



General Certificate of Secondary Education

Chemistry 3421/H

Specification B

Mark Scheme

2006 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.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Chemistry (Specification B) Higher Tier 3421/H

3421/H Q1

question	answers	extra information	mark
(a)	accurate plotting of points ($\pm\frac{1}{2}$ square)	2 marks for all points 1 mark for 3 or 4 points accept if points cannot be seen and lines go through points	2
	sensible attempt at a smooth curve	may not be perfect but do not accept joining the dots ignore any extension before first point do not accept multiple lines that cover more than one large square	1
(b)(i)	75 seconds	accept answers correctly read from their graphs ($\pm \frac{1}{2}$ square) accept 73 to 77 without reference to graph	1
(ii)	rate doubles (owtte)	accept time halves accept speed doubles do not accept just gets faster etc. do not accept the rate of reaction takes half the time	1
(iii)	more particles (owtte)	n.b. they / them = particles accept molecules	1
	<u>more</u> collisions	max 1 mark for any reference to particles moving faster / gaining energy ignore reference to 'react'	1
total			7

3421/H Q2

question	answers	extra information	mark
(a)(i)	broken down (owtte)	accept big molecules to small molecules or production of smaller molecules do not accept separated do not accept cracking / breaking down to elements do not accept mention of oxygen ignore decompose / decomposed	1
	by heat / high temperature	(owtte)	1
(ii)	carbon dioxide	accept CO ₂ do not accept CO ² , Co ₂ (apply halfway rule for O and ₂)	1
(iii)	to mix the reactants (owtte)	accept to increase rate of reaction accept idea of movement accept 'so that the reactants are heated evenly' (owtte) accept to ensure complete reaction	1
(b)(i)	coke	accept carbon / C do not accept coal / charcoal	1
	iron	accept Fe / pig iron / cast iron do not accept FE ignore references to solid / molten etc.	1
(ii)	oxygen removed (owtte)	accept gains electrons accept decrease in oxidation number / state do not accept oxide removed	1

Continued

3421/H Q2

question	answers	extra information	mark
(iii)	for any sensible idea e.g. <ul style="list-style-type: none">• saves energy• less waste (to dispose of)• less CO₂/ pollution caused• makes use of waste product / slag• two products from one process• saves money• less limestone / clay needs to be obtained / used	answers have to be chemically correct	1
	either explanation of the idea or another sensible idea	accept “environmentally friendly” as an explanation of a bullet	1
total			9

3421/H Q3

question	answers	extra information	mark
(a)	<p>Science marks</p> <p>any three from:</p> <ul style="list-style-type: none"> • inert / unreactive • not broken down / decomposed / non-biodegradable • by micro-organisms • causes litter • problems of waste disposal e.g. landfill • difficult to recycle • incineration / burning causes problems such as (air) pollution <p>QoWC</p> <p>1 mark which is awarded for the use of one of the following scientific words:</p> <ul style="list-style-type: none"> • (non-) biodegradable • micro-organism / bacteria • inert / unreactive • decomposed • toxic / poisonous 	<p>accept flooding (in India) by blocked drains</p> <p>accept does not rot / decay / disintegrate</p> <p>ignore erode and corrode</p> <p>must be linked to not broken-down</p> <p>can be implied</p> <p>must be linked to incineration</p> <p>annotate Q✓ or Q*</p> <p>word must be used in correct context</p> <p>must be linked to air pollution</p>	<p>3</p> <p>1</p>
(b)	<p>any two from:</p> <ul style="list-style-type: none"> • plastic tar is harder (than ordinary tar) • plastic tar has better resistance to water penetration (than ordinary tar) • plastic tar lasts longer (than ordinary tar) • using plastic waste to make plastic tar means less has to be disposed of in other ways i.e. buried / burned • plastic is recycled 	<p>ignore cost / strength</p> <p>ignore saving tar or bitumen</p> <p>accept more waterproof</p> <p>accept it causes less pollution</p> <p>accept makes use of a waste product</p>	2
total			6

3421/H Q4

question	answers	extra information	mark
(a)	152	$56 + 32 + (4 \times 16)$ for 1 mark	2
(b)	36.8%	accept 37% / 36.84% etc accept error carried forward from (a) accept 36% for 1 mark or $56 / 152 \times 100$ ($56 / (a) \times 100$) for 1 mark	2
(c)	7.3 to 7.4	accept error carried forward from (b) e.g. $36 \rightarrow 7.2$ $20 \times 36.84 / 100$ ($20 \times (b) / 100$) for 1 mark	2
total			6

3421/H Q5

question	answers	extra information	mark
(a)	any three sensible properties e.g. transition elements are metals TM high melting points / boiling points TM hard / strong TM conduct electricity TM conduct heat TM sonorous TM ductile TM malleable TM high density TM are catalysts TM form positive ions	they = transition elements ignore references to colours ignore other chemical properties / reactivity if point is not made for TM accept converse for halogens accept halogens are diatomic / molecular / covalent ignore halogens form covalent <u>compounds</u> / bonds ignore electrons ignore solid	3
(b)(i)	hydrogen forms a 1+ ion	accept form a positive ion accept one electron in outer shell	1
(ii)	any one from: <ul style="list-style-type: none"> • can form 1– ion • forms diatomic molecule (owtte) or small molecule or molecular • (very) low boiling point/ melting point / gas • only needs one electron to fill outer shell • non metal • any other general property of non-metals 	accept form a negative ion ignore has covalent bonds	1
total			5

3421/H Q6

question	answers	extra information	mark
	action by water running over the surface (owtte)	currents / waves / tides ignore action of wind	1
	on a beach / mud flats / river / under water etc	any place where water may run over the sediment accept seabed do not accept rock	1
total			2

3421/H Q7

question	answers	extra information	mark
(a)(i)	2	accept multiples i.e. 2, 4, 2, 2 any other numbers / symbols lose the mark	1
(ii)	warm / heat acid / mixture	do not accept heat MgO	1
	add MgO or mix together acid and MgO		1
	until no more will react	accept dissolve	1
	filter (off excess MgO)		1
	QoWC mark: awarded for getting any two steps in the correct not necessarily consecutive order	annotate Q✓ or Q✗	1
(b)(i)	magnesium / ions / it / they are <u>positive</u> / Mg ²⁺	accept magnesium ions / it / they gain electrons	1
	so are attracted / go / move to the negative electrode / cathode	from the negative electrode	1
(ii)	kill / destroy bacteria / microbes / germs etc.	accept disinfect / sterilise ignore purify / clean / get rid of bacteria n.b. kills bacteria and removes impurities = 0 marks	1
total			9

3421/H Q8

question	answers	extra information	mark
(a)(i)	water / aqueous	accept sugar solution	1
	yeast / enzyme / named enzyme	do not accept bacteria	1
	temperature in range 10 – 40 °C	accept warm / gentle heat / room temperature	1
	extra point / detail e.g. any one from:	do not accept heat on its own	1
	<ul style="list-style-type: none"> • exclusion of air / air lock or from diagram • exclude bacteria cotton wool plug / sterile conditions • leave until reaction complete / slows down / no more bubbles / a few days (2+) • filter / allow to settle and decant / yeast removed • $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ 	accept anaerobic (respiration)	
QoWC mark for linking any two correct statements	accept cover solution	accept leave until next lesson	1
	do not accept word equation	annotate Q✓ Q✗	
(ii)	carbon dioxide	CO ₂	1
		do not accept Co ₂ (apply half way rule)	
(b)(i)	fractional	fractionation / fractionating	1
		do not accept fraction	
(ii)	ethanol because it has the <u>lower</u> boiling point	comparison needed but it can be implied	1
		accept it boils at 78°C	
		accept ethanol is more volatile	
		do not accept ethanol is the first to boil / evaporate	
total			8

3421/H Q10

question	answers	extra information	mark
(a)	e.g. HCl gives hydrogen ions / H^+ H^+ reacts with OH^- (from NaOH) (to form water)	$HCl \rightarrow H^+ + Cl^-$ ignore proton donation $H^+ + OH^- \rightarrow H_2O = 2$ marks $H^+ + OH^- = 1$ mark	1 1
(b)	any one from the following ideas: <ul style="list-style-type: none"> no previously (proven) theory of ion formation no evidence / proof lack of communication / technology lack of information 	ignore he spoke a foreign language	1
total			3

3421/H Q11

question	answers	extra information	mark
(a)	20000	accept $20 m^3$ (must specify unit) $(100 / 0.9) \times 180$ gets 1 mark	2
(b)(i)	full <u>outer</u> / <u>last</u> shell (of electrons) or 8 (electrons) in <u>outer</u> / <u>last</u> shell no need to gain / lose / share electrons	accept energy level / ring / orbit for shell do not accept orbital accept no need to form bonds (owtte) accept don't form ions	1 1
(ii)	prevent oxidation / reaction with oxygen etc. (owtte)	accept reacts with air to form oxides do not accept air only ignore reference to burning	1
total			5

3421/H Q12

question	answers	extra information	mark																																																		
(a)(i)	catalyst / speed reaction (owtte)	accept lower activation energy	1																																																		
(ii)	any two from: <ul style="list-style-type: none"> break down <u>large</u> molecules / hydrocarbons / alkanes / chains change <u>large</u> molecules into small molecules / hydrocarbons / alkanes / chains (into) more useful products or smaller molecules are more useful or greater demand for products / smaller molecules to give alkenes / petrol 	accept named short alkenes do not accept petroleum	2																																																		
(b)	X marked in the inverted test tube in the portion where gas has collected		1																																																		
(c)(i)	<table border="1" style="margin-left: auto; margin-right: auto;"> <tbody> <tr><td></td><td>H</td><td>H</td><td>H</td><td>H</td><td>H</td><td>H</td><td>H</td><td>H</td><td></td></tr> <tr><td></td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td></td></tr> <tr><td>H—</td><td>C—</td><td>C—</td><td>C—</td><td>C—</td><td>C—</td><td>C—</td><td>C—</td><td>C</td><td>—H</td></tr> <tr><td></td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td></td></tr> <tr><td></td><td>H</td><td>H</td><td>H</td><td>H</td><td>H</td><td>H</td><td>H</td><td>H</td><td></td></tr> </tbody> </table>		H	H	H	H	H	H	H	H												H—	C—	C—	C—	C—	C—	C—	C—	C	—H												H	H	H	H	H	H	H	H		do not accept condensed structures	1
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(ii)	<table border="1" style="margin-left: auto; margin-right: auto;"> <tbody> <tr><td>H</td><td>H</td></tr> <tr><td> </td><td> </td></tr> <tr><td>C =</td><td>C</td></tr> <tr><td> </td><td> </td></tr> <tr><td>H</td><td>H</td></tr> </tbody> </table>	H	H			C =	C			H	H	ignore bond angles accept CH ₂ = CH ₂ H ₂ C = CH ₂	1																																								
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total			6																																																		

3421/H Q13

question	answers	extra information	mark
(a)	enzyme / biological catalyst	accept catalyst accept protein	1
(b)	it / enzyme / lactase is trapped / held / fixed (owtte)	accept cannot move	1
	in the resin / gel / (alginate) bead	accept inert solid do not accept column	1
(c)	avoids losing the lactase / enzyme or helps to stabilise the enzyme / lactase or helps to allow the enzyme to withstand higher temperatures / wider range of pH	accept doesn't have to be separated at end accept don't have to keep adding lactase not left in the milk on its own accept stops decomposition accept it lasts longer or it can be used over and over again	1
(d)	does not have to be stopped after each batch or no breaks in production etc. or faster process / saves time / saves money or less labour intensive	ignore same enzyme used for a long time ignore faster reaction or more products or saves energy ignore comments about purity	1
total			5

3421/H Q14

question	answers	extra information	mark
(a)	2, 8, 8,1		1
(b)	they both have one electron in the <u>outer</u> shell / same number of electrons in <u>outer</u> shell	accept ring / orbit for shell do not accept orbital for shell	1
(c)		it = potassium	
	outer shell electron further from nucleus or more shells	outer electron must be mentioned once for all 3 marks or converse argument for sodium less reactive provided sodium is specified assume it etc. means potassium	1
	less attraction to nucleus or more shielding		1
	outer electron more easily lost	not potassium reacts more easily	1
(d)	sodium	do not accept symbols or formulae	1
	water	accept sodium hydrogen (phosphate)	1
total			7

3421/H Q15

question	answers	extra information	mark
(a)	<p>X = oxygen</p> <p>Y = calcium carbonate / limestone</p> <ul style="list-style-type: none"> • One statement about redox <ul style="list-style-type: none"> – carbon is oxidised or carbon \rightarrow CO₂ – silicon oxidised or silicon \rightarrow SiO₂ – phosphorus is oxidised or phosphorus \rightarrow phosphorus (pent) oxide • One statement about acid/base <ul style="list-style-type: none"> – CaCO₃ / CaO is a base / alkali – non-metal oxides are acidic – CaO reacts with SiO₂ – slag is formed • One other statement about either redox or acid/base 	<p>blast furnace max 4</p> <p>O₂</p> <p>air is insufficient</p> <p>CaCO₃</p> <p>ignore references to sulphur</p> <p>e.g. a balanced equation</p> <p>n.b. C + O₂ \rightarrow CO₂ gains 2 marks</p>	<p>1</p> <p>1</p> <p>1</p> <p>1</p>
(b)	0.155769	<p>accept 0.15 to 0.16</p> <p>$45 \times \frac{18}{100}$ or 8.1</p> <p>or <u>their 8.1</u> gives 1 mark 5.2</p>	2
total			7

3421/H Q16

question	answers	extra information	mark
(a)	64 g	$2 \times (2 \times 16)$ for 1 mark	2
(b)(i)	(-) 730	ignore sign bonds broken 2736 kJ for 1 mark bonds formed 3466 kJ for 1 mark accept ecf	3
(ii)	the energy given out in forming new bonds is more / greater / bigger than the energy needed to break existing bonds (owtte)	energy needed to form new bonds is more than energy needed to break bonds = 0 marks	1
(c)	incomplete combustion / not enough / less oxygen (owtte)	do not accept air for oxygen do not accept no oxygen	1
total			7

3421/H Q17

question	answers	extra information	mark
(a)	any two from: <ul style="list-style-type: none"> the gases / they are cooled or temperature goes down the ammonia turns into a liquid the nitrogen and hydrogen / others / remain as gases (owtte) 	accept ammonia is liquified / condensed accept the others don't (liquefy)	2
(b)	catalyst / make reaction faster / lower activation energy		1
(c)(i)	the reaction / it is <u>exothermic</u> / <u>gives out heat</u> (owtte)	accept ΔH is negative accept the reverse reaction is endothermic	1
(ii)	reaction too slow at low temperatures or catalyst does not work at low temperatures or compromise between yield and rate (owtte) or does not provide sufficient energy to overcome the activation energy		1
total			5

3421/H Q18

questions	answers	extra information	mark
(a)(i)	$P_4 + 6 Cl_2 \rightarrow 4 PCl_3$	correct formulae (1 mark) correctly balanced (1 mark) (or multiples) $P + 1.5 Cl_2 \rightarrow PCl_3$ or $4P + 6Cl_2 \rightarrow 4PCl_3$ for 1 mark	2
(ii)	three bonding pairs and one lone pair on the P 6 unbonded electrons and a bonding pair around the three Cl	circles not necessarily required	1 1
(iii)	liquid		1
(iv)	intermolecular bond or intermolecular forces or forces between molecules or Van de Waals forces weak (owtte)	dependant on first marking point bonds / attractive forces between atoms are weak = 0 ionic / covalent bonds are weak = 0 intramolecular bonds / forces are weak = 0	1 1
(b)	$\begin{array}{cc} Zn & P \\ 1.95 / 65 & 0.62 / 31 \\ = 0.03 & = 0.02 \\ 3 & 2 \\ & Zn_3P_2 \end{array}$	1 mark for mass / Ar 1 mark for proportions 1 mark for correct whole number ratio 1 mark for correct formula accept P_2Zn_3 second or third step can be inferred if empirical formula is correct if ratio upside down max is 2 marks	4
total			11

3421/H Q19

question	answers	extra information	mark
(a)	NaOH in <u>burette</u>	must be a description of a titration no titration = no marks do not accept biuret etc	1
	add NaOH until <u>indicator</u> changes (colour)	indicator must be mentioned in the account for this mark can be named acid-base indicator colour change does not have to be correct accept pH probe / indicator / paper	1
	note (burette) volume used or final reading	accept 'work out the volume of NaOH added'	1
	accuracy: e.g. repeat	accept: white tile or dropwise / slowly (near end) or white background or swirling / mix or read meniscus at eye level or wash apparatus	1
(b)	citric acid also present	another acid also present	1
(c)	3.2386×10^{-4} or any number from 3.2 to 3.24×10^{-4}	for 2 marks <u>0.0057</u> or 3.2 to 3.24×10^{-5} 176 their $3.2(4) \times 10^{-5} \times 10$ for 1 mark	2
total			7

3421/H Q20

question	answers	extra information	mark
(a)	any three from: Al^{3+} : <ul style="list-style-type: none"> white precipitate / white solid dissolves (to give colourless solution) NH_4^+ : <ul style="list-style-type: none"> NH_3 / ammonia / alkaline gas produced which turns (damp) (red) litmus blue (not blue litmus) 	conditional on white precipitate any suitable named indicator e.g. UI with consequential marking white fumes / smoke with concentrated HCl do not accept white gas	3
total			3

3421/H Q21

question	answers	extra information	mark
(a)(i)	same (molecular) formula	accept both are C ₄ H ₁₀ do not accept empirical formula	1
	different structures or one is branched	atoms arranged differently or different structural formulae	1
(ii)	closer packing of molecules / particles	accept neater / easier packing accept more contact between molecules but not surface area on its own	1
	stronger / more intermolecular forces / intermolecular bonds (owtte)	accept bonds between molecules harder to break ignore more energy needed to separate particles any mention of ionic = 0 marks many intermolecular forces is insufficient any indication of covalent bonds breaking = 0 marks	1
(b)	can only arrange the atoms one way (owtte)	e.g. hasn't got 4 or more carbon atoms	1
total			5

3421/H Q22

question	answers	extra information	mark
(a)(i)	computing / information technology / IT / ICT	accept electronics accept miniaturisation do not accept technology on its own	1
(ii)	any one from: <ul style="list-style-type: none"> • fast / quick or comment about speed • small amounts • greater sensitivity / more accurate • ease of automation • greater versatility • sample not used up • more reliable 	ignore anything to do with cost accept any valid answer ignore human error accept operators do not need chemical skills	1
(b)(i)	electron / e^- / e		1
(ii)	ethanoic (acid)	CH_3COOH	1
total			4