

Question			Answer	Marks	Guidance
1	(a)		$\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$ correct formulae (1) balancing marks – dependent on correct formulae (1)	2	allow one mark for balanced equation with formulae showing minor errors of case and subscript eg $\text{MG} + 2\text{HCL} \rightarrow \text{MgCL2} + \text{H2}$
	(b)	(i)	$1.67 \times 10^{-3} / 0.00167$ (1)	1	answer must have three significant figures allow 16.7×10^{-4} allow $0.00166 / 1.66 \times 10^{-3}$

Question			Answer	Marks	Guidance
1	(b)	(i)	<p>[Level 3] Applies knowledge and understanding of collision theory to explain <u>both</u> factors in detail although the reference to more collisions may only be made for one of the factors. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks)</p> <p>[Level 2] Applies knowledge and understanding of collision theory to explain one of the factors in detail <u>or</u> partially explain both factors Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p>[Level 1] Appreciation that the rate of any reaction depends on the number of collisions in whatever context it is used Quality of written communication impedes communication of the science at this level. (1 – 2 marks)</p> <p>[Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	6	<p>This question is targeted at grades up to C At all levels ignore reference to faster collisions and to more particles and ignore particles vibrate more allow answers that give ora but it must be very clear that this is what they have done</p> <p>Indicative scientific points at levels 2 and 3 may include: <u>rate increases with temperature because</u></p> <ul style="list-style-type: none"> acid particles move faster / acid particles have more energy more collisions between particles of acid and magnesium – this does not have to be qualified eg more (successful) collisions or more collisions (per second) <p>allow – higher level answers for temperature that refer to more acid particles having sufficient energy to react or more acid particles having energy above that of the activation energy</p> <p><u>rate increases with powder because</u></p> <ul style="list-style-type: none"> magnesium has greater surface area / powder has more magnesium particles exposed more collisions between particles of acid and magnesium – this does not have to be qualified eg more (successful) collisions or more collisions (per second) <p>Indicative scientific points at level 1 may include:</p> <ul style="list-style-type: none"> more collisions gives a faster reaction even if referring to concentration or pressure link between number of collisions and rate of reaction
			Total	9	


Question	Answer	Marks	Guidance
2 a	(no because) hastelloy is more resistant to corrosion at high(er) concentrations of acid (at 20°C) / ora (1) but (yes because) all (three) metals are more resistant to corrosion at low(er) temperatures / ora (1)	2	marks are for explanations
b i	0.6 (cm ³ /hour) (1)	1	
b ii	(pH) 6	1	
c	$2Al + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2$ formulae (1) balancing (1)	2	balancing mark is conditional on correct formulae allow any correct multiple e.g. $4Al + 6H_2SO_4 \rightarrow 2Al_2(SO_4)_3 + 6H_2$ allow = or \rightleftharpoons for arrow not 'and' or & for + allow one mark for correct balanced equation with incorrect use of upper and lower case formulae e.g. $2Al + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2$
	Total	6	

Question	Answer	Marks	Guidance
3 a	hydrogen (1)	1	allow correct answer ticked, circled or underlined in list if answer line is blank
b	chlorine is reactive (and may react with the electrode)/ so that the products don't react with the electrode (1)	1	allow electrode product reacts with electrode / hydrogen reacts with electrode (1) ignore so electrodes do not react with sodium chloride (solution) / so electrodes do not react with solution or electrolyte
c i	$2Cl^- - 2e^- \rightarrow Cl_2(1)$	1	allow any correct multiple, including fractions
c ii	oxidation because electrons are lost (1)	1	allow oxidation number of <i>Cl</i> increases / oxidation number of <i>Cl</i> goes from -1 to 0 (1) not chlorine loses electrons or chlorine ions lose electrons
Total		4	

Question	Answer	Marks	Guidance										
4 a	<p>argument for: (world) population is rising / (so) need to produce more food (1)</p> <p>argument against: eutrophication or death of aquatic organisms (from excessive use of fertilisers) / idea of pollution of water supplies (from excessive use of fertilisers) (1)</p>	2	<p>must have an argument for and an argument against the use of fertilisers for 2 marks</p> <p>allow increasing population to feed (1) allow fertilisers increase crop yield (1) allow higher level answers eg replace essential elements (used by a previous crop) (1) ignore crops grow bigger or faster or idea of better crops</p> <p>ignore cost</p>										
b i	<table border="1" data-bbox="380 757 907 994"> <thead> <tr> <th data-bbox="380 757 644 804">Atom</th> <th data-bbox="644 757 907 804">Number</th> </tr> </thead> <tbody> <tr> <td data-bbox="380 804 644 851">N</td> <td data-bbox="644 804 907 851">3</td> </tr> <tr> <td data-bbox="380 851 644 898">H</td> <td data-bbox="644 851 907 898">12</td> </tr> <tr> <td data-bbox="380 898 644 945">P</td> <td data-bbox="644 898 907 945">1</td> </tr> <tr> <td data-bbox="380 945 644 994">O</td> <td data-bbox="644 945 907 994">4</td> </tr> </tbody> </table> <p>all four correct scores (2) two or three correct scores (1) one correct scores (0)</p>	Atom	Number	N	3	H	12	P	1	O	4	2	
Atom	Number												
N	3												
H	12												
P	1												
O	4												

Question	Answer	Marks	Guidance
b ii	<p>Level 3 States the name of the acid <u>and</u> the alkali needed to make ammonium phosphate AND fully describes how ammonium phosphate can be made. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks)</p> <p>Level 2 States the name of the acid <u>and</u> the alkali needed to make ammonium phosphate AND attempts to describe how ammonium phosphate can be made. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p>Level 1 States the name of the acid <u>and</u> the alkali needed to make ammonium phosphate OR attempts to describe how ammonium phosphate can be made. Quality of written communication impedes communication of the science at this level. (1 – 2 marks)</p> <p>Level 0 Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	6	<p>This question is targeted at grades up to A</p> <p>Indicative scientific points may include:</p> <p>Acid needed is phosphoric acid / H_3PO_4</p> <p>Alkali needed is ammonia / ammonium hydroxide / NH_3 / NH_4OH ignore ammonia hydroxide</p> <p>To make ammonium phosphate:</p> <ul style="list-style-type: none"> • titrate the acid with the alkali, using an indicator / add the acid to the alkali (or vice versa), using an indicator • repeat the titration until consistent results are obtained • use the titration result to add the correct amounts of acid and alkali together without the indicator / decolourise indicator with carbon • evaporate (most of) the solution • leave the remaining solution to crystallise <p>allow add excess ammonia to phosphoric acid and then heat the mixture to drive off the excess ammonia</p> <p>Use the L1, L2, L3 annotations in Scoris. Do not use ticks.</p>
	Total	10	

Question	Answer	Marks	Guidance										
5 a	<table border="1" data-bbox="415 232 869 555"> <thead> <tr> <th></th> <th>Number of atoms</th> </tr> </thead> <tbody> <tr> <td>nitrogen</td> <td>2</td> </tr> <tr> <td>hydrogen</td> <td>8</td> </tr> <tr> <td>sulfur</td> <td>1</td> </tr> <tr> <td>oxygen</td> <td>4</td> </tr> </tbody> </table> <p>(1)</p>		Number of atoms	nitrogen	2	hydrogen	8	sulfur	1	oxygen	4	1	
	Number of atoms												
nitrogen	2												
hydrogen	8												
sulfur	1												
oxygen	4												
b	<p>names of reactants: (acid is) sulfuric acid (1) (alkali is) ammonia / ammonium hydroxide / ammonium carbonate / ammonium hydrogencarbonate (1)</p> <p>AND</p> <p>any one from:</p> <p>acid is titrated with alkali using an indicator / idea of controlled addition of acid to alkali with use of indicator (1)</p> <p>(heat to) evaporate water / leave solution to crystallise (1)</p>	3	<p>allow correct formulae or mix of formula and name H_2SO_4 NH_3 / NH_4OH / $(NH_4)_2CO_3$ / NH_4HCO_3 not ammonium / NH_4 / ammonia hydroxide</p> <p>allow acid is added to alkali (or vice versa) until a neutral solution is obtained (1) allow idea of controlled addition of acid to alkali with use of pH meter or test with indicator paper (1)</p>										

Question	Answer	Marks	Guidance
<p> c</p>	<p>[Level 3] Answer describes advantages AND disadvantages of conditions used AND includes the balanced symbol equation for the reaction. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks)</p> <p>[Level 2] Answer describes an advantage AND a disadvantage of conditions used OR includes the balanced symbol equation for the reaction. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p>[Level 1] Answer describes <u>either</u> an advantage <u>or</u> a disadvantage of conditions used OR includes the symbol equation for the reaction (may not be balanced). Quality of written communication impedes communication of the science at this level. (1 – 2 marks)</p> <p>[Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	<p>6</p>	<p>This question is targeted at grades up to A*</p> <p>Indicative scientific points may include:</p> <p>Symbol equation $\text{NH}_3 + 2\text{O}_2 \rightarrow \text{HNO}_3 + \text{H}_2\text{O}$ allow any correct multiple, including fractions allow = / = instead of → not and / & instead of '+'</p> <p>Advantages of conditions listed</p> <ul style="list-style-type: none"> • high temperature or temperature of 900°C increases rate of reaction • (platinum) catalyst reduces costs • (platinum) catalyst increases rate of reaction • atmospheric pressure means lower energy costs • atmospheric pressure means lower plant costs <p>Disadvantages of conditions listed</p> <ul style="list-style-type: none"> • high temperature or temperature of 900°C increases energy use or expensive • high temperature reduces percentage yield • (platinum) catalyst is (initially) expensive • atmospheric pressure means slower rate of reaction <p>allow answers in terms of position of equilibrium e.g. more moles on LHS so should use higher pressure e.g. if reaction is exothermic equilibrium is on LHS at higher temperature</p> <p>Use the L1, L2, L3 annotations in Scoris; do not use ticks.</p>
	<p>Total</p>	<p>10</p>	

Question	Answer	Marks	Guidance
6 a	$2\text{Br}^- - 2\text{e}^- \rightarrow \text{Br}_2(1)$	1	allow any correct multiple, including fractions not any additional symbols, other than balancing
b	(oxidation because) electrons are lost (from Br^-) (1)	1	allow oxidation number of Br increases (1) not bromine (atoms) lose electrons but allow ions lose electrons (1)
	Total	2	

Question	Answer	Marks	Guidance
7 a	<p>any one from: fewer collisions (1) less crowded particles (1)</p> <p>fewer hydrogen ions / less concentrated H⁺ (1)</p>	1	<p>ignore any extra qualification about collisions but not particles have more energy</p> <p>fewer ions / fewer particles is not sufficient not atoms or molecules as particles if particles are named</p> <p>allow weak acids do not fully ionise (but strong acids do) / weak acids do not completely dissociate (but strong acids do) / weak acids are less ionised</p> <p>allow ora if strong acid specified</p>
b	<p>correct measuring equipment to measure volume of gas in diagram e.g. gas syringe / displacement of water using measuring cylinder or upturned burette (1)</p> <p>equipment will work and it is gas tight (1)</p>	2	The measuring apparatus does not have to be set up or part of a correct diagram
	Total	3	

Question			Answer	Marks	Guidance
8	(a)	(i)	4 (1)	1	
		(ii)	15 (1)	1	
	(b)		<p>Level 3 (5–6 marks) Names <u>both</u> the reagents needed AND Describes a neutralisation experiment, including how both a neutral solution <u>and</u> solid ammonium sulfate is obtained. Quality of written communication does not impede communication of the science at this level.</p> <p>Level 2 (3–4 marks) Names <u>both</u> the reagents needed AND Attempts to describe a neutralisation experiment. Quality of written communication partly impedes communication of the science at this level.</p> <p>Level 1 (1–2 marks) Names <u>one</u> of the reagents needed OR Attempts to describe a neutralisation experiment. Quality of written communication impedes communication of the science at this level.</p> <p>Level 0 (0 marks) Insufficient or irrelevant science. Answer not worthy of credit.</p>	6	<p>This question is targeted at grades up to A*.</p> <p>Indicative scientific points may include:</p> <p>names of reagents</p> <ul style="list-style-type: none"> acid is sulfuric acid alkali is (a solution of) ammonia or ammonium hydroxide or ammonium carbonate. <p>method</p> <ul style="list-style-type: none"> sulfuric acid is added to ammonia solution until a neutral solution is formed neutral solution obtained by use of pH meter / indicator solution / indicator paper / universal indicator solution the neutral solution is evaporated until saturated solution is allowed to stand and crystallise crystals are filtered off and dried. <p>allow idea of ‘evaporation to dryness’ as an alternative to crystallisation</p> <p>N.B. It is not necessary to describe a titration method to get Level 3.</p> <p>Use the L1, L2, L3 annotations in scoris; do not use ticks.</p>
			Total	8	

Question		Answer	Marks	Guidance
9	(a)	salt (1)	1	
	(b)	acid – nitric acid / HNO_3 (1) base – potassium hydroxide / KOH (1)	2	allow potassium oxide / K_2O (1) allow potassium carbonate / K_2CO_3 (1) allow potassium hydrogencarbonate / KHCO_3 (1)
	(c)	20 / twenty (1)	1	
		Total	4	