydrogen sulphide $FeS \quad 2HCl \quad FeCl_2 \quad H_2S$
4a(ii)	Hydrogen gas	metal + acid → salt + hydrogen iron + hydrochloric acid → iron (II) chloride + hydrogen
4b	-20 kJ mol^{-1}	Equation ❶x-1: $H_2O + SO_2 \rightarrow H_2S + 1\frac{1}{2}O_2$ ΔH=+563kJ Equation ❷: $S + O_2 \rightarrow SO_2$ ΔH=-297kJ Equation ❸: $H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ ΔH=-286kJ Add ❶'+❷+❸ $H_2 + S \rightarrow H_2S$ ΔH=- 20kJ mol^{-1}
5a(i)		C=C double bonds must be located between C_1 and C_2 as step 2 has H_2O added across this C=C double bond and –OH ends up on C_1
5a(ii)	Hydration (or addition)	Water is added across a C=C double bond ∴ hydration reacgion
5a(iii)	orange → green	(see table below)
5a(iv)	Butanoic acid	$CH_3CH_2CH_2CH_2OH$ is a primary alcohol so oxidises to butanoic acid (see table below)

5a(iii):

Oxidising agent	Start Colour	End Colour
Acidified Dichromate	Orange	Green
Benedict's/Fehling's	Blue	Brick Red (orange)
Hot copper (II) oxide	Black	Brown
Tollen's Reagent	(Colourless)	Silver mirror produced

5a(iv):

Oxidation of alcohols					
	Primary alcohol	→	Aldehyde	→	Carboxylic acid
	Secondary alcohol	→	etone	✕→	[No oxidation]
	Tertiary alcohol	✕→	[No oxidation]		

5b(i)	Nice smell or layer on top formed	Esters are not soluble in water and will float on top of water. Ester often have a nice smell.
5b(ii)	1 from: Flavourings, solvents or perfumes	Esters are used as flavourings, solvents and perfumes
6a	To allow maximum transfer of heat to the water.	Heat from burning food must transfer to the water as eccifiently as possible and the highest temperature read from the thermometer.
6b	Incomplete combustion or error in reading highest temp	Or other reasonable answer
6c	$-1365.6 kJ mol^{-1}$	$\Delta H = cm\Delta T = 4.18 \times 0.4 \times 17.4 = 29.09$ kJ 1mol of ethanol $C_2H_5OH = (2x12) + (6x1) + (1x16) = 24 + 6 + 16 = 46g$ 0.980g ⟷ 29.09 kJ 46g ⟷ 29.09 kJ x $^{46}/_{0.980}$ = $1365.6 kJ mol^{-1}$ Exothermic reaction $= -1365.6 kJ mol^{-1}$
7a	Van der Waals' forces	Hydrogen and fluorine are both diatomic pure covalent molecules. The only forces of attraction must be Van der Waals attractions.
7b	Hydrogen bonding between H-F molecules	H-F has hydrogen bonding between molecules which means that H-F molecules are going to be much closer to one another than H-H or F-F which both only have weak Van der Waals between the molecules.
8a(i)	precipitation	$Ag^+(aq) + Cl^-(aq) \rightarrow Ag^+Cl^-(s)$
8a(ii)	$AgNO_3$ in excess	**gfm** $AgNO_3 = 107.9 + 14 + (3x16) = 169.9g$ **n**o. of mol $AgNO_3 = {}^{mass}/_{gfm} = {}^{0.2}/_{169.9} = 0.001177$mol **n**o. of mol HCl = **v**olume x **c**oncentration = 0.02 x 0.0010 = 0.00002mol $AgNO_3 + HCl \rightarrow AgCl + HNO_3$ 1mol 1mol 0.001177mol 0.001177mol ($AgNO_3$ in excess as only 0.00002 mol HCl available)
8b(i)	Fully dissociated acid (or fully ionises)	Strong acids fully dissociate e.g. hydrochloric, sulphuric and nitric Weak acids only partially dissociate e.g. $CH_3COOH \rightleftharpoons CH_3COO^- + H^+$
8b(ii)	pH=3	$[H^+] = 0.001 mol l^{-1} = 10^{-3} \therefore \log_{10}[H^+] = -3 \therefore -\log_{10}[H^+] = 3 \therefore pH = 3$
9a(i)	0.0155	$rate = \frac{\Delta quantity}{\Delta time} = \frac{59.99 - 59.68}{20 - 0} = 0.0155\ g\ min^{-1}$
9a(ii)	Higher the pH the better the enzyme's efficiency up to pH=10 (efficiency decreases at pH=14)	More mass is lost over 50 minutes from pH=1 → pH=10 ∴ enzyme working better. At pH=14 the mass loss is reduced showing the enzyme does not work better at very alkaline conditions
9b	Count bubbles of gas or measure volume of gas released.	The mass loss is a measure of the amount of gas being released.
10a	Contact: O_2 Haber: N_2	Contact: O_2 is obtained from air but SO_2 has to be made from burning sulphur Haber: N_2 is obtained from air but H_2 has to be extracted from either water or natural gas
10b	Increased temp favours endo. reaction – endo. reaction removes products	Increasing temperature favours the endothermic reaction. Equilibrium moves to left (the endothermic reaction) to remove heat and less products formed.
10c	Equilibrium in Haber Process lies more to the left than in the Contact process	Contact Process: $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$: 3vol → 2vol Haber Process: $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$: 4vol → 2vol (not a pressure consideration) The pressure is raised in the Haber Process because the equilibrium lies more to the left. In Contact Process the equilibrium lies more to the right and the pressure should only be raised if necessary due to cost/safety considerations
10d	57.4%	gfm H_2 = (2x1) = 2g gfm NH_3 = (1x14)=(3x1) = 14 + 3 = 17g $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ 1mol 3mol 2mol 28g 6g 34g 200g 34g x $^{200}/_6$ = 1133g 200kg 1133kg (theoretical) $\% Yield = \frac{Actual}{Theoretical} \times 100 = \frac{650}{1133} \times 100 = 57.4\%$

11a(i)	H H | | H – C = C – C ≡ N	-C≡N as carbon makes 4 bonds and N makes 3 bonds C=C as end carbon makes 2 bonds with H leaving 2 bonds for the C=C bond
11a(ii)	Addition	Monomer contains C=C double bond ∴ addition polymerisation
11b	$2CH_2CHCN + 2H_2O + 2e^-$ ↓ $(CH_2CH_2CN)_2 + 2OH^-$	1. Write down chemicals $CH_2CHCN \rightarrow (CH_2CH_2CN)_2 + OH^-$ 2. Balance all elements other than O and H $2CH_2CHCN \rightarrow (CH_2CH_2CN)_2 + OH^-$ 3. Add H_2O to other side to balance O atoms $2CH_2CHCN + H_2O \rightarrow (CH_2CH_2CN)_2 + OH^-$ 4. Add H^+ to other side to balance H atoms $2CH_2CHCN + 2H_2O \rightarrow (CH_2CH_2CN)_2 + 2OH^-$ 5. Balance charge by electrons to one +ve side $2CH_2CHCN + 2H_2O + 2e^- \rightarrow (CH_2CH_2CN)_2 + 2OH^-$
12a	Water will not heat up to 112°C	Temperature of 112°C required to decompose sodium hydrogen carbonate. Water boils at 100°C into steam so oil is used as it boil above 112°C
12b(i)	0.23litres (or $230cm^3$)	gfm $NaHCO_3$ = 23 + 1 + 12 + (3x16) = 23+1+12+48 = 84g no. of mol = $\frac{mass}{gfm} = \frac{1.68}{84}$ =0.02mol $2NaHCO_3 \longrightarrow Na_2CO_3 + CO_2 + H_2O$ 2mol (NaHCO₃) : 1mol (CO₂) 0.02mol : 0.01mol Volume = no. of mol x Molar Volume = 0.01mol x 23 litres mol^{-1} = 0.23 litres
12b(ii)	CO_2 dissolves in water	CO_2 is partially soluble in water and a small amount will dissolve in the water in the measuring cylinder as it bubbles to the surface.
13a	Aldehyde	R groups are not defined so aldehyde is the better answer. If R is an alkyl group (methyl, ethyl, etc) then alkanals would be an appropriate answer
13b	4-methylpent-2-ene	R' is a $-CH_3$ group R'' is a $-CH(CH_3)CH_3$ group R'-CH=CH-R'' → $CH_3CH{=}CHCH(CH_3)CH_3$ → 4-methylpent-2-ene
14a	$5.54x10^{-6}$mol	Q=It = 0.010A x (60+37)seconds = 0.010 x 97 = 0.97C $2I^- \rightarrow I_2 + 2e^-$ 1mol 2mol 1mol 2x96500C 1mol 193000C $^{0.97}/_{193000}$ x1mol 0.97C = $5.03x10^{-6}$mol
14b(i)	starch indicator	Starch will turn blue/black in the presence of Iodine. (When the thiosulphate ions run out, iodine will remain to react with starch)
14b(ii)	8 $x10^{-3}$ (or 0.008)	$I_2 + 2S_2O_3^{2-} \longrightarrow 2I^- + S_4O_6^{2-}$ 1mol 2mol $1.2x10^{-5}$mol $2.4x10^{-5}$mol concentration = $\frac{no. of mol}{volume} = \frac{2.4x10^{-5} mol}{0.003 litres}$ = 0.008mol l^{-1} = $8x10^{-3}$mol l^{-1}
14b(iii)	Remove iodine layer regularly to keep electrode conducting	Iodine is a solid forming on the outside of the positive electrode. Iodine is a non-metal so does not conduct. Eventually positive electrode will stop conducting when the iodine completely coats the electrode.
15a(i)	$2H_2 + O_2 \rightarrow 2H_2O$	Equation ❶x2: $2H_2 \rightarrow 4H^+ + 4e^-$ Equation ❷: $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ Add ❶' + ❷: $2H_2 + O_2 \rightarrow 2H_2O$
15a(ii)	Arrow from Left (H_2) side to Right (O_2) side	Electrons are produced by hydrogen (which enters on Left) Electrons are accepted by oxygen (which enters on Right)
15b	No CO_2 gas produced in this fuel cell	Petrol, and other fossil fuels, produce CO_2 when burned. This fuel cell does not produce any CO_2 as there is no carbon in any of the reactants.