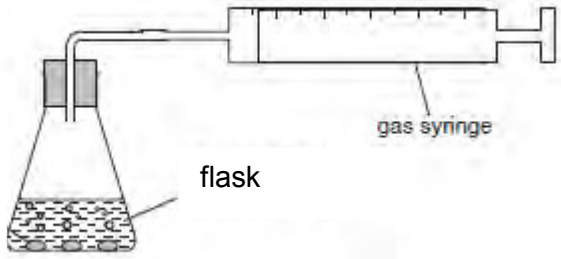
Question	Answer	Marks	Guidance
1	**Level 3** **Complete evaluation including some information from the graph** **AND** **explanation using reacting particle model that must mention the idea of collision frequency** Quality of communication does not impede communication of science at this level. (5 - 6 marks) **Level 2** **Complete evaluation including some information from the graph <u>AND</u> 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) **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) **Level 0** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	**This question is targeted at grades up to A** **Indicative scientific points may include:** **Evaluation** • results support the analysis • idea that as concentration increases reaction time decreases and the rate of reaction increases **Reacting particle model** • 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 **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 **Use the L1, L2, L3 annotations in Scoris. Do not use ticks.**
	Total	**6**	

Question	Answer	Marks	Guidance
2 a	**any two from:** correct piece of apparatus to collect and measure gas e.g. (gas) syringe, upturned measuring cylinder with water or upturned burette with water (1) workable and gas tight (1)	2	 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 **allow** even if the syringe / measuring cylinder is not graduated **allow** the tube can be a single line **ignore** if tube does not appear to go through the stopper **not** the delivery tube must not go in the reaction mixture

Question	Answer	Marks	Guidance
2 b	**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) **Level 2** **EITHER** **Describes the difference between strong and weak acids <u>and</u> 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) **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) **Level 0** Insufficient or irrelevant science. Answer not worthy of credit. (0marks)	6	**This question is targeted at grades up to A.** **Indicative scientific points at level 3 must include:** **Shapes of graph** • 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 **allow** references to increased chance of collision, collisions more often, collisions more likely, as alternatives to increased collision frequency **allow** ora for propanoic acid **Indicative scientific points at all levels may include:** **Strength of acid** • strong acid completely dissociates / ionises completely • weak acid partially dissociates / does not completely ionise **Shapes of graph** • 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 **allow** ora for propanoic acid **ignore** comments about similarities of the graph **Use the L1, L2, L3 annotations in Scoris; do not use ticks.**
2 c i	Moles = $0.0025 / 2.5 \times 10^{-3}$ (1)	1	

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

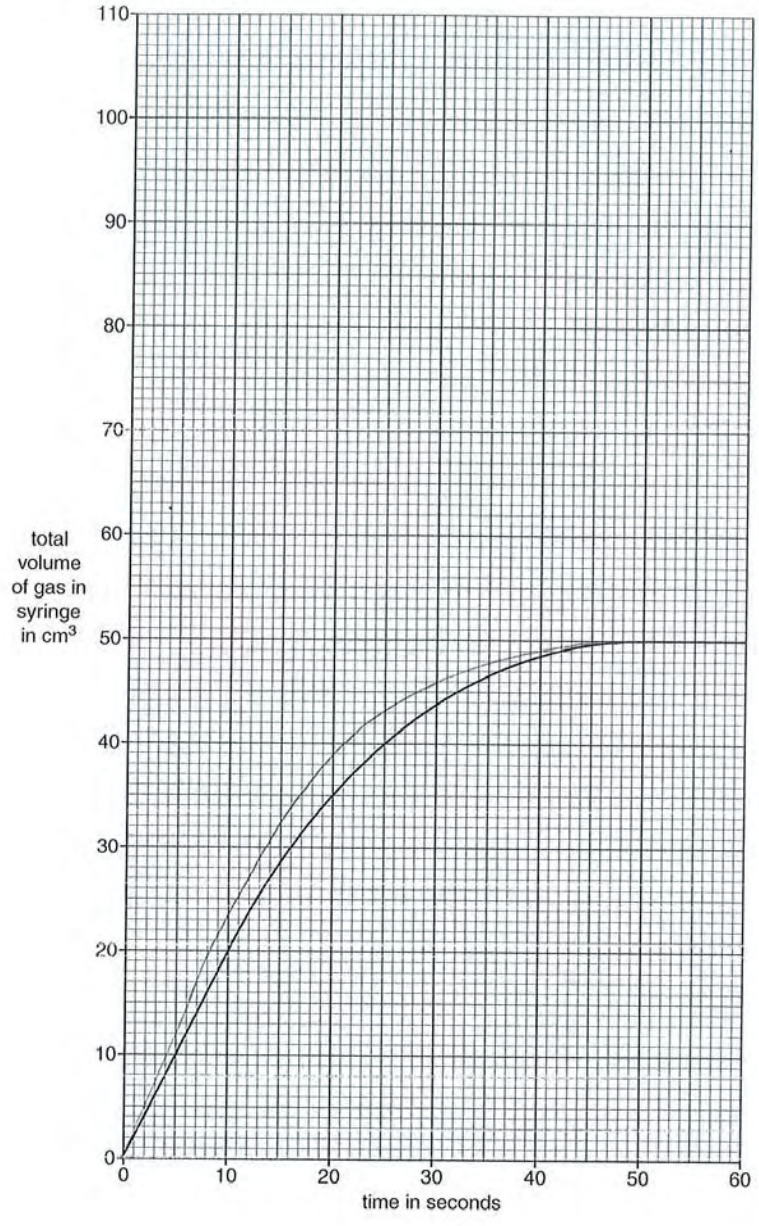
Question	Answer	Marks	Guidance
3 a	**[Level 3]** **Explanation that the results (in relation to <u>both</u> volume of acid & mass of magnesium) do not support the prediction with reference to experimental data** **AND** **an explanation *<u>using collision frequency</u>* that reaction in experiment 4 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) **[Level 2]** **Explanation that the results (in relation to <u>both</u> 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 *using idea of more collisions rather than collision frequency*** **OR** **an explanation *<u>using collision frequency</u>* 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) **[Level 1]** **Explanation that the results (in relation to <u>either</u> volume of acid <u>or</u> 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 *using idea of more collisions rather than collision frequency*.** Quality of communication impedes communication of the science at this level (1-2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	**This question is targeted at grades up to A*** **Indicative scientific points for explanation may include:** • results show as volume increases reaction time does not change • results show that as mass increases reaction time does not change **Indicative scientific points for experiments 3 and 4 may include:** • 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 cm^3 / more acid particles in the same space • more (successful) collisions per second / collisions more often / increased collision frequency / more chance of a collision **Use the L1, L2, L3 annotations in Scoris; do not use ticks**

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

Question			answer	Marks	Guidance
4	(a)	(i)	(copper carbonate is) broken down (using heat) (1)	1	**allow** two or more substances are produced from one substance (by heating) (1) **allow** break up of (copper carbonate) (with heat) (1) **ignore** breaks up bonds **not** heat particles broken down **ignore** decay / dissolve
		(ii)	$2CuO + C \rightarrow 2Cu + CO_2$ formulae correct (1) balancing (1)	2	**allow** any correct multiple, including fractions **allow** = / ⇌ instead of → **not** and / & **not** '+ heat' in equation balancing mark is dependent on the correct formula **but** **allow** 1 mark for a balanced equation with minor errors of case, subscripts, superscripts, etc 2CuO + C → 2CU + CO2
	(b)	(i)	at the anode electrons are lost which is oxidation (1) at the cathode electrons are gained which is reduction (1)	2	**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
		(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	if ion is missed out in both marking points then **allow** one mark **allow** copper ions move from the anode to the cathode for 1 mark if no other mark awarded

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

Question			answer	Marks	Guidance
5	(a		$Mg + 2HCl \rightarrow MgCl_2 + H_2$ formulae correct (1) balancing (1)	2	**allow** any correct multiple, including fractions **allow** = / ⇌ instead of → **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 $Mg + 2HCL \rightarrow MgCl2 + H_2$
	(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**	


total volume of gas in syringe in cm3
110
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
time in seconds

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 low**er** 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 high**er** 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**	

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>7</td><td>(a)</td><td></td><td>
<table>
<tr><th>acid</th><th>base</th><th>salt</th></tr>
<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>
</table>
</td><td>3</td><td>allow correct formulae i.e.
$NaNO_3$ (1)

HCl (1)

MgO / $Mg(OH)_2$ / $MgCO_3$ (1)</td></tr>
<tr><td></td><td>(b)</td><td></td><td>$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$

formulae correct (1)
balancing (1)</td><td>2</td><td>balancing mark is dependent on correct formulae
but
allow one mark for balanced equation with minor errors of subscripts, superscripts, etc eg
$CACO_3 + 2HCl \rightarrow CaCl^2 + CO_2 + H2O$

not and or & for +
allow = instead of →
allow correct multiples eg
$2CaCO_3 + 4HCl \rightarrow 2CaCl_2 + 2CO_2 + 2H_2O$</td></tr>
<tr><td></td><td>(c)</td><td></td><td>$H^+ + OH^- \rightarrow H_2O$ (1)</td><td>1</td><td>order of reactants unimportant
allow OH_2 / HOH
allow correct multiples
subscripts and superscripts must be correct eg H^2O scores 0</td></tr>
</table>

Question			Answer	Marks	Guidance
	(d)			3	**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
			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		**allow** algal bloom for increased growth of water plants idea that **fertiliser** kills or poisons fish (0)
			Level 2 (2 marks) idea that (algal bloom) / plant growth blocks off sunlight (from other plants which then die).		**allow** idea that plants below surface cannot photosynthesis for level 2
			Level 3 (3 marks) idea that in addition to level 2, (aerobic) bacteria use up the oxygen in the water.		**allow** decomposers or microbes or micro organisms for bacteria
			Total	**9**	

Question			Answer	Marks	Guidance
8	(a)		$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$ formulae (1) balancing (1)	2	**allow** any correct multiple, including fractions **allow** = / ⇌ instead of → **not** and / & / '+ energy' balancing mark is dependent on the correct formulae but **allow** 1 mark for a balanced equation with a minor error in subscripts / formulae eg CaCO3 + 2HCl → CaCl2 + CO2 + H_2O
	(b)	(i)	any value within range 5½ - 6 (minutes) (1)	1	
		(ii)	15 / 15.0 (1) cm³/min or cm³/minute (1)	2	 **allow** 0.25 (1) cm^3/s (1) **not** cm^3/m
		(iii)	rate of reaction for first 2 minutes is greater than between 2 and 4 minutes / ora (1)	1	it is faster / it goes slower are not sufficient answer must be **comparative** **allow** rate is 15 for first 2 minutes and 8 for second 2 minutes **allow** reaction starts to slow down

Question			Answer	Marks	Guidance
8	(c)		**[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) **[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) **[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) **[Level 0]** Quality of written communication impedes communication of the science at this level (0 marks)	6	**This question is targeted at grades up to A.** **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 **Indicative scientific points at level 2 and 3 can include:** **concentration of hydrochloric acid** • idea of increased collision frequency between acid particles and calcium carbonate / more collisions per second between acid particles and calcium carbonate **crushed tablet** • idea of increased collision frequency between acid particles and calcium carbonate / more collisions per second between acid particles and calcium carbonate **Indicative scientific points at level 1 can include:** **concentration of hydrochloric acid** • 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 **crushed tablet** • idea of increased surface area of calcium carbonate or tablet / more calcium carbonate or tablet particles exposed to the acid
			Total	**12**	