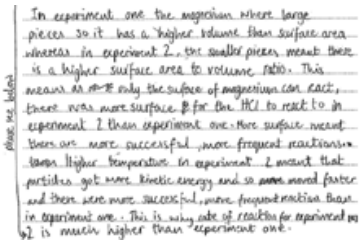
Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1	a	i	(Gas) <u>syringe</u> / (upturned) burette ✓	1 (AO 2.2)	**<u>Examiner's Comments</u>** Most candidates correctly suggested using a gas syringe.
		ii	Idea that marble chips are left over at the end of the reaction / marble chips are in excess✓	1 (AO 2.2)	**IGNORE** idea that hydrochloric acid was used up first **<u>Examiner's Comments</u>** Many candidates stated that the acid would be all used up. Whilst this statement is correct it does not address the question and explain <u>how the student could tell</u> that the acid is the limiting reactant.
	b		Tangent drawn at 60 seconds ✓ Rate = $\frac{\text{y-step}}{\text{x-step}} = \frac{71 - 20}{120}$ ✓ = 0.425 / 0.43 / 0.4 (cm^3/s) ✓	3 (3 x AO 2.2)	**ALLOW ECF** for y-step and x-step from incorrect tangent / attempted tangent **ALLOW** answers in range 0.4 – 0.5 (cm^3/s) **ALLOW ECF** for correct rate from incorrect y-step and x-step **<u>Examiner's Comments</u>** Most candidates were able to construct a tangent at 60 seconds and were then able to use it to determine a rate within the acceptable range. Common errors included using x-step ÷ y-step for the rate or using a single point (usually 46,60) to calculate the rate.
	c	i	Stays the same / **AW** ✓	1 (AO 1.2)	**<u>Examiner's Comments</u>** Most candidates stated that the final volume would stay the same, but 'increase' was a common incorrect answer.
		ii	Stays the same / **AW** ✓	1 (AO 1.2)	**<u>Examiner's Comments</u>** Most candidates stated that the mass of the catalyst would stay the same, but 'decrease' was a common incorrect answer

	d		**Level 3 (5–6 marks)** **Analyses the results to conclude that experiment 2 has the faster rate of reaction and suggests how the experiment could be improved.** **Applies knowledge and understanding to give a detailed explanation, involving both surface area and temperature, why experiment 2 is faster.** *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** **Analyses the results to conclude that experiment 2 has the faster rate of reaction OR suggests how the experiment could be improved AND** **Applies knowledge and understanding to clearly explain the difference in the rate of reaction.** *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** **Analyses the results to conclude that experiment 2 has the faster rate of reaction** **OR** **Suggests how the experiment could be improved OR** **Applies knowledge and understanding to attempt to explain the difference in the rate of reaction.** *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 mark** *No response or no response worthy of credit.*	6 (2 x AO 2.2) (2 x AO 3.2b) (2 x AO 3.3b)	**AO3.2b Analyses information to draw conclusions** • The data shows that experiment 2 has a faster **rate**. **AO2.2 Applies knowledge & understanding to explain results** • Experiment 2 is faster because the magnesium is in smaller pieces (than experiment 1). • Smaller pieces have a larger surface area so there is a higher collision frequency, and the reaction is faster. • Experiment 2 is faster because the temperature of the acid is higher (than experiment 1). • Higher temperature means that the particles move faster / have more energy. • There is a higher frequency of (successful) collisions, and the reaction is faster. **AO3.3b Analyses information to improve experimental procedures** • The experiment could be improved by only changing one variable (size of magnesium / temperature of acid) at a time **<u>Examiner's Comments</u>** This 6 mark Level of Response question assessed AO2 and AO3. At Level 3 (5 – 6 marks) candidates needed to analyse the results to conclude that experiment 2 has the faster rate of reaction and to apply knowledge and understanding to give a detailed explanation, involving both surface area and temperature, why Experiment 2 is faster. Candidates also needed to suggest how the experiment could be improved. Virtually all candidates attempted the question which generated a wide range of responses and differentiated well. Some candidates thought that Experiment 1 had the faster rate of

					reaction,either thinking that 0.0044 was larger than 0.04 or misreading rate for time. Candidates who did notgain Level 3 usually correctly explained that smaller pieces have a larger surface area and a highertemperature would mean the particles had more energy and/or moved faster but did not then go on to explain their ideas in terms of particle collision frequency. Whilst many candidates suggested only having one independent variable as an improvement, many also wrote about repeats, measuring the size ofthe magnesium more accurately, using a larger range of temperatures or changing the concentration of the acid. **Exemplar 3**  This is a Level 2, 4 mark response. The candidate clearly identifies that Experiment 2 is faster than Experiment 1. They have clearly explained the difference in the rate of reaction, but this is not detailed and does not describe increased particle collision frequency. ‘More frequent reactions’ is insufficient. The candidate has alsonot suggested an improvement to the experiment. **OCR support** OCR produces 4 themed chemistry Candidate Exemplars every summer series for you to use with teachers and students: Maths skills, Practical activity, Short answer and Level or Response. Each one includes

					commentary from our examiner team, tips to improve examination technique and help to identify common misconceptions. They are all available on Teach Cambridge.
			Total	**13**	
2			B ✓	1 (AO 2.1)	
			Total	**1**	
3			C ✓	1 (AO 1.1)	
			Total	**1**	
4		i	Yield decreases ✓ (Lower pressure) moves position of equilibrium to the left / favours the backward reaction / **ORA** ✓ As there are more moles or molecules on the LHS / **ORA** ✓	3 (AO 2.1) (2 × AO 1.1)	**ALLOW** yield of CO and H_2 increases **ALLOW** (equilibrium moves) to favour the reactants / to favour CO and H_2 **ALLOW** equilibrium moves to increase the pressure **Examiner's Comments** Many candidates were able to identify that the lower pressure would decrease the yield of methanol, explaining that the position of equilibrium would move to the left as there are more moles/molecules on the left-hand side of the equation. Lower attaining candidates usually explained the lower yield in terms of particle collisions and rate of reaction.
		ii	Idea that the rate of reaction is slow(er) when a lower temperature is used / **ORA** ✓	1 (AO 1.1)	**Examiner's Comments** Most candidates appreciated that the reaction would be slower at 150 °C. Two thirds of candidates were able to respond correctly to this question.
			Total	**4**	
5	a		Idea that the reaction (with magnesium powder) takes less time the more concentrated the (hydrochloric) acid / **AW** ✓	1 (AO 3.1b)	**IGNORE** just quoting data from the table **Examiner's Comments** Most candidates explained that the

					reaction at higher concentration took less time. Lower attaining candidates simply quoted experimental results rather than drawing a conclusion from the data, or explained why the reaction would be faster using particle theory rather than using the results.
	b	i	60 (s) ✓	1 (AO 2.2)	**Examiner's Comments** Most candidates correctly used the graph to deduce the time to be 60s.
		ii	Line drawn above line for magnesium powder ✓ Line follows same general shape as line for magnesium powder ✓	2 (2 × AO 2.2)	**ALLOW** line starting at (0.5, 117) MP2 is dependent on MP1 **Examiner's Comments** Successful responses to this question drew a line above the line for magnesium powder but following the general shape. **Assessment for learning** Some candidates omitted this question. Centres are encouraged to make candidates aware that not all questions have a dotted answer line, e.g. graph questions or table completion.
	c		$2HCl + Mg \rightarrow MgCl_2 + H_2$ Formulae ✓ Balancing ✓	2 (2 × AO 2.2)	**ALLOW** any correct multiple, including fractions **DO NOT ALLOW** and / & instead of '+' Balancing mark is dependent on the correct formulae but **ALLOW** 1 mark for a balanced equation with a minor error in subscripts / formulae e.g., 2HCL + Mg → MgCl2 + h_2 **Examiner's Comments** Most candidates were able to write the correct balanced symbol equation for

					the reaction between hydrochloric acid and magnesium. 1 mark was given for the correct reactants and products and 1 mark for the correct balancing. The balancing mark was dependent on the correct formulae, but 1 mark was allowed for a balanced equation with minor errors in subscripts or formulae. For example, 2HCL + Mg → MgC*l*2 + H_2, would gain 1 mark. When candidates did not gain marks, it was often because they wrote the formula for magnesium chloride as MgC*l*.
			Total	**6**	
6			**B**	1 (AO 2.2)	
			Total	**1**	