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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Secondary Education

Chemistry 3421/H
Specification B

Mark Scheme

2005 examination – June series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

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Chemistry (Specification B)
Higher Tier 3421/H

3421/H Q1

question	answers	extra information	mark
(a)	6	accept 5.8 – 6	1
(b)	hydrochloric acid used up / reacted / combined / **or** fewer particles (of hydrochloric acid) **or** fewer hydrogen ions owtte fewer collisions owtte	accept reactants used up accept less calcium carbonate **or** smaller surface area of calcium carbonate accept lower concentration / less crowded do **not** accept atoms / molecules ignore references to energy do **not** accept references to atoms or molecules independent mark	1 1
(c)	steeper curve initially levels out at same volume	independent marks • must indicate levelling out • if line goes higher than 66 do **not** award this mark • diagonal line only = 0 marks • if steeper initially and then crosses the line and finishes correctly, then loses one	1 1
total			5

3421/H Q2

question	answers	extra information	mark
(a)	(very) small percentage / amount (in the Earth's crust)	any indication that there is a small amount, eg not much (left) accept rare (elements) / rarer accept not commonly found ignore cannot find easily ignore hard to extract	1
(b)(i)	oxygen / O_2 / O	do **not** accept O^2	1
(ii)	any **one** from: • potassium / K • sodium / Na • calcium / Ca • magnesium / Mg	symbols must be correct write name and incorrect symbol, ignore symbol	1
(c)(i)	heating (with) **or** hot air blown into furnace carbon / carbon monoxide / coke / coking coal **or:** carbon reacts with O_2 **or** carbon / coke burning (1) CO reacts with the ore (1)	accept high temperatures or (very) hot do **not** accept coal / charcoal accept balanced equation only accept balanced equation only CO / CO_2 for naming the reducing agent	1 1
(ii)	cost of melting ore / electricity makes aluminium expensive (owtte) **or** (large amount of) electricity used **or** because you have to use electrolysis **or** aluminium is higher in the reactivity series **or** aluminium is harder to <u>reduce</u> **or** unable to reduce with carbon **or** the cost of purifying the bauxite	do **not** accept harder to extract / produce more energy is **not** enough	1
total			6

3421/H Q3

question	answers	extra information	mark
(a)	fractional distillation / fractionation	accept distillation accept refining do **not** accept cracking	1
(b)	**Quality of written communication**	for technical words correctly used **two** from: evaporat(ion) / condensat(ion) / boiling points / gas / vapour / molecules / fraction / vaporised QoWC mark can be awarded for cracking described	1
	any **three** from:		3
	• crude oil is heated to high temperature **or** heated to 340°C or above		
	• (most of the) oil is **evaporated** / turns into **gas** / **vapour**	accept oil is boiled	
	• heavier **molecules** do not boil	accept converse accept particles instead of molecules	
	• heavier **molecules** sink to the bottom **or** lighter **molecules** rise up (the tower)	accept particles instead of molecules	
	• oil **<u>vapours</u>** / **<u>gases</u>** go up the tower		
	• vapours **condense** at different points (up the tower)	accept heavier molecules condense first / at the bottom accept lighter molecules condense last / at the top	
	• separation depends on their boiling points owtte	vapours condense at different temperatures	
	• oil separated into **fractions** which have similar numbers of carbon atoms **or** similar chain lengths **or** similar boiling points	accept in terms of similar chains	
	• temperature gradient up the tower		
total			5

3421/H Q4

question	answers	extra information	mark
(a)(i)	(actual value 2403°C)	accept values between 2100 and 2450	1
(ii)	(actual value is 5.9 g/cm^3)	accept values between 3.5 and 6.5	1
(b)(i)	any **two** sensible ideas such as: • (why) put in order of mass • he left gaps **or** table not complete • no evidence for undiscovered elements **or** they believed all the elements had been discovered • he changed the order of some elements **or** there were exceptions to the rule(s) • he put metals and non-metals together • he did not explain his ideas clearly (owtte)	accept other equally valid orders, eg alphabetical accept predictions could not be backed by evidence accept why change previous ideas accept they didn't like his groupings / groups do **not** accept modern explanations, eg proton number etc	2
(ii)	(the properties of gallium) fitted the predictions (owtte) **or** predictions were correct **or** (properties) would make it fit in the gap **or** (properties) would make it fit in group 3	do **not** accept gallium fitted his theory accept finding gallium proved there were new elements to be discovered	1
total			5

3421/H Q5

question	answers	extra information	mark
(a) **G**	harmful / noxious / nocif	accept less dangerous than a toxic substance do **not** accept irritant	1
(b)	gives oxygen	accept oxidising accept 'it oxidises' accept 'it contains oxygen'	1
	needed for burning (must be linked to oxygen)	oxidising agent scores **2** marks oxidising agent because it is flammable = **1** mark flammable loses a mark when both marks awarded accept oxygen makes the flame burn stronger **or** oxygen helps combustion for **2** marks	1
(c)(i)	122.5 or 123	accept 39 + 35.5 + (3 × 16) for **1** mark 122 with no working scores **1** mark	2
(ii)	39% (39.18…. or 39.02….)	allow ecf accept 48/122.5 × 100 for **1** mark	2
total			7

3421/H Q6

question	answers	extra information	mark
(a)	colour		1
(b)	Fe_2O_3 or $(Fe^{3+})_2 (O^{2-})_3$	2 and 3 should be below halfway on Fe and O	1
(c)(i)	4 4	or correct multiples	1
(ii)	any **two** from: • high melting point • strong / tough • hard • not (very) reactive	ignore references to malleable / ductile / conductivity / stiff / boiling point / density accept can withstand high temperatures accept <u>not</u> brittle do **not** accept flexible	2
total			5

3421/H Q7

question	answers	extra information	mark
(a)	all electrons correct (inner shell need not be shown)	three bond pairs and two electrons anywhere else can use dots, crosses or e's in any combination	1
(b)	covalent	accept phonetic spelling do **not** accept convalent	1
(c)	reversible **or** any indication that reaction can go in either way	accept can go either / both ways accept equilibrium accept can be reversed accept ammonia can be turned into nitrogen and hydrogen	1
(d)(i)	increase yield (owtte) **or** helps plants to grow	accept answers in terms of fast / <u>better</u> growth accept nitrogen needed for making amino acids / protein / enzymes accept replace / add nitrogen / nutrients in the soil ignore make ground more fertile **or** plants more healthy	1
(ii)	any **one** from: • jobs • money • exports • increased <u>yield</u> **or** more coffee	accept increased business accept land used over again	1
(iii)	washed by rain / permeated / soaked down / passed through soil / rocks etc	accept leached **or** dissolved / soluble in water ignore absorbed / picks up nitrate	1
(iv)	harmful / risk to health **or** because it is drinking water **or** main supply of water **or** blue baby syndrome etc.	accept references to eutrophication / weed growth do **not** accept kills people / animals unqualified	1

cont...

3421/H Q7 cont…

(v)	use less	ignore do not use / stop using	1
	especially at end of growing season	do not use at end of growing season = **2** marks	1
	or use natural/ slow release fertilisers (1) release nitrogen less quickly (1)	for alternative (nitrogen) fertiliser	
	or grow leguminous crops (1) nitrates not needed (1)	accept nitrogen obtained from air	
	or treat the water (1) to remove nitrates (1)	do **not** accept denitrifying bacteria allow marks for mixing different routes	
total			9

3421/H Q8

question	answers	extra information	mark
(a)	sodium carbonate / sodium hydrogencarbonate / sodium bicarbonate	Na_2CO_3 / $NaHCO_3$ ie sodium / sodium ions (**1** mark) carbonate / carbonate ions (**1** mark) incorrect formula including Na and CO_3 = **1** mark	2
(b)	calcium chloride	$CaCl_2$ ie calcium / calcium ions (**1** mark) chloride / chloride ions (**1** mark) incorrect formula including Ca and Cl = **1** mark	2
(c)	iron or iron(II) ions	Fe^{2+} ferrous ions ignore anions ignore nickel / chromium do **not** accept iron(III) or ferric ions	1
total			5

3421/H Q9

question	answers	extra information	mark
	Quality of written communication:	for correct sequencing or linking of **two** ideas or **two** points	1
	any **three** from: • **B** is least energy efficient in terms of cost (kJ per p), so **A** = **C** = **D** in terms of cost **or B** is the most expensive in terms of energy efficiency owtte • **D** is 1st, since gives only water as product **or** gives no harmful products / gases **or** there are no pollutants owtte • **A** is 2nd best, since produces CO_2 owtte • **C** is 3rd, since gives SO_2 owtte	ignore superfluous statements accept **B** is poor value for money / **B** is most expensive one is insufficient for mark if no other marks, then **D A C B** – based on energy per kJ per 100g only = **1** mark and Q mark if 2 ideas are linked	3
total			4

3421/H Q10

question	answers	extra information	mark
(a)(i)	to make sure all sulphuric acid reacts **or** to neutralise the acid **or** unreacted sulphuric acid difficult to remove owtte	ignore 'to maximise the product' accept otherwise (sulphuric) acid left	1
(ii)	filter(ing) / filtration or described owtte	accept use filter paper accept centrifuge **and** decant do **not** accept sieve / strain filter funnel is insufficient	1
(iii)	no more solid / solute can dissolve **or** maximum amount of solid owtte at that temperature	 accept any link to temperature or any specified temperature	1 1
(iv)	<u>solubility</u> decreases (as temperature falls) owtte	accept <u>less soluble</u> in cold water answer must be linked to solubility ignore the extra cannot dissolve	1
(v)	otherwise get anhydrous $CuSO_4$	accept otherwise get white $CuSO_4$ accept do not get hydrated $CuSO_4$ accept could get CuO **or** thermal decomposition / decomposes allow SO_3 / SO_2 produced allow dehydration accept removes the water of crystallisation **not** just remove water from the crystals or just steam	1
(b)(i)	56		1
(ii)	answer = 36	correct answer = **2** marks (ecf) (working seen for their 56– 20 for **1** mark)	2
total			9

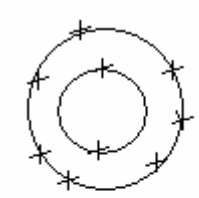
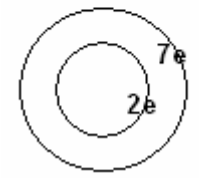
3421/H Q11

question	answers	extra information	mark
(a)(i)	heat (the limestone)	accept decompose limestone accept heat with coke	1
	add water / slake	dependent on 1st mark unless they say add water to the calcium oxide	1
(ii)	magnesium hydroxide + hydrochloric acid → magnesium chloride + water / H_2O	**1** mark for each side of the equation (if a symbol equation is given then give **1** mark for correct formulae (**all**) and **1** mark for balancing)	1 1
(b)	hydrogen ions (from acid) or protons / H^+		1
	react with hydroxide ions (from alkali) / OH^-		1
	to produce water	$H^+ + OH^- \longrightarrow H_2O$ gains all **3** marks ignore state symbols molecules of hydrogen ions and molecules of hydroxide ions produce water = **2** marks if they fail to get any of the above marks they can get **1** mark for neutralisation / product neutral	1
total			7

3421/H Q12

question	answers	extra information	mark
(a)	$C_6H_{12}O_6$	any order accept $C_6H_7O(OH)_5$ accept 'the same'	1
(b)	sweeter / use in smaller quantities	accept uses more energy to be metabolised	1
(c)	enzyme	accept (biological) catalyst accept protein accept carbohydrase do **not** accept description alone	1
(d)	enzyme is trapped in / bonded to / attached / linked / combined / held / adsorbed a gel / solid / (alginate) beads / surface / resin	ignore 'reacted with' **not** absorbed	1 1
(e)	to prevent being lost **or** to allow the same enzyme to be used for a long period of time	accept do not denature accept it is not washed away accept does not need to be replaced <u>as often</u> accept they can be reused do **not** accept recycled	1
total			6

3421/H Q13

question	answers	extra information	mark
(a)(i)	all points plotted to ± $\frac{1}{2}$ square		1
	sensible line of best fit extended	could be curve must **not** join dots, ie zig zag if they draw 2 lines then lose second mark, but can still gain marks in (a)(ii)	1
(ii)	as read from their graph ± ½ square		1
(iii)	iodine **and** astatine I/I_2 At/At_2	must give **both**	1
(b)(i)	 **or** 	ignore symbol ignore nucleus / lack of nucleus accept dots / crosses etc / e / e^- **not** 2.7 alone	1
(ii)	same number of electrons in **outer** shell **or** seven electrons in **outer** shell (owtte)	accept missing one electron in outer shell / energy level / orbit accept trying to gain one electron accept they all form 1^- ions do **not** accept orbital / rings	1
(c)(i)	8 electrons in outer shell **or** full outer shell / energy level		1
	does not need to lose / gain / share electrons **or** don't need to form bonds	accept don't bond ionically or covalently they do not react is **not** enough	1
(ii)	fluorine atom is smaller / fewer shells (owtte) **or** outer shell closer to nucleus	accept answers argued in terms of iodine	1
	more strongly attracted (to nucleus) **or** less shielding	accept holds electrons tighter (to the nucleus)	1
	gains electron(s) more easily	accept easier to gain electrons	1
total			11

3421/H Q14

question	answers	extra information	mark
(a)	352 g gains **3** marks (moles C_8H_{18} = 114 / 114 = 1 mole) moles CO_2 = 8 (1) mass CO_2 = 8 × 44 (1) = 352 g (1) **or** 114 → 8 (1) × 44 (1) 114 → 352 g (1)	 **1** mark for each point (ecf allowed between parts) ecf allowed between parts	3
(b)	**Quality of written communication** any **three** from: • plants take in (CO_2) • converted to glucose / starch / carbohydrates • CO_2 locked up in fossil fuels • CO_2 reacts with / dissolves (sea)water • producing hydrogencarbonates • producing carbonates • marine animals use carbonates to make shells • forms sedimentary rocks	for any **two** ideas sensibly stated accept photosynthesis uses (CO_2) ignore carbon compounds by itself accept coal / oil / <u>natural</u> gas / methane for fossil fuels accept ocean removes CO_2 accept carbonic acid accept named carbonates do **not** accept bones accept limestone / chalk accept marble do **not** accept sediments alone	1 3
(c)	any **two** from: • burning of fossil fuels **or** cars / industry / air travel / power stations • natural processes cannot absorb all the extra CO_2 • deforestation	 ignore increase in population ignore more use of electricity accept less photosynthesis ignore volcanic activity accept burn trees	2
total			9

3421/H Q15

question	answers	extra information	mark
(a)(i)	yield increases	two marks are linked	1
	because more (gaseous) reactant molecules / particles than (gaseous) product molecules / particles	accept 7 → 4 moles or volumes ignore more reactants accept fewer particles on the right	1
(ii)	increased (rate) / faster / speeds up etc	two marks are linked	1
	more collisions **or** increased concentration **or** particles closer together	greater chance of more successful collisions	1
(b)	heat / high temperatures	do **not** accept burn it ignore cracking / catalyst	1
(c)	bromine (water)		1
	goes colourless **or** decolourised **or** loses colour / paler **or** orange bromine water goes yellow	do **not** accept discoloured / clear	1
	or potassium manganate (VII) / potassium permanganate (1)	accept potassium manganate	
	colourless / decolourised etc (1) **or** purple colour goes pink		
(d)	polychloroethene **or** poly(chloroethene)	accept polyvinylchloride / PVC	1
total			8

3421/H Q16

question	answers	extra information	mark
(a)	Ag S		
	$\frac{10.8}{108}$ $\frac{1.6}{32}$	for evidence of mass / Ar	1
	0.1 0.05	for proportions of each	1
	2 1	for any whole number ratio can be assumed from correct formula	1
	Ag_2S	correct formula allow SAg_2	1
		N.B. Ag S $\frac{108}{10.8}$ $\frac{32}{1.6}$ × 10 20 × 1 2 ✓ Ag S_2 ✓ ratio mark can be given for correct formula if the first two steps are present	
(b)(i)	2 2	accept correct multiples eg 4 4 2	1
	electrons are lost owtte	accept $Br^- - e^- \rightarrow ½ Br_2$ accept bromine ions lose electrons do **not** accept bromine loses electrons reference to oxygen loses the mark	1
(ii)	+ e **or** e^-	accept correct multiples but **not** if they write Ag_2 etc	1
total			7

3421/H Q17

question	answers	extra information	mark
	steel spoon made the negative electrode / cathode **and** <u>silver electrode</u> made positive electrode / anode	owtte indicate correct polarity for one of the electrodes **and** that one electrode is silver – use a silver electrode is insufficient	1
	<u>solution</u> contains ions of the plating metal / silver ions	do **not** accept silver halides allow other silver salts	1
total			2

3421/H Q18

question	answers	extra information	mark
(a)	melamine / bakelite / polyurethane / epoxy resins **or** any correct example	accept formica do **not** accept perspex / PVC	1
(b)	test: (effect of) heat		1
	thermosoftening: softens / melts **or** can be reshaped / remoulded	accept can be repeatedly melted and cooled (owtte)	1
	thermosetting: does not soften / does not melt	accept chars / burns / decomposes (owtte) wrong test = 0 marks no test given, can be implied from other answers	1
(c)	both: long chains / molecules **or** long molecules (owtte)	can be from diagrams	1
	thermosoftening: <u>weak</u> / intermolecular forces / attractions between chains / molecules (owtte)	accept van der Vaals forces between the chains accept <u>weak</u> bonds between chains / molecules do **not** accept reference to intramolecular forces / bonds	1
	thermosetting: cross linkages **or** strong / covalent <u>bonds</u> between (owtte)	can be from diagram do **not** accept force or attraction for bond	1
total			7

3421/H Q19

question	answers	extra information	mark
(a)	oxidation / combustion / redox	allow exothermic	1
(b)	any **four** from: low temperature gives best / greatest yield owtte reaction is exothermic / gives out heat owtte rate too slow at low temperature owtte catalyst does not work at low temperature owtte 450 °C is a compromise owtte	**or** converse statements ignore references to cost throughout must be linked to first statement allow 450°C is the optimum temperature	4
(c)	acid mist / fumes form **or** limited solubility of SO_3 in H_2O **or** **very** exothermic **or** violent reaction owtte	allow corrosive atmosphere ignore acid rain ignore dangerous reaction	1
(d)	31250	moles of S = moles of H_2SO_4 **or** 1 mole of $S_8 \rightarrow 8$ moles of H_2SO_4 **or** $\frac{1 \times 10^6}{32}$ gets **1** mark	2
total			8

3421/H Q20

question	answers	extra information	mark
(a)(i)	$Na_2C_2O_6 = 166$ $\frac{50}{166} = 0.3\,(012)$	 ecf	1 1
(ii)	1 dm^3 contains $\frac{0.3}{6} = 0.05$ mole	ecf	1
(b)(i)	moles of $O_2 = \frac{0.3}{2} = 0.15$ mole	ecf	1
(ii)	0.15×24 **or** 0.15×24000 3.6 **or** 3600 $\underline{cm^3}$	ecf ecf 3.6144576 **or** anything rounding down to 3.6 (dm^3)	1 1
total			6

3421/H Q21

question	answers	extra information	mark
(a)	both / they give carbon dioxide / CO_2	ignore CO	1
	both / they give water / H_2O / steam	accept hydrogen oxide same (combustion) products (owtte) gains **1** mark	1
(b)	spectrum **A** (is the alcohol): absorption in O - H / 3230 - 3550 range **or** absorption in the C – C / 800 – 1000 range	must be comparison of **A** and **B** for both marks	1
	spectrum **B** (is the ether): no absorption in the O - H / 3230 – 3550 range **or** no absorption in the C – C / 800 – 1000 range	**NB**. <u>only</u> have absorption in O – H range for **A** = **2** marks give both marks for a logical argument eg in the ether 2 C-O bonds therefore strong<u>er</u> absorption in 1000 – 1300 range **or** in the alcohol 1 C-O bond therefore weak<u>er</u> absorption in 1000 – 1300 range ignore any comment about C-H bonds	1
total			4