

Question	Answer	Marks	Guidance
1	<p>Level 3 Complete evaluation including some information from the graph AND explanation using reacting particle model that must mention the idea of collision frequency Quality of communication does not impede communication of science at this level. (5 - 6 marks)</p> <p>Level 2 Complete evaluation including some information from the graph AND explanation using reacting particle model that must mention the idea of collisions OR explanation using reacting particle model that must mention the idea of collision frequency Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p>Level 1 Complete evaluation including some information from the graph OR explanation using reacting particle model that must mention the idea of collisions Quality of 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: Evaluation</p> <ul style="list-style-type: none"> • results support the analysis • idea that as concentration increases reaction time decreases and the rate of reaction increases <p>Reacting particle model</p> <ul style="list-style-type: none"> • as acid is more concentrated particles (of acid) are more crowded • as acid is more concentrated particles (of acid) are closer together • as acid is more concentrated more particles (of acid) per unit volume • as acid is more concentrated there are more collisions • as acid is more concentrated there are more collisions per second <p>allow collisions more often, more chance of collision, increases collision frequency for more collisions per second allow reverse argument with as acid gets less concentrated</p> <p>Use the L1, L2, L3 annotations in Scoris. Do not use ticks.</p>
Total		6	

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2 a	<p>any two from:</p> <p>correct piece of apparatus to collect and measure gas e.g. (gas) syringe, upturned measuring cylinder with water or upturned burette with water (1)</p> <p>workable and gas tight (1)</p>	2	<div data-bbox="1310 181 1864 435" data-label="Diagram"> </div> <p>The measuring apparatus must be graduated and does not need to be assembled. The apparatus does not need to be named if there is no ambiguity from the diagram</p> <p>allow even if the syringe / measuring cylinder is not graduated</p> <p>allow the tube can be a single line</p> <p>ignore if tube does not appear to go through the stopper</p> <p>not the delivery tube must not go in the reaction mixture</p>

Question	Answer	Marks	Guidance
2 b	<p>Level 3 Describes the difference between strong and weak acids AND explains the different shapes of the graphs in terms of collision frequency and hydrogen ions Quality of written communication does not impede communication of the science at this level. (5 – 6 marks)</p> <p>Level 2 EITHER Describes the difference between strong and weak acids and explains the different shapes of the graphs in terms of rate of reaction and strength of acid OR explains the different shapes of the graphs in terms of collision frequency or hydrogen ions Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p>Level 1 EITHER Describes the difference between strong and weak acids OR explains the different shapes of the graphs in terms of rate of reaction and strength of acid 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. (0marks)</p>	6	<p>This question is targeted at grades up to A.</p> <p>Indicative scientific points at level 3 must include:</p> <p>Shapes of graph</p> <ul style="list-style-type: none"> • reference to hydrogen ions e.g. nitric acid has more hydrogen ions / greater concentration of hydrogen ions • reference to collision frequency e.g. nitric acid has more collisions per second / collisions more often / greater collision frequency <p>allow references to increased chance of collision, collisions more often, collisions more likely, as alternatives to increased collision frequency</p> <p>allow ora for propanoic acid</p> <p>Indicative scientific points at all levels may include:</p> <p>Strength of acid</p> <ul style="list-style-type: none"> • strong acid completely dissociates / ionises completely • weak acid partially dissociates / does not completely ionise <p>Shapes of graph</p> <ul style="list-style-type: none"> • nitric acid faster than propanoic acid • nitric acid has more reacting particles / greater concentration of reacting particles • nitric acid has more collisions • nitric acid has particles closer together <p>allow ora for propanoic acid</p> <p>ignore comments about similarities of the graph</p> <p>Use the L1, L2, L3 annotations in Scoris; do not use ticks.</p>
2 c i	Moles = $0.0025 / 2.5 \times 10^{-3}$ (1)	1	

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ii	Mass = 0.25 (g) / 2.5×10^{-1} (1)	1	allow ecf from number of moles, i.e. moles \times 100
	Total	10	

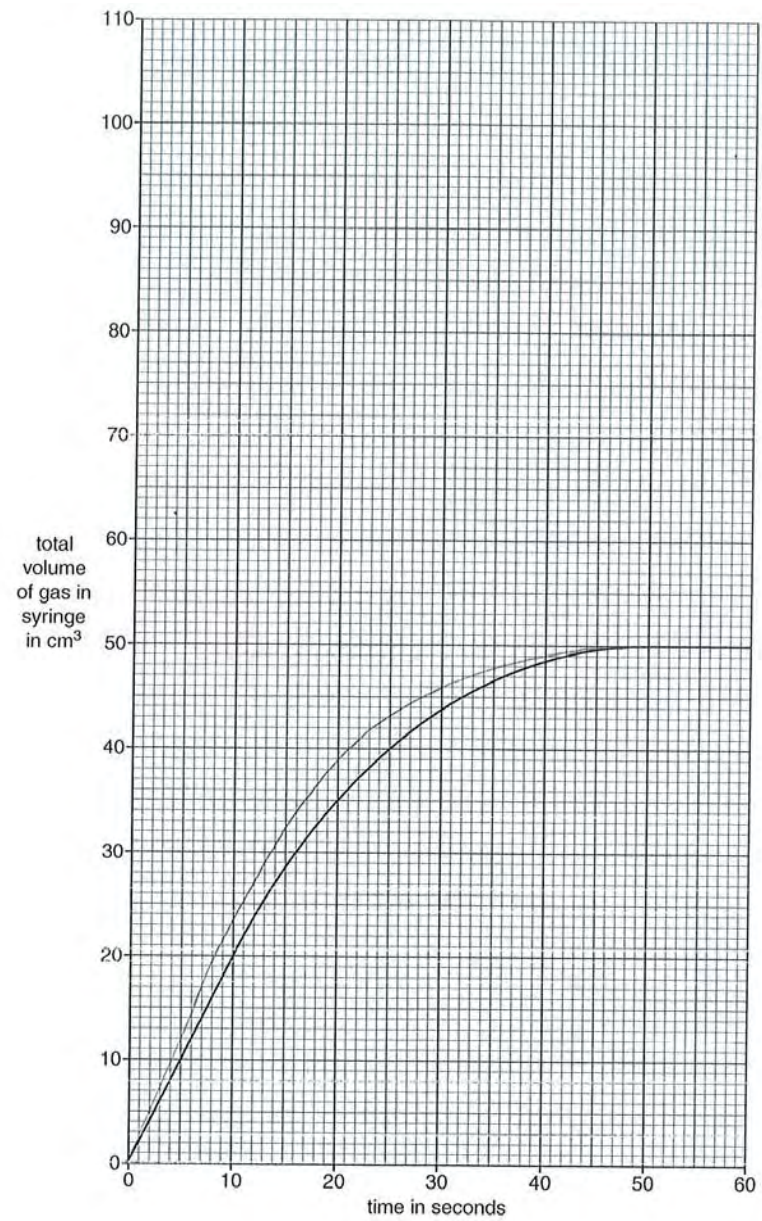
Question	Answer	Marks	Guidance
3 a	<p>[Level 3] Explanation that the results (in relation to both volume of acid & mass of magnesium) do not support the prediction with reference to experimental data AND an explanation <i>using collision frequency</i> that reaction in experiment 4 is faster, or has a shorter reaction time, than experiment 3. Quality of communication does not impede communication of science at this level. (5-6 marks)</p> <p>[Level 2] Explanation that the results (in relation to both volume of acid & mass of magnesium) do not support the prediction with reference to experimental data AND an explanation that the reaction in experiment 4 is faster, or has a shorter reaction time, than experiment 3 <i>using idea of more collisions rather than collision frequency</i></p> <p>OR an explanation <i>using collision frequency</i> that reaction in experiment 4 is faster or has a shorter reaction time than experiment 3. Quality of written communication partly impedes communication of the science at this level. (3-4 marks)</p> <p>[Level 1] Explanation that the results (in relation to either volume of acid or mass of magnesium) do not support the prediction with reference to experimental data OR an explanation that the reaction in experiment 4 is faster or has a shorter reaction time than experiment 3 <i>using idea of more collisions rather than collision frequency</i>. Quality of 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 for explanation may include:</p> <ul style="list-style-type: none"> • results show as volume increases reaction time does not change • results show that as mass increases reaction time does not change <p>Indicative scientific points for experiments 3 and 4 may include:</p> <ul style="list-style-type: none"> • concentration is higher in experiment 4 • acid particles are more crowded in experiment 4 / acid particles are closer together / more acid particles per unit volume / more acid particles per cm³ / more acid particles in the same space • more (successful) collisions per second / collisions more often / increased collision frequency / more chance of a collision <p>Use the L1, L2, L3 annotations in Scoris; do not use ticks</p>

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3 b	<p>(acid) particles have more energy / (acid) particles are moving faster / more collisions per second (1)</p> <p>more successful collisions / more energetic collisions / more collisions above the activation energy / more effective collisions (1)</p>	2	<p>ignore particles vibrate more or vibrate faster ignore particles move more</p> <p>allow more successful collisions per second / more frequent energetic collisions for two marks ignore harder collisions / faster collisions</p> <p>allow more collisions (1), if no other mark awarded allow rate increases / reaction is faster (1), if no other mark awarded</p>
	Total	8	

Question			answer	Marks	Guidance
4	(a)	(i)	(copper carbonate is) broken down (using heat) (1)	1	<p>allow two or more substances are produced from one substance (by heating) (1)</p> <p>allow break up of (copper carbonate) (with heat) (1)</p> <p>ignore breaks up bonds</p> <p>not heat particles broken down</p> <p>ignore decay / dissolve</p>
		(ii)	$2\text{CuO} + \text{C} \rightarrow 2\text{Cu} + \text{CO}_2$ formulae correct (1) balancing (1)	2	<p>allow any correct multiple, including fractions</p> <p>allow = / \rightleftharpoons instead of \rightarrow</p> <p>not and / &</p> <p>not '+ heat' in equation</p> <p>balancing mark is dependent on the correct formula</p> <p>but</p> <p>allow 1 mark for a balanced equation with minor errors of case, subscripts, superscripts, etc</p> $2\text{CuO} + \text{C} \rightarrow 2\text{Cu} + \text{CO}_2$
	(b)	(i)	at the anode electrons are lost which is oxidation (1) at the cathode electrons are gained which is reduction (1)	2	<p>allow 1 mark if oxidation is described as electron loss and reduction as electron gain without identification of the electrodes or with incorrect identification of the electrodes</p>
		(ii)	the anode loses mass because copper ions go into solution (1) the cathode gains mass because the copper ions gain electrons and become copper (1)	2	<p>if ion is missed out in both marking points then allow one mark</p> <p>allow copper ions move from the anode to the cathode for 1 mark if no other mark awarded</p>

Question		Answer	Marks	Guidance
	(c)	<p>advantages any one from:</p> <p>saves resources (because the ore does not have to be extracted) (1)</p> <p>uses less energy (1)</p> <p>idea of less environmental damage (due to quarrying) (1)</p> <p>problems any one from:</p> <p>copper has to be collected (1)</p> <p>copper has to be sorted from other metals (1)</p>	2	<p>must be one advantage and one problem for 2 marks</p> <p>allow copper is in short supply (1)</p> <p>ignore saves landfill space</p> <p>allow loss of jobs mining or extracting copper ore (1)</p>
	(d)	<p>(aluminium because) low(est) density (1) and does not corrode (1)</p> <p>or</p> <p>(copper because) best conductor (1) and only corrodes slowly (1)</p>	2	<p>no mark for metal; marks are for explanation</p> <p>ignore (aluminium because) it is light</p> <p>ignore other factors from the table</p> <p>allow (copper because it is) a good conductor (1)</p> <p>ignore other factors from the table</p> <p>allow one mark for iron because it is strongest</p>
Total			11	

Question		answer	Marks	Guidance	
5	(a)	$\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$ formulae correct (1) balancing (1)	2	allow any correct multiple, including fractions allow = / \rightleftharpoons instead of \rightarrow not and / & balancing mark is dependent on the correct formula but allow 1 mark for a balanced equation with minor errors of case, subscripts, superscripts, etc $\text{Mg} + 2\text{HCL} \rightarrow \text{MgCl2} + \text{H}_2$	
	(b)	(i)	47–51 (seconds) (1)	1	
		(ii)	2 (cm ³ /s) (1)	1	allow 120 cm ³ /min (1)
		(iii)	Please see suggested answer on page 15 line drawn to left of original and passing through the origin (1) line ending at same volume (1)	2	allow line drawn to left of original but ending above or below 50 cm ³ (1) allow line drawn to right of original but ending at 50 cm ³ (1)
			Total	6	



Question		Answer	Marks	Guidance
6	(a)	strong acid is fully ionised (in water) (1) weak acid is only partially ionised (1)	2	allow dissociated for ionised
	(b) (i)	ethanoic acid contains a lower concentration of hydrogen ions (than hydrochloric acid) (1) so lower collision frequency (1)	2	allow ethanoic acid contains less crowded hydrogen ions / hydrogen ions in ethanoic acid are further apart / ora allow ethanoic acid has a higher pH / ora allow collisions less often / less chance of a collision / fewer collisions per second / ora if specified for hydrochloric acid
	(ii)	both contain the same number of moles of magnesium (1)	1	allow both contain the same amount of magnesium / both contain same mass of magnesium (1) ignore magnesium is the limiting reagent not same number of moles of acid
		Total	5	

Question		Answer	Marks	Guidance															
7	(a)	<table border="1"> <thead> <tr> <th>acid</th> <th>base</th> <th>salt</th> </tr> </thead> <tbody> <tr> <td>sulfuric acid</td> <td>copper oxide</td> <td>copper sulfate</td> </tr> <tr> <td>nitric acid</td> <td>sodium carbonate</td> <td>sodium nitrate (1)</td> </tr> <tr> <td>hydrochloric acid (1)</td> <td>zinc oxide</td> <td>zinc chloride</td> </tr> <tr> <td>sulfuric acid</td> <td>magnesium oxide / magnesium hydroxide / magnesium carbonate (1)</td> <td>magnesium sulfate</td> </tr> </tbody> </table>	acid	base	salt	sulfuric acid	copper oxide	copper sulfate	nitric acid	sodium carbonate	sodium nitrate (1)	hydrochloric acid (1)	zinc oxide	zinc chloride	sulfuric acid	magnesium oxide / magnesium hydroxide / magnesium carbonate (1)	magnesium sulfate	3	<p>allow correct formulae i.e. NaNO_3 (1)</p> <p>HCl (1)</p> <p>$\text{MgO} / \text{Mg(OH)}_2 / \text{MgCO}_3$ (1)</p>
acid	base	salt																	
sulfuric acid	copper oxide	copper sulfate																	
nitric acid	sodium carbonate	sodium nitrate (1)																	
hydrochloric acid (1)	zinc oxide	zinc chloride																	
sulfuric acid	magnesium oxide / magnesium hydroxide / magnesium carbonate (1)	magnesium sulfate																	
	(b)	$\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$ formulae correct (1) balancing (1)	2	<p>balancing mark is dependent on correct formulae but allow one mark for balanced equation with minor errors of subscripts, superscripts, etc eg $\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$</p> <p>not and or & for + allow = instead of \rightarrow allow correct multiples eg $2\text{CaCO}_3 + 4\text{HCl} \rightarrow 2\text{CaCl}_2 + 2\text{CO}_2 + 2\text{H}_2\text{O}$</p>															
	(c)	$\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$ (1)	1	<p>order of reactants unimportant allow OH_2 / HOH allow correct multiples subscripts and superscripts must be correct eg H^2O scores 0</p>															

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	(d)	<p>Level 1 (1 mark) idea that fertiliser or nitrates increase the growth of water plants or that the outcome is that living organisms in the water die. idea that fertilisers cause water to become toxic limits mark to a maximum of 1</p> <p>Level 2 (2 marks) idea that (algal bloom) / plant growth blocks off sunlight (from other plants which then die).</p> <p>Level 3 (3 marks) idea that in addition to level 2, (aerobic) bacteria use up the oxygen in the water.</p>	3	<p>Use ticks in this question Mark scheme is hierarchical – level 1 is required before level 2 can be awarded and levels 1 & 2 required before level 3 can be awarded</p> <p>allow algal bloom for increased growth of water plants</p> <p>idea that fertiliser kills or poisons fish (0)</p> <p>allow idea that plants below surface cannot photosynthesis for level 2</p> <p>allow decomposers or microbes or micro organisms for bacteria</p>
		Total	9	

Question		Answer	Marks	Guidance
8	(a)	$\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$ formulae (1) balancing (1)	2	<p>allow any correct multiple, including fractions</p> <p>allow = / \rightleftharpoons instead of \rightarrow</p> <p>not and / & / '+ energy'</p> <p>balancing mark is dependent on the correct formulae but</p> <p>allow 1 mark for a balanced equation with a minor error in subscripts / formulae</p> <p>eg $\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$</p>
	(b) (i)	any value within range 5½ - 6 (minutes) (1)	1	
	(ii)	15 / 15.0 (1) cm ³ /min or cm ³ /minute (1)	2	<p>allow 0.25 (1) cm³/s (1)</p> <p>not cm³/m</p>
	(iii)	rate of reaction for first 2 minutes is greater than between 2 and 4 minutes / ora (1)	1	<p>it is faster / it goes slower are not sufficient</p> <p>answer must be comparative</p> <p>allow rate is 15 for first 2 minutes and 8 for second 2 minutes</p> <p>allow reaction starts to slow down</p>

Question		Answer	Marks	Guidance
8	(c)	<p>[Level 3] Answer applies understanding of the reacting particle model to comprehensively explain both ways of increasing the rate of reaction. Quality of written communication does not impede communication of the science at this level (5 – 6 marks)</p> <p>[Level 2] Answer applies understanding of the reacting particle model to comprehensively explain one way of increasing the rate of reaction. Quality of written communication partly impedes communication of the science at this level (3 – 4 marks)</p> <p>[Level 1] Answer shows appreciation that the rate of reaction is increased by having more collisions in one of the two contexts or explains concentration using particles or uses surface area to explain crushed tablet. Quality of written communication impedes communication of the science at this level (1 – 2 marks)</p> <p>[Level 0] Quality of written communication impedes communication of the science at this level (0 marks)</p>	6	<p>This question is targeted at grades up to A.</p> <p>allow 'tablet' for calcium carbonate ignore faster collisions / quicker collisions ignore reference to 'more particles' ignore successful in terms of collisions but particles have more energy or move faster is not correct not atoms colliding</p> <p>Indicative scientific points at level 2 and 3 can include:</p> <p>concentration of hydrochloric acid</p> <ul style="list-style-type: none"> idea of increased collision frequency between acid particles and calcium carbonate / more collisions per second between acid particles and calcium carbonate <p>crushed tablet</p> <ul style="list-style-type: none"> idea of increased collision frequency between acid particles and calcium carbonate / more collisions per second between acid particles and calcium carbonate <p>Indicative scientific points at level 1 can include:</p> <p>concentration of hydrochloric acid</p> <ul style="list-style-type: none"> idea of more crowded acid particles / more acid particles in the same volume / more H⁺ ions in the same volume / acid particles closer together idea of more collisions between acid particles and particles of the tablet <p>crushed tablet</p> <ul style="list-style-type: none"> idea of increased surface area of calcium carbonate or tablet / more calcium carbonate or tablet particles exposed to the acid
Total			12	