Separate Science (Chemistry) Unit 6 Rate and extent of chemical change – mark scheme

Foundation

Question number	Description	Marks	Page number
4.6.1 Rate of reaction			
1	Naming equipment multiple choice, observations to show reaction taking place between magnesium and hydrochloric acid, placing results into results table, calculating rate of reaction from a graph using equation and giving unit, determine time when reaction finished from graph, rate of reaction multiple choice	14	4
3	Balancing symbol equation, apparatus to measure volume of hydrochloric acid, completing results table with headings and results, suggest reason for results lower than expected, giving control variables, rate of reaction gap fill	12	5
5	Matching variables and examples, naming compound symbol formulae, suggesting how to improve method, calculating rate of reaction using equation in question, identifying unit for rate of reaction, plotting results on graph and line of best fit, surface area multiple choice	11	7
7	(4.8.2 gas test for oxygen), repeatable and accuracy multiple choice based on method, reading values on graph and calculating gradient using equation, sketching rate of reaction line on graph, rate of reaction surface area multiple choice	10	9
7	Reading measurement on gas syringe, control variables multiple choice, calculate mean from results table, plotting results onto graph, reading values from graph to calculate rate of reaction, describing rate of reaction graph, rate of reaction multiple choice (4.8.2 gas tests)	17	10
4.6.2 Reversible reactions and dynamic equilibrium			
1	Copper sulphate reversible reaction multiple choice, conservation of mass (g) calculations, compound symbol formulae matching with names multiple choice	8	12
6	Reversible reaction symbol, reading balance and calculating mass of water and copper sulphate in results table, reading	7	13

	measurement on a thermometer (4.5.1 exothermic multiple choice)		

Common content

Question number	Description	Marks	Page number
4.6.1 Rate of reaction			
3	States of matter symbols, pieces of apparatus for measuring rate of production of hydrogen gas, plotting results onto graph and line of best fit, giving conclusions on rate of reaction from results table and graph, multiple choice on rate of reaction when changing temperature	11	14

Higher

Question number	Description	Marks	Page number
4.6.1 Rate of reaction			
5	Ionic equation for magnesium and hydrochloric acid reaction, plotting results onto graph and line of best fit, describing changes in rate of reaction, explaining why rate of reaction changes	11	15
5	Completing symbol equation between calcium carbonate and hydrochloric acid, describing trend in graph, describing how to calculate the rate of reaction for curved part of line, give units for rate of reaction, conclusion from results table, reason for maximum volume of gas produced, calculate surface area of cube, explaining why surface area affects rate of reaction, explaining difference in rate of reaction graph for different concentrations of acids	17	16
5	Explain why sodium thiosulphate reaction becomes cloudy, plan investigation between sodium thiosulphate and hydrochloric acid (6 marks)	8	19
6	Equipment for measuring volume of hydrogen produced, drawing and completing results table for experiment, calculating rate of reaction for point on curved line and answer to two significant figures, explaining why rate of reaction is increased at higher temperatures	11	20

8	Explain why conical flask loses mass when gas produced in a reaction, plotting results onto a graph, calculating rate of reaction for point on curved line and answer to two significant figures	9	21
9	(4.8.2 test for oxygen), improvements to method multiple choice, calculating mean rate of reaction from graph to two significant figures, sketching line on rate of reaction graph, explain how surface area affects rate of reaction	11	22
4.6.2 Reversible reactions and dynamic equilibrium			
4	(4.7.1 products of cracking, explain why shorter chain alkene has lower boiling point), explain how changing pressure affects percentage yield for reversible reaction graph, evidence from graph that forward reaction is exothermic, (4.5.1 reaction profile), suggest why catalyst does not affect yield at equilibrium	13	24
6	(4.8.2 test for oxygen), explaining the effect of removing product on position of equilibrium, **calculate the mass of product from balanced symbol equation and mass of one reactant**	8	26
6	(4.8.2 test for chlorine), explain why equilibrium is reached in closed system, explain what happens to equilibrium when closed system is opened, predict and explain effect on product of increasing temperature of reversible reaction, explain the effect on equilibrium of increasing pressure of reversible reaction	12	28
9	Moles in symbol equation multiple choice, explain the effect on yield when temperature in reversible reaction is increased, explain why higher pressure gives greater yield and rate of reaction in reversible reaction, explain how catalyst increases rate of reaction, effect of catalyst on equilibrium	12	29

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	hydrogen		1	AO1 4.7.3.1
01.2	conical flask		1	AO1 4.7.4.1
01.3	any **two** from: • bubbles • magnesium becomes smaller • level of water in measuring cylinder goes down	allow magnesium disappears allow change in temperature	2	AO2 4.7.3.1
01.4	(heading) volume (unit in heading) (in) cm^3 values for time (from 0 to 120)		1 1 1	AO2 4.7.4.1
01.5	replace magnesium ribbon with magnesium powder		1	AO1 4.7.4.2
01.6	$\frac{28}{10}$ = 2.8 cm^3/s	an answer of 2.8 cm^3/s scores **3** marks an answer of 2.8 scores **2** marks allow volume readings in range 28–29 cm^3 allow answer correctly calculated from incorrect volume reading	1 1 1	AO2 4.7.4.1
01.7	59 (s)	allow values in range 58–60 s	1	AO2 4.7.4.1
01.8	particles collide more often particles have more energy		1 1	AO1 4.7.4.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	2	allow multiples of whole equation	1	AO2 5.1.1.1 5.3.1.1 5.6.1.1 10.2.11
03.2	50 cm^3 measuring cylinder		1	AO3 5.6.1.1 10.2.11
03.3	headings: time **and** volume (of gas) units: s **and** cm^3 time values correct (and match units) volume values match time values	allow in either column allow any units of time and volume placed in relevant column ignore incorrect representation of time values if no other marks awarded allow **1** mark for time with correct units or volume with correct units	1 1 1 1	AO2 5.6.1.1 10.2.11
03.4	any **one** from: • concentration of the acid was lower (than expected) • some (gas) escaped • impure magnesium • temperature lower (than expected)	answers must relate to figure 4 ignore answers relating to amount or surface area or time	1	AO3 5.6.1.2 10.2.11

03.5	any **two** from: • length of magnesium or surface area of magnesium • volume of acid • temperature (of acid)	 allow mass of magnesium allow same form of magnesium allow same size of magnesium ignore concentration of hydrochloric acid ignore room temperature	2	AO2 5.6.1.2 10.2.11

03.6	increased particles frequently	allow went up allow got bigger allow ions or molecules ignore concentration allow often	1 1 1	AO1 5.6.1.2 5.6.1.3 10.2.11

Total			**12**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	lines from: • independent to size of marble chips • control to volume of acid	ignore arrowheads do **not** accept if more than one line from one box	 1 1	AO2 AO3 5.6.1.2
05.2	calcium chloride carbon dioxide water	all three needed for **2** marks allow **1** mark if two correct do **not** accept carbon oxide do **not** accept hydrogen oxide	2	AO2 5.1.1.1 5.3.1.3
05.3	stops loss of acid	allow stops loss of water / liquid allow to ensure that only the gas escapes do **not** accept stops acid evaporating do **not** accept stops gas / CO_2 / water vapour escaping	1	AO3 5.6.1
05.4	0.053	allow 0.05 allow 0.053333… do **not** accept 0.052 ignore units	1	AO2 5.6.1.1
05.5	g/s		1	AO1 5.6.1.1

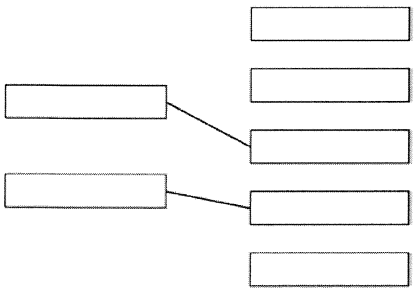
Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	all points correctly plotted	allow **1** mark for 5 points correctly plotted allow ± ½ a small square	2	AO2 5.6.1.1
	line of best fit	should be a curve nearer to (10,0.8) than the anomaly (20, 0.6) and through all other points if plotting incorrect allow **1** mark for appropriate line of best fit through student's points	1	AO3 5.6.1.1
05.7	the eight small marble chips have a larger surface area, so more frequent collisions		1	AO3 5.6.1.2 5.6.1.3
Total			**11**	

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	a glowing splint		1	AO1 4.8.2.2
07.2	student **A** should measure the mass of manganese dioxide.		1	AO3 4.6.1.1 4.6.1.2
07.3	calculate a mean but do not include any anomalous results.		1	AO3 4.6.1.1 4.6.1.2
07.4		an answer of 0.173 (cm^3/s) scores **4** marks		AO2 4.6.1.1
	(volume of oxygen formed =) (58 - 20 =) 38 (cm^3)	allow values between 36 (cm^3) and 40 (cm^3) inclusive	1	
	(time taken = 250 – 30 =) 220 (s)		1	
	$\frac{38}{220}$ **or** 0.1727 (cm^3/s)	allow a correct calculation using an incorrectly determined value for volume and / or time	1	
	= 0.173 (cm^3/s)	allow a correctly calculated answer given to 3 significant figures from an incorrect attempt at the rate equation	1	
07.5	line starts at the origin **and** steeper than existing line		1	AO2 4.6.1.1
	final volume same as existing line	allow a tolerance of ± ½ a small square	1	
07.6	fine manganese dioxide powder has a larger surface area		1	AO3 4.6.1.2 4.6.1.3
Total			**10**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	83 (cm^3)	allow 83.0 / 83.00	1	AO2 4.6.1.2
07.2	mass of magnesium powder temperature of hydrochloric acid		1 1	AO1 4.6.1.2
07.3	 $\frac{(46 + 47 + 49)}{3}$ = 47 (cm^3) (2 sf)	an answer of 47 (cm^3) scores **2** marks allow 47.3(333) (cm^3) for **1** mark an answer of 43 (cm^3) scores **1** mark	 1 1	AO2 4.6.1.1 4.6.1.2
07.4	all points plotted correctly (inc 0,0)	allow a tolerance of ± ½ a square allow ecf from question **07.3** ignore line allow **1** mark for four points plotted correctly	2	AO2 4.6.1.1 4.6.1.2
07.5	 $\frac{80}{50}$ = 1.6 (cm^3/s)	an answer of 1.6 (cm^3/s) scores **2** marks allow 80 ± 2 allow 1.60 ± 0.04	 1 1	AO2 4.6.1.1
07.6	rate is greatest at start (then) rate decreases reaction stops	allow rate is faster at start allow (then) rate slows down	1 1 1	AO2 4.6.1.1 4.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.7	there are more particle collisions each second there are more particles in the same volume		1 1	AO1 4.6.1.3
07.8	(gas is) not carbon dioxide	ignore does not react with limewater	1	AO3 4.8.2.3
07.9	hydrogen pop sound	allow H_2	1 1	AO1 4.8.2.1
Total			**17**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	reactant		1	AO1 4.6.2.1
01.2	reversible		1	AO1 4.6.2.1
01.3	blue	allow shades of blue, eg pale blue	1	AO1 4.6.2.2
01.4	1.6 (g)		1	AO2 4.6.2.2
01.5	$\frac{0.9}{2.5} \times 100$ = 36 (%)	an answer of 36 (%) scores **2** marks	1 1	AO2 4.6.2.2
01.6		copper sulfate – $CuSO_4$ water – H_2O	1 1	AO2 4.1.1.1 AO1 4.1.1.1
Total			**8**	

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	⇌	allow description of the reversible sign	1	AO1 4.7.4.8
06.2	(**X**) 0.81 (g)		1	AO2 4.7.4.8
	(**Y**) 0.45 (g)	allow correct subtraction using an incorrect value for **X**	1	
06.3	to make sure all the water was removed		1	AO3 4.7.4.8
06.4	a reaction that gives out energy to the surroundings		1	AO1 4.7.3.3
06.5	18 (°C)		1	AO2 4.7.3.3
06.6	increases		1	AO2 4.7.3.3
Total			**7**	

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	(aq)	allow aqueous / aq	1	AO1 4.2.2.1 4.2.2.2
03.2	(gas) syringe	allow measuring cylinder (and water trough) allow balance	1	AO1 4.6.1.1
	stopclock / stopwatch	allow timer / clock / watch	1	
03.3	all points plotted correctly	allow a tolerance of ± ½ a small square allow at least 3 points plotted correctly for **1** mark.	2	AO2 4.6.1.1
	line of best fit	allow correctly drawn line of best fit for incorrectly plotted points	1	
03.4	(rate) decreases	allow slows down	1	AO3 4.6.1.1
	(rate decreases) more slowly as time increases	allow (rate decreases) at a non-linear rate	1	
	(rate) becomes zero at 60 s	allow the reaction stops at 60 s allow ecf from question **03.3**	1	
03.5	more bubbles were produced in the first 10 seconds		1	AO2 4.6.1.2
	the magnesium was used up more quickly		1	
Total			**11**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	$Mg + 2H^+ \rightarrow Mg^{2+} + H_2$		1	AO2 5.6.1.2 5.1.1.1
05.2	electron transfer		1	AO2 5.11
05.3	all points correctly plotted	allow a tolerance of ± ½ a small square allow **1** mark for at least 4 points correctly plotted	2	AO2 5.6.1.1
	line of best fit		1	
05.4	(rate) decreases	allow (rate is) fastest at the beginning	1	AO3 5.6.1.1
	(rate decrease) more slowly as time increases (in rate)		1	AO3 5.6.1.1
	(rate) becomes zero at time read from graph	allow reaction stops at time read from graph	1	AO3 5.6.1.1
05.5		Incorrect reference to energy scores **max. 1**		AO2 5.6.1.3
	(rate decreases because) fewer particles (of acid / magnesium) as reaction progresses	allow (rate decreases because) concentration of acid decreases as reaction progresses	1	AO1 5.6.1.3
	(so) less frequent collisions	allow collisions less likely ignore less / fewer collisions	1	AO2 5.6.1.3
	reaction stops due to limiting factor / reagent	allow reaction stops because a reactant is used up	1	5.3.2.4
Total			**11**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	$CaCl_2$ + CO_2 + H_2O	products in any order	1	AO2 5.1.1.1
	balancing: **2** (HCl)	dependent on correct formulae for products	1	5.6.1.2
05.2		values must be approximately correct		AO2 5.6.1.1
	value from graph used to show volume increase	must include a time or volume value	1	
	values from graph used to show the volume increases less rapidly	must include time interval or volume increment	1	
	volume **or** time stated when graph line levels off	allow levels off at 60 (cm^3) **or** 28 to 30 s allow descriptions in terms of rate of reaction	1	
05.3	draw tangent at <u>15 s</u>	allow draw a straight line on the curve at <u>15 s</u>	1	AO2 5.6.1.1
	calculate gradient	allow correct description of gradient calculation ignore calculations if given	1	
05.4	centimetres cubed per second	allow cm^3/s **or** $cm^3\ s^{-1}$ (all lower case) allow mixture of abbreviations and words, eg centimetres cubed/s do **not** accept non-SI abbreviations (eg sec for s)	1	AO1 5.6.1.1
05.5	(rate) increases as chips get smaller	allow converse	1	AO3 5.6.1.1 5.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	same amount of acid **or** same number of moles of acid	allow same volume of acid allow same concentration of acid allow same mass of $CaCO_3$ / marble chips allow one reactant is the limiting factor	1	AO3 5.3.2.4 5.6.1.1
05.7		an answer of 24 (cm^2) scores **2** marks		AO2 5.6.1.2
	(surface area of each face = 2 × 2 =) 4		1	
	(6 × 4 =) 24 (cm^2)	allow 6 × student's value from step 1	1	
05.8	small(er) chips have large(r) surface area (for the same volume)	allow converse	1	AO3 5.6.1.2 5.6.1.3
	so more frequent collisions	allow more chance of collisions allow more likely to collide do **not** accept reference to speed of particles or energy of collisions ignore more collisions ignore more successful collisions	1	AO1 5.6.1.2 5.6.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.9		allow converse for more concentrated acid		AO2 5.6.1.2 5.6.1.3
	(sloping part is less steep because) reaction is slower		1	
	due to less frequent collisions	do **not** accept reference to speed of particles or energy of collisions ignore fewer collisions	1	
	fewer acid particles (in same volume)	ignore weaker acid	1	
	or (sloping part is less steep because) reaction is slower (1)			
	there are fewer acid particles (in same volume) (1)			
	(graph levels off lower) so less gas is produced (1)			
Total			**17**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	sulfur (formed) (which is a) precipitate	allow S / S_8 (formed) allow (which is a) solid allow (which is) insoluble	1 1	AO2 4.2.2.2
05.2	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.		5–6	AO1 4.6.1.2
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.		3–4	
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.		1–2	
	No relevant content		0	
	Indicative content **method** • measure (indicated) volume of sodium thiosulfate • place sodium thiosulfate in (conical) flask • measure (indicated) volume of hydrochloric acid • place on cross **or** between light sensor **or** connect to a gas syringe **or** other suitable method for timing a change • add hydrochloric acid to (conical) flask • swirl • start stopclock / stopwatch • measure time for cross to become no longer visible **or** log light transmission over time **or** measure time for fixed volume of gas to be produced • repeat and find mean • repeat for different concentrations of sodium thiosulfate **or** change ratio of sodium thiosulfate volume : water volume **control variables** • concentration of hydrochloric acid • volume of hydrochloric acid • (total) volume of sodium thiosulfate solution			
Total			**8**	

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	(gas) syringe	allow description of displacement of water in a measuring cylinder	1	AO1 4.7.4.1
06.2	(table headings + units)			AO2 4.7.4.1
	time in s(econds) **and** volume (of gas) in cm^3		1	
	values for times		1	
	(from 0 to 120 seconds)	allow **1** mark if otherwise correct but 0,0 not included		
	values for volumes		1	
	(from 0 to 79 cm^3)			
06.3		an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps		AO2 4.7.4.1
	correctly drawn tangent at 30 s		1	
	correct value for x step **and** y step from tangent	allow evidence of use of two points on tangent either on the graph or in the text	1	
	(rate =) $\frac{\text{value for y step}}{\text{value for x step}}$	allow correct expression using incorrectly determined values from tangent for x step and / or y step	1	
	correctly calculated and rounded to 2 significant figures	allow a correctly calculated answer to 2 significant figures from an incorrect attempt at rate determination	1	
06.4	particles have more energy	allow particles move faster	1	AO1 4.7.4.3 4.7.4.4
	(so) frequency of collisions increases	allow (so) more collisions per unit time	1	
		allow more likelihood of collisions		
		ignore more collisions		
	(and) more particles have the necessary activation energy		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	a gas is produced	allow carbon dioxide is produced do **not** accept an incorrect gas	1	AO2 4.3.1.3 4.6.1.1
	(which) escapes	**max 1** mark if evaporation mentioned	1	
08.2	all eight points plotted correctly	allow a tolerance of ± half a small square. allow six or seven points plotted correctly for **1** mark	2	AO2 4.6.1.1
	line of best fit		1	
08.3		an incorrect answer for one step does not prevent allocation of marks for subsequent steps		AO2 4.6.1.1
	correctly drawn tangent at 0.95 g		1	
	correct value for x step **and** y step from tangent	allow evidence of use of two points on tangent either on the graph or in the text	1	
	(rate =) $\frac{\text{value for y step}}{\text{value for x step}}$		1	
	correctly evaluated and rounded to 2 sig figs	allow (rate =) $\frac{\text{value for x step}}{\text{value for y step}}$ (ie inverted division) correctly evaluated and rounded to 2 sig figs	1	
Total			**9**	

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	glowing splint	do **not** accept burning splint	1	AO1 4.8.2.2
	(which) relights	dependent on correct test in MP1 ignore with a pop	1	
09.2	place the conical flask in a water bath at constant temperature.		1	AO3 4.6.1.2
	use a mass of 1 g manganese dioxide each time.		1	
09.3		an answer of 0.092 (cm^3/s) scores **3** marks allow an answer of 0.091666 (cm^3/s) correctly rounded to at least 2 significant figures for **2** marks allow an answer of 0.033 (cm^3/s) for **2** marks allow an answer of 0.033333 (cm^3/s) for **1** mark		AO2 4.6.1.1
	11 (cm^3) **and** 120 (seconds)		1	
	(mean rate of reaction = $\frac{11}{120}$) = 0.09167	allow a correct calculation using incorrectly determined value(s) for difference in volume and / or time	1	
	= 0.092 (cm^3/s)	allow a correctly calculated answer given to 2 significant figures from an incorrect attempt at the rate equation	1	

09.4	line starts at origin **and** less steep than solid line		1	AO2
	line levelling off at 40 (cm^3)	allow a tolerance of ± ½ a small square	1	AO3 4.6.1.2
09.5	(because) surface area (of fine manganese dioxide powder) greater	allow converse for coarse lumps	1	AO2 4.6.1.2 4.6.1.3
	(so) more collisions (with hydrogen peroxide molecules / particles) per unit time	do **not** accept references to changes in kinetic energy or speed (of molecules / particles) ignore references to activation energy.	1	
Total			**11**	

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	C_3H_6		1	AO2 4.5.2.1 4.8.1.4
04.2	smaller molecule	allow shorter (hydrocarbon) chain allow smaller hydrocarbon if MP2 obtained	1	AO2
	(so) fewer intermolecular forces	do **not** accept fewer covalent bonds	1	AO1 4.6.2.5 4.8.1.4
04.3	yield increases as pressure increases (because) fewer (gas) molecules as products (so) equilibrium moves to right / products	allow converse argument	1 1 1	AO2 4.7.4.8 4.7.4.10
04.4	the yield increases when temperature is decreased	allow converse statements	1	AO2 4.7.4.8 4.7.4.10

04.5	reaction profile showing exothermic reaction		1	AO1
	labelling of activation energy	allow correct labelling of activation energy if endothermic reaction shown	1	AO1
	second profile drawn with different activation energy	in each profile reactants level and products level must be the same	1	AO2
	correct distinction between catalyst and no catalyst		1	AO1 4.7.4.4 4.7.4.6
04.6	increases the rate of the forward and reverse reaction	allow changes the rate of the forward and reverse reaction	1	AO3 4.7.4.6 4.7.4.9
	by the same amount		1	
Total			**13**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	glowing splint relights		1 1	AO1 5.8.2.2
06.2	equilibrium shifts to right-hand side (because) concentration of SO_3 decreases	allow towards the products allow in favour of the forward reaction this marking point is dependent on first marking point being awarded allow pressure decreases allow to increase the concentration of SO_3 allow to re-establish equilibrium	1 1	AO3 AO2 5.6.2.5 5.6.2.7
06.3	(M_r CaO =) 56 (M_r $CaSO_3$ =) 120 $\frac{7}{56} \times 120$ = 15(.0 g)	an answer of 15(.0 g) scores **4** marks in all approaches allow a correct calculation using an incorrectly calculated M_r **alternative approach A** (M_r CaO =) 56 (1) $\frac{7}{56}$ = 0.125 (moles) (1) (mass $CaSO_3$ =) 0.125 × 120 (1) = 15(.0 g) (1)	1 1 1 1	AO2 5.3.1.2 5.3.2.1 5.3.2.2

		alternative approach B (M_r CaO =) 56 (1) $\frac{56}{7}$ = 8 (factor) (1) (M_r $CaSO_3$ =) 120 (1) $\frac{120}{8}$ = 15(.0 g) (1) **alternative approach C** (M_r CaO =) 56 (1) (M_r $CaSO_3$ =) 120 (1) $\frac{120}{56}$ = 2.14235714 (factor) (1) 2.14235714 × 7 = 15(.0 g) (1)		

Total			**8**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	damp / moist litmus paper	ignore colour of litmus paper	1	AO1 5.8.2.4
	bleaches / goes white		1	
06.2	forward and reverse rates equal		1	AO1 5.6.2.1 5.6.2.3
	because no escape of reactants or products	allow closed system allow particles for reactants or products	1	AO2 5.6.2.1 5.6.2.3
06.3	equilibrium shifts	allow no longer in equilibrium	1	AO3 5.6.2.3 5.6.2.4 5.6.2.5 5.6.2.7
	to right-hand side	allow in favour of forward reaction	1	
	to produce more of any products **or** to reduce any reactants	allow correct references to Le Chatelier's Principle	1	
	(new) equilibrium will be established		1	
06.4	amount of chlorine gas increases		1	AO2 5.6.2.4 5.6.2.6
	(because) system shifts to counteract the change	allow (because) system shifts to take in energy allow (because) system shifts in endothermic direction	1	AO1 5.6.2.4 5.6.2.6
06.5	no change		1	AO2 5.6.2.4 5.6.2.7
	because equal numbers of molecules **or** moles (of gas) on each side		1	AO1 5.6.2.4 5.6.2.7
Total			**12**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	enzyme		1	AO2 4.6.1.4
09.2	2.0×10^3 moles		1	AO2 4.3.2.1
09.3	smaller yield (because) favours endothermic reaction	allow less methanol is produced allow (because) favours reverse reaction allow equilibrium / reaction shifts to the left allow equilibrium / reaction shifts to reduce the temperature ignore reference to forward reaction is exothermic ignore references to rate	1 1	AO2 4.6.2.4 4.6.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4		allow converse arguments		AO2 4.6.1.3 4.6.2.4 4.6.2.7
	(yield) equilibrium position moves to the product side	allow equilibrium / reaction moves to the right allow equilibrium / reaction shifts to reduce the pressure	1	
	(because) fewer molecules / moles / particles on product side	allow (because) fewer molecules / moles / particles on the right allow (because) smaller volume on product side	1	
	(rate) more collisions per unit time	allow increases collision frequency / rate ignore more collisions alone ignore faster collisions do **not** accept any indication of more energetic / forceful collisions	1	
	(because) more molecules / particles per unit volume	allow (gas) molecules / particles closer together ignore more molecules / particles alone	1	
09.5	provides different reaction pathway	allow provides a different mechanism / route	1	AO1 4.6.1.4
	(which has a) lower activation energy	ignore references to collisions	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.6	less energy is needed	allow reduces the temperature required allow reduces costs ignore references to pressure ignore references to rate or time	1	AO2 4.6.1.4
09.7	no effect / change		1	AO3 4.6.1.4 4.6.2.3
Total			**12**	