Question	Answers	Extra information	Mark	AO / Specification reference
01.1	increases reaction rate by providing a pathway with a lower activation energy		1	AO1 4.6.1.4
01.2	B		1	AO1 4.6.1.4
01.3	$2H_2O_2 \rightarrow 2H_2O(l) + O_2$	one mark for balancing one mark for state symbols	2	AO1 4.2.2.2 4.3.1.1
01.4	it is a catalyst/regenerated at the end		1	AO1 4.5.1.2
02.1	half points plotted correctly all points plotted correctly points plotted at (0,0) (30,21) (60,38) (90, 52) (120, 58) (150, 61) (180 61)		1 1	AO2 4.6.1.1
02.2	line of best fit correctly drawn	must be a curve	1	AO3 4.6.1.1
02.3	rate = gradient of tangent drawn at 100 $= \frac{18}{80}$ = 0.225 = 0.23 (cm^3/s)		1 1 1 1	AO2 4.6.1.1

Question	Answers	Extra information	Mark	AO / Specification reference
02.4	concentration of acid is less at 100 seconds		1	AO3 4.6.1.1
03.1	start the timer and add the acid at the same time		1	AO3 4.6.1.2
03.2	the temperature will be the actual temperature at which the reaction occurs		1	AO3 4.6.1.2
03.3	judging exactly when the cross disappears varies slightly from person to person		1	AO3 4.6.1.2
03.4	the one at 45 °C		1	AO2 4.6.1.2
03.5	as temperature increases, rate also increases		1	AO1 4.6.1.2
03.6	increasing the temperature increases the frequency of collisions more particles have energy above the activation energy		1 1	AO1 4.6.1.3
04.1	one of the products (carbon dioxide) is a gas which escapes from the flask		1	AO1 4.3.1.3

Question	Answers	Extra information	Mark	AO / Specification reference
04.2	do not remove the paper because doing this makes the mass lower than it would be as a result of loss of carbon dioxide gas alone		1 1	AO3 4.6.1.2
04.3	the smaller the calcium carbonate pieces, the faster the reaction powder has the highest surface area to volume ratio so collisions are more frequent		1 1 1	AO1 × 1 AO2 × 2 4.6.1.2 4.6.1.3
05.1	hydrogen		1	AO1 4.4.2.1
05.2	decreasing the acid concentration		1	AO1 4.6.1.2
05.3	rate decreases		1	AO1 4.6.1.2
06.1	$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$	one mark for formulae and state symbols of reactants one mark for formulae and state symbols of reactants **or** one mark for correct formulae one mark for correct state symbols one mark for balancing	3	AO2 4.4.3.5
06.2	**Level 3:** The variables are correctly identified and the account is clearly written and well-structured.		5-6	AO1 × 2

Question	Answers	Extra information	Mark	AO / Specification reference
	Level 2: The variables are mainly correct, although there might be one or two errors. The account is written fairly clearly, and may be somewhat disorganised.		3-4	AO2 × 2 AO3 × 2 4.6.1.1 4.6.1.2
	Level 1: One or two of the variables are correctly identified. The account is not written clearly, and consists of isolated points rather than one coherent piece of work.		1-2	
	No relevant content.		0	
	Indicative content • temperature increased/size of pieces decreased/acid concentration increased/surface area of magnesium increased • because in P, more gas is produced in a given time at first (than Q) • kept constant: correct two from: acid concentration, size of magnesium pieces, acid concentration • because these are the control variables • kept constant: mass and volume of both substances/amount of limiting reactant • because total volume of hydrogen gas produced is the same			
07.1	move delivery tube so that its end is not in the acid to avoid acid going up the delivery tube	allow other suitable reasons	1 1	AO3 4.6.1.2
07.2	$\frac{91}{5}$ = 18.2 = 18 cm^3/min		1 1 1	AO2 4.6.1.1

Question	Answers	Extra information	Mark	AO / Specification reference
07.3	increase powder has bigger surface area		1 1	AO3 4.6.1.4
08.1	half points plotted correctly all points plotted correctly line of best fit drawn		1 1 1	AO2 AO3 4.6.1.2
08.2	100,65		1	AO3 4.6.1.2
08.3	more reactant particles at the start of the reaction greater frequency of collisions as reaction progresses, more reactant particles become product particles therefore frequency of collisions		1 1 1 1	AO1 4.6.1.3
08.4	tangent drawn at 60 seconds gradient of tangent calculated		1 1	AO2 AO3 4.6.1.1
09.1	**Level 3:** The method is clear and variables are correctly explained.		5-6	AO1 4.6.1.2
	Level 2: The method is clear but variables are absent or incorrect OR the method is attempted but not clear and some variables correctly provided.		3-4	
	Level 1: Either an unclear method (perhaps with some steps missing) or a few variables correctly identified.		1-2	
	No relevant content		0	

Question	Answers	Extra information	Mark	AO / Specification reference
	Indicative content • put nitric acid into conical flask • prepare a bung with gas syringe attached • add sodium carbonate • put bung in as soon as sodium carbonate is added • measure time taken to produce a set volume of carbon dioxide/measure the volume of carbon dioxide produced in set time • repeat with different concentrations of nitric acid control variables: • same mass of sodium carbonate used • same surface area sodium carbonate/always use solid pieces or powder • same volume of nitric acid used independent variables: • concentration of nitric acid dependent variables: • rate/volume of CO_2	accept an upside-down measuring cylinder as an appropriate method accept a method that involves measuring the change in mass of sodium carbonate		
09.2	as the concentration of nitric acid increases, the rate of reaction increases. the higher the concentration the more acid particles are available so frequency of successful collisions will increase		1 1 1	AO1 AO3 4.6.1.2

Question	Answers	Extra information	Mark	AO / Specification reference
09.3	cm^3/s		1	AO2 4.6.1.1
09.4	$\frac{500}{42} = 11.904$ = 11.9		1 1	AO2 4.6.1.1
09.5	catalyst/temperature		1	AO2 4.6.1.2
10.1	increase the number of hydrochloric acid particles so frequency of collisions increased		1 1	AO1 4.6.1.3
10.2	particles move faster so increases the frequency of collisions increases the energy of the particles so more particles have energy greater than the activation energy so more collisions are successful		1 1 1 1	AO1 4.6.1.3
10.3	time on x-axis, turbidity on y-axis curve starts high and decreases higher temperature has steeper curve both curves finish at the same point		1 1 1 1	AO2 4.6.1.2

Question	Answers	Extra information	Mark	AO / Specification reference
11.1	$2H_2(g) + 4OH^-(aq) \rightarrow 4H_2O(l) + 4e^-$	one mark for formulae and state symbols of reactants one mark for formulae and state symbols of reactants **or** one mark for correct formulae one mark for correct state symbols one mark for balancing	3	AO1 4.5.2.2
11.2	$O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$	one mark for formulae and state symbols of reactants one mark for formulae and state symbols of reactants **or** one mark for correct formulae one mark for correct state symbols one mark for balancing	3	AO1 4.5.2.2
11.3	fuel cells do not need to be electrically recharged, but rechargeable batteries do no pollutants are produced at the pint of use from either type of cell hydrogen is highly flammable, but the substances in rechargeable batteries are not hydrogen is difficult to store	accept other sensible suggestions	1 1 1 1	AO3 4.5.2.1 4.5.2.2

Question	Answers	Extra information	Mark	AO / Specification reference
12.1	no atoms/mass are lost or made during a chemical reaction so the mass of products is equal to the mass of reactants		1 1	AO1 4.3.1.1
12.2	$Pb(NO_3)_2(aq) + 2NaI(aq) \longrightarrow PbI_2(s) + 2NaNO_3(aq)$	one mark for formulae and state symbols of reactants one mark for formulae and state symbols of reactants **or** one mark for correct formulae one mark for correct state symbols one mark for balancing	3	AO2 4.4.3.5
12.3	M_r of lead iodide = 207 + 127 +127 = 461 6.68 g of lead iodide is $\frac{6.68}{461}$ = 0.014 mol 0.014 mol of lead iodide made from (0.014 x 2 =) 0.028 mole sodium iodide M_r of sodium iodide = 23 + 127 = 150 150 x 0.028 = 4.2 g		1 1 1 1 1	AO1 × 2 AO2 × 3 4.3.2.2
13.1	fluorine – 2,7 neon – 2,8		1 1	AO2 4.1.1.7
13.2	Group 7 – atoms have 7 electrons in outer shell; reactive because atoms gain one electron in reactions to achieve full outer shell/stable electronic structure Group 0 – atoms have full outer shell; unreactive because this arrangement is stable		1 1	AO1 4.1.2.4 4.1.2.6

Question	Answers	Extra information	Mark	AO / Specification reference
13.3	increases from top to bottom of both groups	1	1	AO1 4.1.2.4 4.1.2.6
14.1	buckminster fullerene	allow 'buckyball'	1	AO1 4.2.3.3
14.2	both – three covalent bonds per carbon atom graphite – giant layer structure buckminsterfullerene – spherical structure		1 1 1	AO1 4.2.3.2 4.2.3.3
	two from • high boiling point • hard • does not conduct electricity explanation for hard and high boiling point: each carbon atom forms four covalent bonds with other carbon atoms in a giant covalent structure explanation for does not conduct electricity: no charged particles that are free to move	one mark for each correct property (maximum of two) one mark for each correct explanation (maximum of two)	4	AO1 4.2.3.1