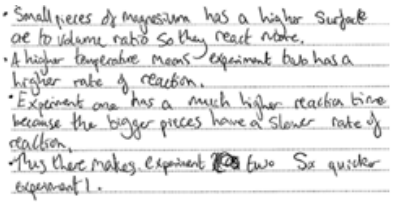
Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1	a		Balance ☐ Beaker ☐ Gas syringe ☑ Pipette ☐	1 (AO 2.2)	**Examiner's Comments** This question was answered well; gas syringe was well known.
	b	i	Linear scale on y-axis so all points can be plotted, with axis numbered ✓ All points plotted correctly scores 2 marks ✓✓	3 (2 x AO 2.2)	**IGNORE** poor choice of axis scale as it is likely to cause problems with the point plotting as well **ALLOW** ± ½ square 3 or 4 points plotted correctly scores 1 mark **Examiner's Comments** Choice of axes and point plotting was generally excellent, the only common mistake being the candidates not plotting the point at 0,0.
		ii	Curve of best fit through all the points ✓	1 (AO 1.2)	**IGNORE** downturn **after** 270 sec, not before **ALLOW** line to miss an occasional point by a square or so. If 2 squares out, should be a clear reason. **DO NOT ALLOW** a bit of double line **DO NOT ALLOW** straight line dot-to-dot except first interval **Examiner's Comments** Candidates also attempted this part very well, drawing a smooth crisp curve that went through all the points. A few did not take their curve down to the 0,0 point, despite it being one of the values in the table, and some took the line above the 80 line to form a hump that then descended.
		iii	240 (s) ✓	1 (AO 2.2)	**ALLOW** ECF **Examiner's Comments**

					This question was well answered, though some candidates went for 270 seconds.
		iv	Idea that all the (dilute hydrochloric) acid was used up / (dilute hydrochloric) acid was the limiting reactant ✓	1 (AO 2.2)	**ALLOW** the reactants are used up, not 'may be' **IGNORE** 'Too many marble chips for the acid to dissolve'/ 'The acid stops giving off CO_2' / 'The marble is used up' **Examiner's Comments** High scoring candidates realised that the acid had been used up, many others made statements about there being no more gas left inside the marble.
	c		**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. **AND** Applies knowledge and understanding to give a detailed explanation 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. **AND** Suggests how the experiment could be improved **OR** applies knowledge and understanding to attempt to explain why experiment 2 is faster. *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**	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 1 is 9 times slower than experiment 2. • The data shows that experiment 2 has a faster **rate** because the reaction **time** is shorter. **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**

			Applies knowledge and understanding to attempt to explain why experiment 2 is faster. *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.		• The experiment could be improved by only changing one variable (size of magnesium / temperature of acid) at a time • But the data shows that experiment 2 is faster than experiment 1. **IGNORE** use a stopwatch **Examiner's Comments** Most candidates correctly linked reaction times to the idea of faster or slower, and many took this further and discussed rate of reaction. Some candidates wrote that the reaction rate was greater when the time was greater. Higher attaining candidates understood the link between the size of the piece and surface area, but elsewhere there was a lot of confusion. Many candidates looked at the particles as individual pieces and stated that the larger pieces had a greater surface area, or that they took longer to break down because there's more to react with. A further feature was the number of candidates who linked size of piece to energy, suggesting that larger pieces require more energy to react, hence Experiment 1 was slower. While those candidates who addressed the effect of varying the temperature often did so very well, there was a lot of confusion over causality, with many candidates stating that the faster reaction causes a temperature increase. A significant minority linked higher temperatures to increased catalytic effect. Most candidates suggested improvements at some level, usually along the lines of 'do the experiment three times'. Candidates with better understanding suggested changing one or both of the variables, and the

					best answers realised that one variable should be held constant while the other one was changed.Some candidates had clearly been exposed to control of variables as a formal concept and wrote 'the variables need to be controlled', though unfortunately they were not always able to translate that statement into improvements for this particular experiment. **Misconception** While large pieces have large surface area as individuals, we don't deal with individual pieces but with the surface area of a collection of them. The surface area of each individual large piece is then swamped by the much greater surface area of the collection of small ones. Exemplar 3  • Small pieces of magnesium has a higher surface ae to volume ratio so they react more. • A higher temperature means experiment two has a higher rate of reaction. • Experiment one has a much higher reaction time because the bigger pieces have a slower rate of reaction. • Thus there makes experiment two 5x quicker experiment 1. The candidate has given a clear description of the experiment and has appreciated that temperature and surface area are two separate variables. They have got surface area the right way round and have made a strong attempt at linking temperature and surface area to rate of reaction. One major part of the question, suggested improvements, has not been addressed, so Level 3 is not a possibility. Also, no mention has been made of collision theory but the rest of this answer makes it a strong Level 2, 4 marks.
			Total	**13**	
2			D ✓	1 (AO 2.2)	**Examiner's Comments**

					The disappearing cross experiment was recognised by the majority of candidates.
			Total	**1**	
3			C ✓	1 (AO 1.2)	**Examiner's Comments** That increasing size would slow the reaction was well understood. Candidates with less understanding often went for option A or B.
			Total	**1**	
4	a		Reaction (with magnesium powder) takes less time (than with magnesium ribbon) / **AW** ✓ For a quoted experiment / for all experiments ✓	2 (2 × AO 3.1b)	Links result to some aspect of the experiment **ALLOW** both times quoted for the same run without saying which is greater **IGNORE** 'the table shows' **Examiner's Comments** Many candidates successfully discussed differences in times, and high scoring candidates went on to link these differences to particular concentrations of acid to gain the second mark. Some responses missed the instruction to 'use the results', and instead discussed the effect of surface area on rate without making any reference to the times, or described how the increase in concentration of acid affected reaction times without referring to the ribbon and the powder. Low scoring candidates often showed their understanding of the question but unfortunately their responses did not take their explanation any further than the information given in the question itself. For example, writing 'the table shows the powder is faster' rather than showing how the table does this.

					Assessment for learning Try to say more than the question is already telling you. The question itself will give you a clue of how to do it.
	b	i	Increases / speeds up / **AW** ✓	1 (AO 3.1a)	**IGNORE** 'time decreases' – this is about rate **Examiner's Comments** A significant number of candidates did not attempt this part. High and medium scoring candidates realised that the rate would increase, but a significant minority appeared to confuse rate with time and suggested it would decrease. **Misconception** Candidates often suggested that an increase in rate was caused by an increase in time.
		ii	Idea that acid particles are more crowded / more particles in the same volume ✓ Idea of more collisions per second / collisions more often / increased collision frequency / more chance of a collision ✓	2 (2 × AO 2.2)	**ALLOW** 'more particles' **ALLOW** 'more acid' **ALLOW** this mark even if first point incorrect e.g., response is written about energy **IGNORE** references to 'faster' collisions **IGNORE** 'more collisions' or 'more successful collisions' without time inference **Examiner's Comments** Most candidates appreciated that there would be more particles in the same space, gaining the first mark. However, arguing that this would lead to more collisions was not enough to gain the second mark. Higher scoring candidates discussed the effect on collision frequency.

					There was a significant number who argued that the increase in concentration would mean the particles moved faster and had more energy, and another group who suggested that increased concentration would slow the reaction down. A small group assumed that higher concentrations slowed reactions, either because there were more particles to react or because they became more crowded so couldn't move around as easily. **Misconception** Increase in concentration does NOT affect particle speed. The only factor which affects particle speed is temperature. **Misconception** Increasing the number of collisions is an insufficient explanation of an increase in rate, it should be increased chance/frequency of collision.
	c		Idea that the mass of the gas is too small (to measure accurately) ✓	1 (AO 3.3b)	**IGNORE** 'won't be accurate' **IGNORE** 'gas won't weigh anything' **IGNORE** 'difficult to measure' without explaining why **<u>Examiner's Comments</u>** While this question was found to be very challenging, and few candidates realised that it would be difficult to measure such a small mass change, all the responses showed thought on the part of candidates. Most candidates appeared to visualise the problem as how to weigh the gas evolved rather than how to measure

					the change in mass during the reaction, so there were often suggestions along the lines of 'you can't catch all the gas'. Other responses showed more basic misunderstandings such as 'you can't use mass to find rate' or 'we only know the mass loss, not the time it took'. General responses such as 'it won't be accurate' did not gain credit as examiners were looking for the reason the inaccuracy might be there.
			Total	**6**	
5		i	**Any two from:** Group 1 metals have a lower density ✓ lower melting point ✓ lower boiling point ✓ are softer ✓ are less strong / hard-wearing ✓ Both Group 1 metals and transition metals conduct electricity ✓ **AND** Group 1 metals are more reactive ✓	3 (2 × AO 2.1) (AO 1.1)	Assume unqualified answer refers to Group 1 metals **ALLOW ORA** for transition metals **ALLOW** transition metals form coloured compounds / variable valency / catalysts **IGNORE** incorrect or uncertain statements for properties not on the list e.g., 'shinier' Must be a comparison between Group 1 and Transition metals, not an individual element **ALLOW ORA** for transition metals **<u>Examiner's Comments</u>** A large number of candidates did not attempt this question, so were unable to gain any marks. The question asked candidates to compare, so it was essential that they discussed both transition metals as well as Group 1. Many suggested that Group 1 metals have higher boiling points and don't conduct electricity.
		ii	Substance that speeds up a reaction ✓ (But) is not used up in the reaction / not chemically changed ✓	2 (2 × AO 1.1)	**ALLOW** speeds up reaction time **DO NOT ALLOW** doesn't take part in the reaction **IGNORE** slows down reaction, it's

					very much a lesser property. **IGNORE** activation energy arguments **Examiner's Comments** Most candidates knew that catalysts speed up reactions, and higher scoring candidates went on to say that they are not used up. **Assessment for learning** There are almost always 2 marks available for a catalyst definition, one for 'speeds up the reaction' and the other for 'and are not used up/are recoverable'.
			Total	**5**	
6			**C**	1 (AO 1.2)	**Examiner's Comments** Nearly two-thirds of candidates gained this mark. That particles had more energy when warm was well understood.
			Total	**1**	