

## Mark Scheme - 2.6 Reversible Reactions, Industrial Processes and Important Chemicals

1.

Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
(a)	(i)	2	number of nitrogen atoms <b>2</b> number of hydrogen atoms <b>6</b> <b>both</b> needed for (1)  equal / same number (of these atoms) on right hand side (1)			
	(ii)	1	gas / gaseous			
(b)	(i)	I	cooling			
	II	1	recycling			
	(ii)	2	iron (1)  speeds up reaction (1)			

2.

Guidance
<p>Indicative content: Explanation of choice of temperature and pressure conditions and rationale of presence of catalyst e.g.</p> <p>reversible reaction, left to right reaction required to produce ammonia</p> <p>(left to right reaction is exothermic and) higher yield is favoured by lower temperature however lower temperature results in lower rate so compromise made – moderately high temperature increases rate at the expense of yield rate further increased by using iron catalyst</p> <p>higher yield is favoured by higher pressure however increasing pressure increases plant costs and is potentially more hazardous – moderate pressure chosen provides moderate yield</p> <p>lower yield acceptable because unreacted nitrogen/hydrogen can be easily separated and returned to reaction vessel</p> <p>5-6 marks: The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.</p> <p>3-4 marks: The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.</p> <p>1-2 marks: The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar.</p> <p>0 marks: The candidate does not make any attempt or give a relevant answer worthy of credit.</p>

## 3.

Sub-section	Mark	Answer	Accept	Neutral answer	Do not accept
(a)	1	hydrogen	H <sub>2</sub>	H	
(b)	2	iron (1)  speeds up the reaction / increases the rate of the reaction (1)			
(c)	2	recycled / returned into reactor (1)  basic qualification required e.g. reduces cost of process / less waste of raw materials (1)	fed back in re-used	more efficient / reacted again / more yield / saves time	
(d)	2	lower yield with higher temperature (1)  higher yield with a higher pressure (1)	vice versa		
(e)	3	N <sub>2</sub> + H <sub>2</sub> (1)  NH <sub>3</sub> (1)  (1), 3, 2 (1)  formulae must be correct to award balancing mark			

4.

Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
(a)	(i)	1	1000 atmospheres 100 °C both needed for (1)			
	(ii)	2	low rate/ slow reaction (1)  (iron) catalyst (1)	decreased rate		incorrectly named catalyst e.g. V <sub>2</sub> O <sub>5</sub>
	(iii)	1	cost of container/more expensive to build/thicker container walls/ cost of getting to high pressure		'cost'	
(b)	(i)	1	exothermic			
	(ii)	1	4 $\longrightarrow$ 4			
	(iii)	2	$\text{CuCO}_3 + 2\text{HNO}_3 \longrightarrow \text{Cu}(\text{NO}_3)_2 + \text{H}_2\text{O} + \text{CO}_2$  formulae correct (1) balancing (1)  formulae must be correct for balancing mark to be awarded			

5.

Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
(a)	(i)	1	ammonia	NH <sub>3</sub>		
	(ii)	1	copper(II) hydroxide	copper hydroxide Cu(OH) <sub>2</sub>		
	(iii)	1	Fe(OH) <sub>2</sub>			
(b)	(i)	1	sulfuric acid is stronger / more acidic (than ethanoic acid) ethanoic acid is weaker / less acidic (than sulfuric acid)	sulfuric acid is strong and ethanoic acid is weak	pH of sulfuric acid is 1 and pH of ethanoic acid is 3	
	(ii)	I	1	reaction with sulfuric acid would be faster  more reactive / more bubbles / gets hotter with sulfuric acid	converse answers	
		II	1	(gas) pops with lighted splint		

6.			Sub-section	Mark	Answer	Accept	Neutral answer	Do not accept
(a)			3	carbon dioxide → turns limewater milky (1)				
				ammonia → turns damp red litmus blue (1)				
				oxygen → relights a glowing splint (1)				
(b)			3	yellow flame (1)				
				green flame (1)				
				brown precipitate (1)				

7.			Sub-section	Mark	Answer	Accept	Neutral answer	Do not accept
(a)	(i)		3	diagrammatic representation showing clearly two Na atoms losing 1 outer electron each (1) one O atom gaining 2 electrons (1) Na <sup>+</sup> and O <sup>2-</sup> (both needed) (1) there must be no ambiguity e.g. electrons cannot be on atoms and ions at the same time				
		(ii)		1				
(b)			3	simple molecular (1) weak bonds between molecules (1) only a small amount of energy needed to break them (1)	simple covalent	covalent		

8.

Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
(a)	(i)	1	air			
	(ii)	2	dissolve sulfur trioxide in concentrated sulfuric acid (1)  dilute with water to produce concentrated sulfuric acid (1)		add to oleum	
	(iii)	1	vanadium pentoxide	$V_2O_5$		
(b)		2	acid dehydrates the sugar removing the <b>elements of water / hydrogen and oxygen</b> (1)  carbon remains (1)	C		

9.

Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
(a)	(i)	I	1	sulfur / S			
		II	1	vanadium(V) oxide / vanadium oxide / vanadium pentoxide / V <sub>2</sub> O <sub>5</sub>		VO	
		III	1	sulfuric acid / H <sub>2</sub> SO <sub>4</sub>	oleum	dilute / conc	
	(ii)		3	reactants: SO <sub>2</sub> + O <sub>2</sub> (1) product: SO <sub>3</sub> (1) balancing: 2(SO <sub>2</sub> ) 2(SO <sub>3</sub> ) (1) – reactants and product must be correct / before balancing mark awarded			
(b)			2	(blue hydrated copper(II) sulfate) turns white (1)  (crystalline hydrated copper (II) sulfate) turns powdery / turns crumbly / loses its crystalline appearance (1)		changes colour	



10.

Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
(a)	(i)	3	$\text{SO}_2$ $\text{O}_2$ (1) $\text{SO}_3$ (1) formulae must be correct to get balancing mark 2, 1, 2 (1)			
	(ii)	2	30 (2) if incorrect answer credit (1) for two correct readings from graph i.e. 86 and 56			
	(iii)	2	$\text{H}_2\text{SO}_4$ (1) [no mark for $\text{SO}_3$ ] $\text{H}_2\text{S}_2\text{O}_7$ (1)			
(b)		3	black mass forms / black solid forms / sugar turns black (1) steam / water vapour / hissing (1) smell (1) any two for (1) each carbon (1)		temperature rise / water formed / bubbles / fizzing	

11.

Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
(a)	(i)	2	sulfur dioxide (1) sulfur trioxide (1)	SO <sub>2</sub> SO <sub>3</sub>		
	(ii)	1	2			
	(iii)	1	far too / very exothermic or acid forms mist / white fumes form or acid is difficult to collect		dangerous / explosive / reactive	
(b)	(i)	2	5 + 5 + 30 + 30 + 15 (1)  15 (1)  follow through error (ft) correct answer only (cao) (2)			
	(ii)	1	ammonia	NH <sub>3</sub>		
	(iii)	3	overgrowth of algae (1) good description of eutrophication – up to (3)  gets into water supplies (1)  must be some linking of points in explanation for full marks to be awarded	gets into water supplies and can lead to blue baby syndrome (2)	kills fish pollution	

12.

Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
(a)		4	<p><b>A</b> sodium iodide  <b>B</b> ammonium carbonate  <b>C</b> calcium chloride  <b>D</b> iron(II) carbonate</p> <p>mark positive and negative ions independently</p> <p>8 ions correct = 4 marks            6/7 ions correct = 3 marks            4/5 ions correct = 2 marks            2/3 ions correct = 1 mark</p>	<p>NaI  <math>(\text{NH}_4)_2\text{CO}_3</math>  <math>\text{CaCl}_2</math>  <math>\text{FeCO}_3</math></p> <p>no credit for either ion if incorrect formula given  <b>instead of name –</b>            ignore formulae if names also given</p>		
(b)		1	<p>barium chloride (solution forms a) white precipitate</p> <p>test <b>and</b> result needed</p>	barium nitrate / $\text{Ba}^{2+}(\text{aq})$		

13.

Mark	Answer
6	<p data-bbox="289 345 537 370"><b>Indicative content</b></p> <p data-bbox="289 402 1894 459"><b>Benefits</b> e.g. increase crop yield, more food, healthier plants, improves quality of soil, cheaper food and releases land for other purposes.</p> <p data-bbox="289 467 1894 597"><b>Problems</b> e.g. increased soil acidity (which needs neutralising using lime), pollutes water supplies/ nitrates in drinking water (possible health problems), overgrowth of plants in canals (which requires unblocking) and 'eutrophication' or full description – (algae over growth, bloom formation, sunlight blocked, plants die, bacteria removes oxygen during decomposition, water de-oxygenated and water becomes lifeless)</p> <p data-bbox="289 621 426 646"><b>5-6 marks</b></p> <p data-bbox="289 654 1894 751">The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.</p> <p data-bbox="289 776 426 800"><b>3-4 marks</b></p> <p data-bbox="289 808 1894 906">The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.</p> <p data-bbox="289 930 426 954"><b>1-2 marks</b></p> <p data-bbox="289 963 1894 1060">The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar.</p> <p data-bbox="289 1084 405 1109"><b>0 marks</b></p> <p data-bbox="289 1117 1356 1149">The candidate does not make any attempt or give a relevant answer worthy of credit.</p>

14.

Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
(a)	(i)	1	sodium chloride / sodium carbonate			
	(ii)	1	sodium carbonate / lithium carbonate			
(b)		3	add silver nitrate solution (1)  white <b>precipitate</b> with potassium chloride (1)  yellow <b>precipitate</b> with potassium iodide (1)  allow (1) for <b>both</b> colours correct if precipitate not used in either case	answer based on displacement reaction – bromine water; description of colour changes	add HNO <sub>3</sub> flame test	
(c)		2	ammonia (1)  turns (damp) red litmus blue (1)			
(d)		3	Fe <sup>3+</sup> + 3OH <sup>-</sup> (1) Fe(OH) <sub>3</sub> (1) correct state symbols (1)			

15.

Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
(a)		3	brick-red (for $\text{Cu}^{2+}$ flame test) (1)			
			yellow precipitate (for $\text{Cl}^-$ ion test) (1)			
			white (precipitate for $\text{Fe}^{3+}$ test) (1)			
(b)		1	sodium chloride, water and ammonia – all needed			

16.

Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
(a)	(i)	1	proton		p	
	(ii)	1	lithium	Li		
(b)		2	nitrogen and hydrogen – both needed (1)		N and H	
			covalent (1)		simple	giant