PEARSON EDEXCEL GCSE COMBINED SCIENCE (HIGHER) · 1SC0

CHEMISTRY



MARK SCHEME

TOPIC 7: RATES OF REACTION AND ENERGY CHANGES: RATES OF REACTION (PAPER 2)

SCORE	PERCENTAGE
/121	%

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Mark Scheme

Q1.

Question number	Answer	Mark
(a)	Measuring cylinder/burette/pipette	(1)

Question number	Answer	Additional guidance	Mark
(b)	• axes with linear scale that use more than half of each edge of the grid and labelled with units from the table (1). • all points correctly plotted to ± half a square (1). • single straight line passing through all points and the origin (1).	7 points plotted correctly (i.e. one error) (1) allow ecf from plotting error.	(3)

Question number	Answer	Mark
(c)	A	(1)

Question number	Answer	Mark
(d)	Line A on graph: • steeper curve/curve drawn to left of original (1) • levelling off at 82 cm^3 (1)	(2)

(**Q04abcd 1SC0/2CF, SAM 2016**)

Q2.

Question Number	Answer	Additional guidance	Mark
	2H_2O_2(aq) → 2H_2O(**l**) + O_2 (**g**) (2) OR **2**H_2O_2 (1) state symbols l, g (1)	 do not allow first marking point if equation unbalanced allow capital or small letters for state symbols do not allow words for state symbols	**(2)** AO 1 1 AO 2 1

(**Q09 1SC0/2CF, June 2018**)

Q3.

Question Number	Indicative content	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • reactions occur when particle collisions have sufficient energy (activation energy) • reaction rates are increased when the energy collisions is increased • and / or the frequency of collisions is increased • two factors in the reaction have been changed (temperature and concentration of one of the reactants) • experiment 2 was carried out at a higher temperature than experiment 1 • concentrations of reactant are the same in experiment 1 and 2 • particles have more (kinetic energy), so move faster • so there are more frequent collisions between particles in solution **A** solution and solution **B** • collisions will also occur with greater energy • so more collisions will have the minimum activation energy to react when they collide • so greater frequency of successful collisions (so decreased reaction time/increased rate in experiment 2 compared to experiment 1) • experiment 3 was carried out at a higher concentration than experiment 2/ a fourfold increase • temperatures of the reactants are the same in experiment 2 and 3 • there are more reacting particles in the same volume of reaction mixture • so there are more frequent collisions between particles in solution **A** and solution **B** • so greater frequency of successful collisions (so decreased reaction time/increased rate in experiment 3 compared to experiment 2) • reaction rate in experiment 3 is greatest due to combined effects of increased temperature and increased concentration	**(6)** AO 2 2 AO 3 2a

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	• Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3) • The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
Level 2	3-4	• Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3) • The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
Level 3	5-6	• Interpretation and evaluation of the information, demonstrating throughout the skills of synthesising relevant understanding. (AO3) • The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)

(**Q22 1SC0/2CH, June 2018**)

Q4.

Question number	Indicative content	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **method** • measure volume of acid • measure mass of marble chips • mix • in a suitable container e.g. flask / boiling tube / test tube • collect the gas • in a {gas syringe/measuring cylinder over water/ burette over water / graduated tube over water} • measure volume of carbon dioxide • measure time • repeat experiment with different size marble chips • same mass of marble chips • same volume of acid • same concentration of acid • same temperature accept alternative method involving measurements of mass loss **results** • smaller chips (of marble) have a more vigorous reaction ORA • smaller chips take less time to {react/produce a certain volume of gas /have a certain mass loss} ORA • shorter time means faster reaction ORA	**(6)**

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	1-2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) • Presents a description which is not logically ordered and with significant gaps. (AO1)
Level 2	3-4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) • Presents a description of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) • Presents a description that has a well-developed structure which is clear, coherent and logical. (AO1)

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(**Q06b 1SC0/2CF/S2, SAM**)

Q5.

	Answer	Acceptable answers	Mark
	A description to include • smaller pieces have larger surface area / ORA (1) • larger surface area, {higher / faster} rate (1) ORA	small**er** pieces give fast**er** rate (1) ORA allow 'bigger surface area produces more carbon dioxide' (or similarly phrased) for one mark	**(2)**

(**Q24 1SC0/2CF, June 2013**)

Q6.

Question number	Answer	Additional guidance	Mark
	$\frac{15.0}{60.0}$ (1) = 0.25 (1) ($cm^3\ s^{-1}$)	$\frac{60}{15}$ = 4 (1)	**(2)** **AO2**

(**Q01e 1SC0/2CF, Nov 2021**)

Q7.

Question number	Answer	Additional guidance	Mark
	final answer of 0.3 with or without working scores 3 MP1 : conversion of time from minutes into seconds 5 x 60 = 300 (seconds) (1) MP2 : rate = volume / time rate = $\frac{90}{300}$ (1) MP3 : evaluation of the fraction = 0.3 (cm^3 s^{-1}) (1)	 allow 90/5 (1) 90/5 = 18 (2) 300/90 = 3.33 (2) 5/90 = 0.0556 (1)	**(3)**

(**Q02b 1SC0/2CH, Nov 2020**)

Q8.

Question number	Answer	Additional guidance	Mark
(i)	13	answer may be given in table	**(1)** **AO2-1**

Question number	Answer	Additional guidance	Mark
(ii)	An explanation linking • rate of reaction decreases / reaction is slow**er** (1) • as {reactants /acid/ marble chips} are used up (1) • so less frequent collisions (1)	Note: a comparison of the rate of marble chips with that of marble powder is ignored ignore anything about rate increasing at the beginning / starts fast allow (rate of) reaction slows down ignore references to volumes of gas produced ignore reaction stops allow {concentration/amount} of acid decreases / marble chips getting smaller allow {marble chips <u>have</u> / acid <u>has</u>} react**ed** allow less {reactants/ marble chips/ acid} available ignore limiting factor/ reaction is ending allow fewer (successful) collisions ignore less particles have less energy	**(3)** **AO3-2**

(**QU05b 1SC0/2CF, June 2023**)

Q9.

Question number	Answer	Additional guidance	Mark
(i)	13	answer may be given in table	**(1)** **AO2-1**

Question number	Answer	Additional guidance	Mark
(ii)	An explanation linking • rate of reaction decreases / reaction is slow**er** (1) • as {reactants /acid/ marble chips} are used up (1) • so less frequent collisions (1)	Note: a comparison of the rate of marble chips with that of marble powder is ignored ignore anything about rate increasing at the beginning / starts fast allow (rate of) reaction slows down ignore references to volumes of gas produced ignore reaction stops allow {concentration/amount} of acid decreases / marble chips getting smaller allow {marble chips <u>have</u> / acid <u>has</u>} react**ed** allow less {reactants/ marble chips/ acid} available ignore limiting factor/ reaction is ending allow fewer (successful) collisions ignore less particles have less energy	**(3)** **AO3-2**

(**QU01b 1SC0/2CH, June 2023**)

Q10.

Question Number	Answer	Additional guidance	Mark
	• slower • slower • unchanged all 3 rows correct – 2 marks one or two rows correct – 1 mark	may indicate correct answer in any way e.g. by underlining do not credit a row if more than one answer is indicated in a row	**(2)** AO 1 1

(**Q08 1SC0/2CF, June 2018**)

Q11.

Question number	Answer	Additional Guidance	Mark
	a diagram that includes • apparatus that would collect and measure gas using a gas syringe, measuring cylinder or burette (1) • label stating {**gas** syringe / measuring cylinder/ burette} (1)	mark independently ignore seals/blockages MP2 for label, independent of drawing ignore any other labels	(2) AO1 2

(**QU01a 1SC0/2CH, June 2024**)

Q12.

Question number	Answer	Mark
	diagram of • delivery tube with bung in flask connected to (1) • gas syringe / gas syringe labelled (1) or • delivery tube with bung in flask leading into water trough (below upturned measuring cylinder) (1) • upturned measuring cylinder containing water / measuring cylinder labelled (1) allow • connected delivery tube from flask to upturned test tube in water trough (1)	**(2)** **AO1**

(**Q04b 1SC0/2CH, Nov 2021**)

Q13.

Question number	Answer	Additional Guidance	Mark
	a diagram that includes • apparatus <u>that would collect and measure gas</u> using a gas syringe, measuring cylinder or burette (1) • label stating {**gas** syringe / measuring cylinder/ burette} (1)	mark independently ignore seals / blockages MP2 for label, independent of drawing ignore any other labels	**(2)** **AO** **1 2**

(**QU05a 1SC0/2CF, June 2024**)

Q14.

Question number	Answer	Additional guidance	Mark
(i)	stays the same	if no answer on answer line, allow stays the same circled or underlined in box	**AO1 1** **(1)**

Question number	Answer	Additional guidance	Mark
(ii)	**2**H_2O_2 (aq) → 2H_2O (**l**) + O_2 (g) 1 mark for 2 with no other numbers added 1 mark for l	 allow L reject liquid	**AO2 1** **(2)**

(**QU05e 1SC0/2CF, June 2025**)

Q15.

Question Number	Answer	Additional guidance	Mark
(i)	(gas) syringe / graduated tube / burette (instead of measuring cylinder)		(1) AO 3 3b

Question Number	Answer	Additional guidance	Mark
(ii)	final answer in range 0.44 – 0.52 inclusive with or without working (2) If answer not in range: $\frac{\text{difference in volume}}{\text{difference in time}} = \frac{(43 - 15)}{(60 - 0)}$ (1) = 0.47 / 0.467 (1)	allow ecf throughout where values are less than 1 (1 max) use of inverted gradient expression giving 2.27 – 1.92 scores 1 mark (evidence of working required)	(2) AO 2 1

Question Number	Answer	Additional guidance	Mark
(iii)	steeper **curve** to the left of printed curve and same final volume	line must not go above 40 cm^3 and curve back down	(1) AO 2 2

(**Q20 1SC0/2CH, June 2018**)

Q16.

	Answer	Acceptable answers	Mark
	An explanation to include • (substance that) increases rate / speeds up reaction (1) • without being {used up / changed} itself (1)	ignore slows down a reaction lowers activation energy reject provides energy / heat (for 2nd mark)	(2)

(**Q23 1SC0/2CF, June 2013**)

Q17.

Question number	Answer	Additional guidance	Mark
	A description including any two from: • {crush/ break} the large chips (1) • in pestle and mortar (1) • use sieves to separate different sized chips/ sort the chips by size (1)	ignore {cut / chop} them up ignore breaking down by cutting / chopping / tearing / heating etc allow any suitable laboratory apparatus/ tool e.g. hammer ignore domestic equipment e.g. scissors / rolling pin allow leave in acid (to reduce size) for MP2 but MP1 cannot score allow pick out the sizes you need allow repeat the method to get even smaller chips	**(2) AO1 2**

(**QU05c 1SC0/2CF, June 2019**)

Q18.

Question number	Answer	Additional guidance	Mark
	A description including any two from: • {crush/ break} the large chips (1) • in pestle and mortar (1) • use sieves to separate different sized chips/ sort the chips by size (1)	ignore {cut / chop} them up ignore breaking down by cutting / chopping / tearing / heating etc allow any suitable laboratory apparatus/ tool e.g. hammer ignore domestic equipment e.g. scissors / rolling pin allow leave in acid (to reduce size) for MP2 but MP1 cannot score allow pick out the sizes you need allow repeat the method to get even smaller chips	**(2) AO1 2**

(**QU05c 1SC0/2CF, June 2022**)

Q19.

Question number	Indicative content	Mark
	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. A plan to include some of the following points • measure equal masses of zinc using balance • measure equal volumes of acid using measuring cylinder/pipette/suitable named piece of apparatus • pour acid in suitable container • record initial temperature • use of thermometer • add zinc to acid • place bung with delivery tube in container / reaction vessel immediately after the zinc is added • use of timer • start timer on addition of zinc • measure volume of gas evolved using a delivery tube and inverted measuring cylinder/burette over water OR delivery tube and (gas) syringe • record time to collect fixed volume of gas • record final/highest temperature • calculate the temperature increase • repeat for procedure • same initial temperature • same size pieces of zinc • same volume of acid credit use a suitable labelled diagram of apparatus for rate measurement/ temperature of acid	(6)

Level	Mark	Additional Guidance	General additional guidance – the decision within levels Eg - At each level, as well as content, the scientific coherency of what is stated backed up by planning detail will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level1	1–2	Additional guidance Identifies relevant practical operations such as • carries out basic reaction – add zinc to acid • measures at least one of mass, time, volume, temperature	Possible candidate responses • put zinc in test tube and add some acid • find the mass of zinc • measure volume of the acid • carries out basic reaction or measures at least one factor with details scores upper part of level
Level2	3–4	Additional guidance Some correct sequencing of correct operations • carries out basic reaction with dilute acid and repeat with the more concentrated acid and • carries out reaction makes some relevant observation or obtains a result or • measures at least two of mass, time, volume, temperature	Possible candidate responses • put zinc in test tube, add acid and time the reaction • put zinc in test tube, add dilute acid, then repeat experiment and add more concentrated acid • measures mass of zinc and measures volume of acid before adding together • measures temperature of acid before adding to zinc and measures temperature at end of reaction • a similar description, but with detail of apparatus scores the upper part of the level
Level3	5–6	Additional guidance Sequence of operations of an experiment to include two from • measures temperature and volume of acid, and mass of zinc • repeats expt but with more concentrated acid • measure temperature of reaction mixture at end and finds temperature rise	Possible candidate responses • record temperature of 25 cm^3 dilute acid, add to known mass of zinc, record temperature after reaction • using suitable apparatus measure volume of gas every minute • repeat experiment using same conditions but using the more concentrated acid • work out temperature rises for both reactions • descriptions with detail or workable method scores upper part of level

(**Q06b 1SC0/2CF, Nov 2020**)

Q20.

Question number	Indicative content	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO1** **DESCRIPTION** • increases the rate of reaction • does not alter products of reaction • is chemically unchanged by reaction • does not get used up • so catalyst mass does not change **FUNCTION** • particles must have minimum energy for reactions to occur • this is called activation energy • reaction proceeds by an alternative route • which reduces activation energy • so a greater proportion of collisions are successful **DIAGRAM** • reaction profile with catalyst has start and end energies the same • because reactants and products the same (label or in text) • new profile has lower peak • this represents lower activation energy (label or in text) **EXAMPLES** • Haber process to make ammonia uses iron catalyst • cracking to make smaller alkanes uses catalyst • (fermentation) to make alcoholic drinks uses (yeast which contains) an enzyme • hydrogen peroxide decomposition uses catalysts • used in catalytic converters • use of enzymes as biological catalysts	**(6)** **AO1**

Level	Mark	Additional Guidance	General additional guidance – the decision between levels
	0	No rewardable material.	Read whole answer and ignore all incorrect material/ discard any contradictory material then:
Level 1	1-2	Additional Guidance identifies a catalysed reaction describes simply the role of a catalyst or labelling activation energy on the diagram	Possible Candidate Responses • Haber process to make ammonia (uses iron catalyst) • enzymes are catalysts • a catalyst speeds up a reaction but does not get used up
Level 2	3-4	Additional Guidance Two from identifies at least **one** catalysed reaction gives a good description of the role of catalyst describes the function of a catalyst OR draws a labelled reaction profile (or amends that on question)	Possible Candidate Responses Two from: • Haber process to make ammonia (uses iron catalyst) and cracking to make smaller alkanes • a catalyst increases the rate of a reaction without affecting the products; the catalyst is chemically unchanged and its mass remains the same • a catalyst provides an alternative route for a reaction in which the activation energy is lowered so a greater proportion of collisions lead to products OR provides a labelled reaction profile (or amended the one in the question
Level 3	5-6	Additional Guidance Identifies at least **one** catalysed reactions **AND** Gives a good description of the role of catalyst **AND** describes the function of a catalyst **OR** draws a labelled reaction profile (or amends that on question)	Possible Candidate Responses • Haber process to make ammonia uses iron catalyst / cracking to make smaller alkanes a catalyst increases the rate of a reaction without affecting the products; the catalyst is chemically unchanged and its mass remains the same a catalyst provides an alternative route for a reaction in which the activation energy is lowered so a greater proportion of collisions lead to products **OR** provides a labelled reaction profile (or amended the one in the question

Level	Mark	Descriptor
	0	• No awardable content
Level 1	1-2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Deconstructs scientific information but understanding and connections are flawed. An unbalanced or incomplete argument that provides limited synthesis of understanding. (AO3)
Level 2	3-4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Deconstructs scientific information and provides some logical connections between scientific concepts. An imbalanced argument that synthesises mostly relevant understanding, but not entirely coherently (AO3)
Level 3	5-6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Deconstructs scientific information and provide logical connections between scientific concepts throughout. A balanced, well-developed argument that synthesises relevant understanding coherently. (AO3)

(**QU06b 1SC0/2CH, June 2022**)

Q21.

Question number	Answer	Additional guidance	Mark
	6 or 7 points plotted correctly (2) or 4 or 5 points plotted correctly (1) best fit curve starting at (0,0) (1)	allow +/- half a square. for MP3, curve must be a single smooth curved line going through most or all of THEIR plotted points (ecf allowed), or if the points are not visible, through most or all of the correct values. reject curves going above or below 100cm^3 by more than half a square. reject straight line / dot to dot straight lines bar charts – max 2 marks for plotting points if time value is clear	**(3)** **AO2-1**

(**QU05a 1SC0/2CF, June 2023**)

Q22.

Question number	Answer	Additional guidance	Mark
	graph to show • initial line steeper and to the left (1) • line levelling off at 100 cm^3 before 5 minutes (1)	there must be a line from the original line to award these marks. if lines are not labelled, make a reasonable assumption about which is C. mark independently. line should start from start of original line all levelling off within half a square of original line	**(2)** **AO3-2**

(**QU05c 1SC0/2CF, June 2023**)

Q23.

Question number	Answer	Additional guidance	Mark
	graph to show • initial line steeper and to the left (1) • line levelling off at 100 cm^3 before 5 minutes (1)	there must be a line from part (a) to award these marks if lines are not labelled, make a reasonable assumption about which is C mark independently. line should start from start of original line all levelling off within half a square of original line	**(2)** **AO3-2**

(**QU01c 1SC0/2CH, June 2023**)

Q24.

Question Number	Answer	Acceptable answers	Mark
(a)(i)	An explanation linking {the temperature/it} {increased / went up (by 26°C)} (1) (so the reaction is) exothermic (1)	 it got hotter/it gets hot heat (energy){released /given out} ignore incorrect temperature rise do not allow just 'heat increases'	 **(2)**

Question Number	Answer	Acceptable answers	Mark
(a)(ii)	$ZnSO_4$ (1) Cu (1)	allow formulae in either order maximum if additional formulae are included maximum if balancing numbers added do not allow upper case N /superscript 4	 **(2)**

Question Number	Answer	Acceptable answers	Mark
(b)	An explanation linking **First mark – relating concentration to time** (as the concentration/amount of acid increases) the time (taken for the magnesium to react) decreases (1) Ignore any reference to negative correlation Ignore time gets faster/quicker **Second mark – effect on rate** (so){ the rate/it} increases/reaction becomes {faster/quicker} (1) Ignore any reference to positive correlation	Reverse arguments if candidate has related time and rate to decreasing concentration of acid {less/shorter} time	 **(2)**

Question Number		Indicative Content	Mark
QWC	***(c)**	A description including some of the following points **Experiment 1** • measure volume of acid/stated volume • measure mass of marble chips/stated mass • add acid to marble or marble to acid in a suitable container eg flask, beaker, boiling tube, test tube • collect the gas in a {gas syringe/measuring cylinder over water/ tube over water}/bubble gas through limewater/bubble gas through water • measure {amount/volume} of carbon dioxide/count the bubbles/fixed volume of carbon dioxide • measure mass/mass loss (on a balance) • time/measure how long the reaction takes **Experiment 2** • do another experiment with different size marble chips • use the same mass of marble chips • use the same {volume/concentration/mass} of acid/same acid • crush the marble/use powdered marble **Results** • smaller chips (of marble) have a more vigorous reaction/produce more {fizzing/bubbles} ORA • smaller chips take less time to {react/produce a certain volume of gas /have a certain mass loss} ORA • smaller chips have a larger surface area ORA • smaller chips react faster ORA • larger surface gives a faster reaction	**(6)**

Level	**0**	No rewardable content
1	**1 - 2**	• a limited description e.g. crush the marble chips/smaller marble chips give more fizzing • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	**3 - 4**	• a simple description e.g. put marble chips and acid in a flask and repeat with the same mass of small marble chips / collect the gas in a syringe, smaller pieces of marble react faster • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy
3	**5 - 6**	• a detailed description e.g. put marble chips and acid in a flask, repeat the experiment with the same mass of crushed marble, crushed marble takes less time to react • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

(Total for Question = 12 marks)

(**Q06 1SC0/2CF, June 2014**)

Q25.

Question number	Answer	Additional guidance	Mark
	an explanation linking • increases (rate) (1) • (because) lowers activation energy (1)	 allow speeds up (rate) / faster reaction / takes less time (1) allow alternative {pathway / route} (1) allow more {frequent/successful} collisions (1) ignore catalyst doesn't get used up reject particles speed up / have more energy for MP2	**AO1 1 (2)**

(**QU05d 1SC0/2CF, June 2025**)

Q26.

Question number	Answer	Additional guidance	Mark
	an explanation linking • increases (rate) (1) • (because) lowers activation energy (1)	 allow speeds up (rate) / faster reaction / takes less time (1) allow alternative {pathway / route} (1) allow more {frequent/successful} collisions (1) ignore catalyst doesn't get used up reject particles speed up / have more energy for MP2	**(2) AO1-1**

Q27.

Question number	Indicative content	Mark
	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO1 (3 marks) AO3 (3 marks)** • less gas produced with large lumps in same amount of time • therefore, reaction slower ORA • larger lumps have smaller surface area ORA • fewer particles available for reaction • fewer collisions in given time • more gas produced at higher concentration in all experiments • higher concentration there are more particles in same volume • more particles available to react • more frequent collisions • most gas produced in same time with small lumps and highest concentration ORA • therefore, fastest reaction is with small lumps and highest concentration ORA	**(6)**

Level	Mark	Additional Guidance	**General additional guidance** – the decision within levels Eg - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	Additional guidance One statement (1) Two unlinked statements (2) One simple explanation (2)	Possible candidate responses less gas produced with large lumps (1) more gas produced with higher concentration of acid (1) smaller lumps have larger surface area (1) large lumps produced less gas and higher concentration produced more gas (2) the rate of reaction is higher with smaller lumps because they have a larger surface area (2) more gas at a higher concentration because there are more acid particles (2)
Level 2	3–4	Additional guidance Two simple explanations (4) One full explanation including reference to particles and frequency of collisions for either surface area OR concentration (4)	Possible candidate responses less gas with large lumps, reaction is slower due to smaller surface area. more gas at higher concentrations due to more particles (4) more gas at higher concentrations due to more particles having more frequent collisions (4) more gas at higher concentrations due to more particles having more collisions (3) Less gas with large lumps, reaction is slower due to smaller surface area as fewer particles fewer collisions in given time (4) with large lumps, reaction is slower as lower surface area fewer collisions in a given time (4)
Level 3	5–6	Additional guidance One full explanation including reference to particles frequency of collisions AND one simple explanation. The volume of gas must be referred to in at least one part of the answer. (6)	Possible candidate responses Less gas with large lumps, the reaction is slower due to smaller surface area. Fewer particles are available for reaction and fewer collisions in a given time. Whereas more gas is produced with a higher concentration as there are more particles (6) There is more gas produced at higher concentration because at a higher concentration there are more particles, this means that more particles available to react so there are more frequent collisions. Whereas less gas is produced with large lumps because they have a smaller surface area. (6) with large lumps the reaction is slower so less gas is produced because they have a smaller surface area so there are fewer particles available for reaction and fewer collisions. Whereas there is higher rate with a higher concentration as there are more particles in the same volume of solution (5)

(**Q05c 1SC0/2CH, June 2019**)

Q28.

Question number	Answer	Mark
	An explanation that makes reference to: identification – knowledge (1 mark) and reasoning/justification – knowledge (1 mark): • fewer particles/as the reactants are used up there will be fewer particles to react/lower concentration of particles (1) • this will result in a lower frequency of collisions so fewer particles reacting in a given time (1)	**(2)**

(**Q04c 1SC0/2CH, SAM 2016**)

Q29.

Question number	Answer	Additional Guidance	Mark
(i)	An explanation to include • a solid/ precipitate **(1)** • of sulfur **(1)**		**(2)**

Question number	Answer	Additional Guidance	Mark
(ii)	A description to include • flask placed {over/in front of} cross **(1)** • measure time **(1)** • when cross is obscured **(1)**	MP2 dependent on MP1 allow measure how long reaction takes for MP2	**(3)**

Question number	Answer	Mark
(iii)	**B** 150 cm^3 is the only correct answer. **A** is incorrect because this makes 16.7 g dm^{-3} HCl **C** is incorrect because this makes 25.0 g dm^{-3} HCl **D** is incorrect because this makes 33.3 g dm^{-3} HCl	**(1)**

(**Q03a 1SC0/2CH, Nov 2020**)

Q30.

Question Number	Answer	Additional guidance	Mark
	An explanation linking • MP1 : fewer reacting particles left / some particles reacted (1) • MP2 : fewer collisions (1) • MP3 :(fewer) frequent (collisions) (1)	for full marks, reference needs to be made to **particles** in answer allow more particles at the start (than at the end) allow less magnesium / less reactants (1) allow 'less' ignore particle speed allow (fewer collisions) per {second / unit time} {less/fewer} frequent collisions scores MP2 and MP3	**(3)**

(**Q04c 1SC0/2CF, June 2019**)

Q31.

ore frequent collisions/ m

Question number	Answer	Mark
(ii)	**D** use the same metal but in a powdered form is the only correct answer **B** and **C** are incorrect because the reactants are not changed **A** is incorrect because the reaction will be slower	(1) AO2 1

(**QU05b 1SC0/2CF, June 2019**)

Q32.

Question number	Answer	Mark
(ii)	**D** use the same metal but in a powdered form is the only correct answer **B** and **C** are incorrect because the reactants are not changed **A** is incorrect because the reaction will be slower	(1) AO2 1

(**QU05b 1SC0/2CF, June 2022**)

Q33.

Question Number	Answer	Additional guidance	Mark
	An explanation linking • {hydrogen / gas} formed / OWTTE (1) • escapes (from the flask) (1)	 allow released (from the flask) ignore references to magnesium reacting	**(2)**

(**Q04b 1SC0/2CF, June 2019**)

Q34.

Question number	Answer	Additional guidance	Mark
	An explanation linking three of the following • particles have more energy (1) • so (particles) move faster (1) • (so) there are more frequent collisions between particles (1) • higher proportion of collisions have at least the activation energy to react when particles collide (1)	 Allow more kinetic energy for MP1 and MP2 needs to be comparative allow greater chance of collision allow higher {proportion / chance} of collisions are successful / productive allow more particles have activation energy	**(3)**

(**Q02c 1SC0/2CH, Nov 2020**)

Q35.

Question number	Answer	Additional guidance	Mark
	gas syringe	allow upturned burette over water	**(1)** **AO1–2**

(**QU06a 1SC0/2CH, June 2025**)

Q36.

Question number	Answer	Additional guidance	Mark
	(particles) have more energy / (particles) collide more frequently / more successful collisions	allow particles move faster	**(1)** **AO1**

(**Q01d 1SC0/2CF, Nov 2021**)

Q37.

		Indicative Content	
QWC	*	A description / comparison/ explanation / etc including following points **method – what needs to be carried out** • dilute the acid • (to make) different concentrations / stated cor values • add magnesium to acid • in suitable container • equal volumes of the acids • equal lengths of magnesium **observations – to make** • observe/ count bubbles • highest concentration magnesium reacts, lowe	

		concentration magnesium does not react • observe/ time magnesium disappearing • use of timer • measure volume gas produced • measure decrease in mass **conclusion – evidence gathered or seen** • formed bubbles faster • magnesium disappears faster • gas produced faster • mass lost faster	
Level	**0**	No rewardable content	
1	**1 - 2**	• a limited description e.g. add magnesium to acid and time the reaction • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3 - 4**	• a simple description e.g. dilute the acid, add magnesium to both acid solutions and more concentrated one bubbles faster or magnesium reacts quicker • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy	
3	**5 - 6**	• a detailed description e.g. add magnesium to different concentrations of acids in beakers: lower concentration longer time therefore slower reaction • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

(**Q25 1SC0/2CF, June 2013**)

Q38.

Question number	Answer	Mark
	C	**(1)**

(**Q04d 1SC0/2CH, SAM 2016**)

Q39.

Question number	Answer	Mark
	C use a more concentrated acid is the only correct answer **A**, **B** and **D** will have no effect on the speed of reaction	**(1)** **AO1-2**

(**QU05d 1SC0/2CF, June 2023**)

Q40.

Question number	Answer	Mark
	B using acid of a lower concentration is the only correct answer **C** is incorrect because the reactants are not changed **A** and **D** are incorrect because the reaction will be faster	**(1)** **AO1 2**

(**QU05d 1SC0/2CF, June 2024**)