AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.5.1.1

Energy transfer during exothermic and endothermic reactions

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**20**
Available paper years	**2018–2025**

Using this booklet

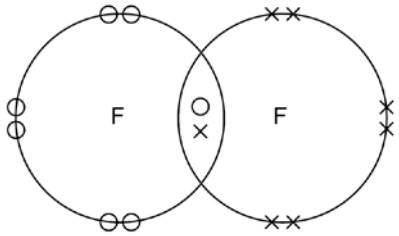
1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

Name: _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 01 · Mark scheme June 2018 | 8464/C/1F | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	group 7		1	AO1 5.1.2.6
02.2		one shared pair anywhere in overlap between two circles **or** on intersection 6 other electrons on each atom allow dots **or** crosses **or** mixture for all marks ignore any inner shell electrons	1 1	AO2 5.1.2.6 5.2.1.4
02.3	bromine potassium chloride	allow correct chemical formulae either order	1 1	AO2 5.1.1.1 5.1.2.6
02.4	displacement		1	AO1 5.1.2.6
02.5	(an) electron		1	AO2 5.1.2.6
02.6	smaller than		1	AO2 5.1.2.1 5.1.2.6

5.5.1.1 Energy transfer during exothermic and endothermic reactions

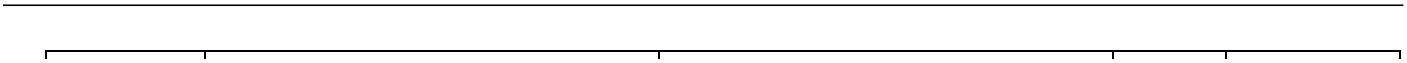
Answer 01 · Mark scheme

02.7	(chlorine has) fewer levels / shells (of electrons)	mark independent of answer to question **02.6** allow converse for bromine allow (chlorine has) fewer electrons allow Cl has 3 levels / shells and Br has 4 levels / shells ignore atomic number **or** mass number **or** number of protons	1	AO2 5.1.2.1 5.1.2.6
02.8	3	allow multiples	1	AO2 5.1.1.1 5.1.2.6
02.9	there are weak forces between molecules which require little energy to overcome / break	do **not** accept weak bonds allow weak intermolecular forces for the first **2** marks allow does not need much energy to boil	1 1 1	AO1 5.1.2.6 5.2.2.4 AO1 5.1.2.6 5.2.2.4 AO2 5.1.2.6 5.2.2.4
Total			**13**	

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 01 · Mark scheme

June 2018 | 8464/C/1F | Original Q2



5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 02 · Mark scheme June 2018 | 8464/C/1F | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	B		1	AO2 5.1.2.1
04.2	calcium oxide **or** CaO carbon dioxide **or** CO_2	either order	1 1	AO1 5.1.1.1 5.3.1.3
04.3	decomposition		1	AO1 5.3.1.3
04.4	endothermic		1	AO1 5.5.1.1
04.5	32 (g)	allow 31–33 (g)	1	AO2 5.3.1.3
04.6	 $\frac{32}{5.2} \times 24$ 148 (g) **or** uses graph eg 12 dm^3 gives 74 (g) (1) (then factors up so that 24 dm^3 gives) 148 (g) (1)	an answer of 148 (g) scores **2** marks allow ecf from question **04.5** allow a range 143–153 (g) allow a range 143–153 (g)	 1 1	AO3 5.3.1.3

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 02 · Mark scheme

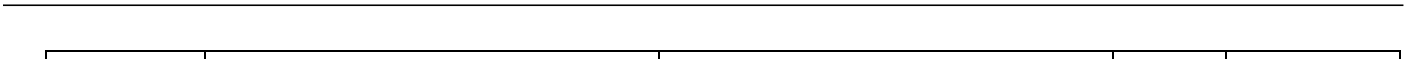
June 2018 | 8464/C/1F | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7		mark mistakes and calculation independently		AO3 5.3.1.3
	(mistakes) increase in mass = 3 (not 4)	allow mistakes in either order	1	
	inserted numbers inversely into formula	allow numbers wrong way round	1	
	(calculation)	an answer of 250 scores the **2** calculation marks	1	
	gradient = $\frac{750}{3}$	allow $\frac{1000}{4}$		
	250 (cm^3 per g)	if no calculation marks awarded allow $\frac{750}{3}$ **or** 187.5 **or** $\frac{3}{750}$ **or** 0.004 for **1** mark	1	
04.8		an answer of 24 scores the **3** calculation marks		AO2 5.3.1.2 5.3.1.3 5.1.1.5
	3 × 16 or 48		1	
	(48) + 12 or 60	allow their mass of oxygen + 12	1	
	84 − (60) **or** 24	allow 84 − their mass of carbonate	1	
	magnesium **or** Mg	magnesium **or** Mg without working scores this mark	1	
Total			**16**	

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 02 · Mark scheme

June 2018 | 8464/C/1F | Original Q4



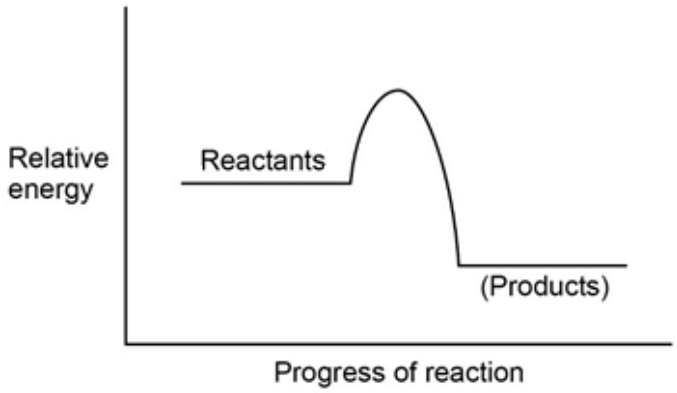
5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 03 · Mark scheme June 2018 | 8464/C/1F | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	(difference) sodium has one and chlorine has seven electrons in outer level / shell **or** number of electrons	number of electrons must be correct if quoted	1	AO2 5.1.1.7 5.1.2.1
	(similarity) both have three / same number of levels / shells **or** have electrons in third level / shell **or** both have incomplete (outer) levels / shells	allow both have 2 electrons in inner shell **or** both have 8 electrons in second shell **or** both are one electron away from full outer level / shell	1	
06.2		allow marks from suitable diagram(s)		AO1 5.2.1.2
	sodium (atom) loses	allow moves / transfers for loses do **not** accept sodium ion loses	1	
	one (outer shell electron)		1	
	chlorine (atom) gains	do **not** accept chloride	1	
	one (electron)		1	
		transfer of 1 electron from chlorine to sodium **max 2** marks		
		reference to sharing **or** covalent bonding **max 3** marks		

5.5.1.1 Energy transfer during exothermic and endothermic reactions

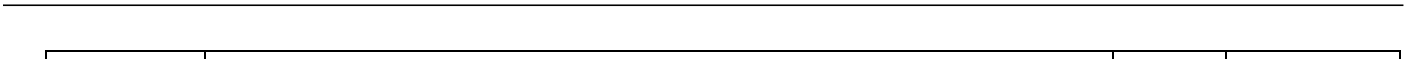
Answer 03 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3		ignore labels any curve / line going up and then down products line below reactants allow curve to start / finish anywhere along reactant / product lines	1 1	AO1 5.5.1.2
Total			**8**	

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 03 · Mark scheme

June 2018 | 8464/C/1F | Original Q6



5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 04 · Mark scheme June 2019 | 8464/C/1F | Original Q1

01.1	sports injury pack		1	AO1 5.5.1.1
01.2	B		1	AO1 5.5.1.2
01.3	C		1	AO1 5.5.1.2
01.4	lower than		1	AO1 5.5.1.2
01.5	thermometer		1	AO1 5.5.1.2
01.6	27.4 (°C) (27.4–14.3 =) 13.1 (°C)	allow values in the range 27.2–27.5 (°C) allow correct subtraction of incorrect temperature reading	1 1	AO2 5.5.1.1
Total			**7**	

5.5.1.1 Energy transfer during exothermic and endothermic reactions

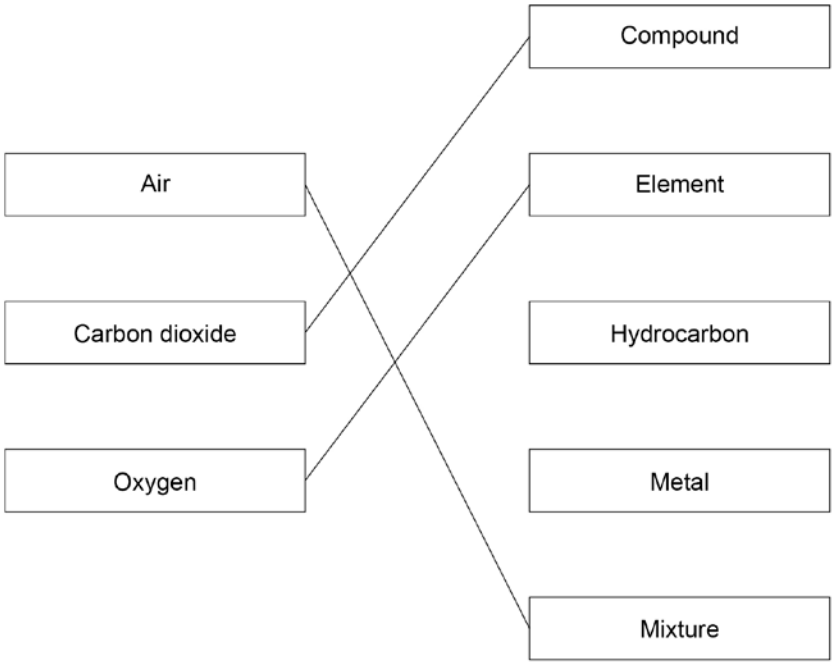
Answer 04 · Mark scheme

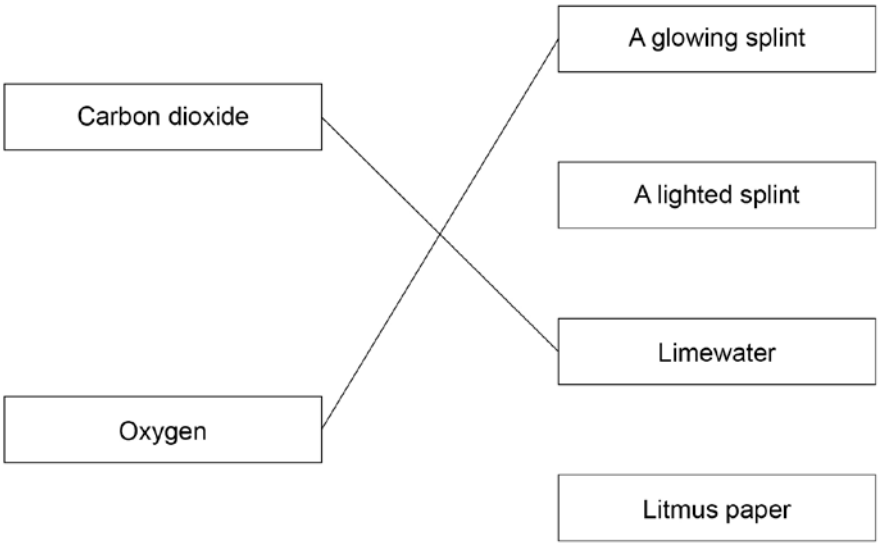
June 2019 | 8464/C/1F | Original Q1

Question	Answers	Extra information	Mark	AO / Spec.

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 05 · Mark scheme June 2019 | 8464/C/2F | Original Q1

01.1	 If more than one line is drawn from any one substance and not crossed out, no mark is given for that substance. The other marks can be awarded.	1 1 1	AO2.1 5.1.1.2 5.8.1.1 5.1.1.1

01.2	 If more than one line is drawn from any one gas and not crossed out, no mark is awarded for that gas. The other mark can be awarded.	1 1	AO1.1 5.8.2.2 5.8.2.3

01.3	dissolved in oceans photosynthesis		1 1	AO1 5.9.1.2 5.9.1.4

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 05 · Mark scheme

01.4	⇌	ignore any other words, formulae or symbols	1	AO1.1 5.6.2.1
01.5	endothermic (reaction)	spelling must be correct do **not** accept exothermic	1	AO1.1 5.6.2.2
01.6	rate (of reaction)	allow speed or velocity do **not** accept any other response	1	AO1 5.6.2.3
Total			**10**	

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 05 · Mark scheme

June 2019 | 8464/C/2F | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 06 · Mark scheme November 2020 | 8464/C/1F | Original Q2

02.1	21.1 (°C) 14.4 (°C)	 allow correct use of an incorrect start temperature	1 1	AO2 5.4.1.2 5.5.1.1 RPA 10

02.2	any **two** from: • surface area of metal • 25 cm^3 / volume of copper sulfate solution • concentration of copper sulfate solution • mass / 1 g of metal	 ignore amount ignore temperature ignore stirring	2	AO2 5.4.1.2 5.5.1.1 RPA 10

02.3	$\frac{9.2 + 9.5 + 9.2}{3}$ **or** $\frac{27.9}{3}$ = 9.3 (°C)	 if no other mark awarded allow **1** mark for 8.8 (°C)	1 1	AO3 AO2 5.4.1.2 5.5.1.1 RPA 10

5.5.1.1 Energy transfer during exothermic and endothermic reactions

02.4	(metal **A** / zinc) is less reactive (than magnesium) **or** (metal **A** / zinc) is lower in reactivity series **or** change in temperature is lower (with metal **A** / zinc)	allow converse	1	AO3 5.4.1.2 5.5.1.1 RPA 10
02.5	stays the same		1	AO3 5.4.1.2 5.5.1.1 RPA 10
02.6	too dangerous **or** too reactive	allow potassium would react with water	1	AO2 5.1.2.5 5.4.1.2 5.5.1.1 (RPA 10)
02.7	$\frac{25}{100} \times 1.8$ **or** $\frac{1}{4} \times 1.8$ = 0.45 (g)		1 1	AO2 5.3.2.5 RPA 10
Total			**11**	

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 06 · Mark scheme

November 2020 | 8464/C/1F | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 07 · Mark scheme November 2020 | 8464/C/2F | Original Q4

04.1	water oxygen	ignore H_2O ignore O_2	1 1	AO1 5.1.1.1
04.2	concentration of hydrogen peroxide mass of catalyst		1 1	AO3 5.6.1.4
04.3	42 (cm^3)		1	AO2 5.6.1.4
04.4	all five points correctly plotted line of best fit drawn	allow a tolerance of ± ½ a small square allow **1** mark for 3 / 4 points correctly plotted	2 1	AO2 5.6.1.4

5.5.1.1 Energy transfer during exothermic and endothermic reactions

04.5	(for the best catalyst) curve is steepest (at the beginning) **or** highest (initial) gradient **or** greatest volume of gas in stated time		1	AO3 5.6.1.1 5.6.1.2
04.6	same volume / concentration of hydrogen peroxide (used)	ignore amount allow catalyst does not affect volume	1	AO3 5.6.1.1 5.6.1.2
04.7	the particles have more energy there are more particle collisions per second		1 1	AO1 5.6.1.2 5.6.1.3
Total			**12**	

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 07 · Mark scheme

November 2020 | 8464/C/2F | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 08 · Mark scheme November 2020 | 8464/C/2F | Original Q7

Question	Answers	Mark	AO / Spec. Ref.
07.1	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO3 5.6.1.2
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the plan 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: • use a measuring cylinder / pipette / burette to measure 50 cm^3 of sodium thiosulfate • use a different measuring cylinder / pipette / burette to measure 10 cm^3 of hydrochloric acid • start the timer when the acid is added • record the temperature of the solution after the acid is added • stop the timer when the cross is no longer visible • record the temperature of the solution at the end of the reaction • calculate the mean temperature of the reaction • repeat the experiment at different temperatures • use the same concentration of sodium thiosulfate and same concentration of hydrochloric acid • use the same volume of sodium thiosulfate and the same volume of hydrochloric acid • describe how to heat the thiosulfate / acid solutions		

5.5.1.1 Energy transfer during exothermic and endothermic reactions

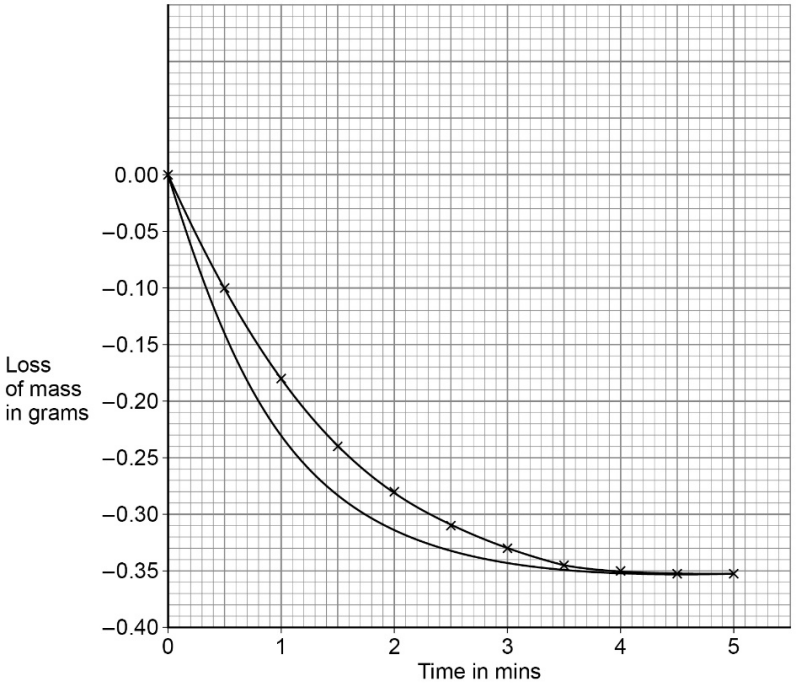
Answer 08 · Mark scheme

November 2020 | 8464/C/2F | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	(change in mass of gas =) 0.15 **and** (time =) 2	ignore signs	1	AO2 5.6.1.1 5.6.1.4
	(rate of reaction =) $\frac{0.15}{2}$	allow correct use of incorrectly determined values for mass and / or time	1	
	0.075 (g/min)		1	

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 08 · Mark scheme

07.3	curve starts at same point, to the left and steeper line levels at −0.35 g the curve below can be awarded 2 marks  	1 1	AO2 5.6.1.1 5.6.1.2 5.6.1.4

Total			**11**

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 09 · Mark scheme

November 2021 | 8464/C/1F | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	any **three** from: • use a (glass) beaker **or** use a polystyrene cup • insulate the metal container • add a lid • measure copper sulfate solution with a pipette • use same volume (of copper sulfate solution) • use a more accurate balance • stir (the mixture) • record the initial **and** the highest temperature • use a digital thermometer **or** use a more accurate thermometer • repeat the experiment **and** calculate the mean (ignoring anomalous results)		3	AO3 5.5.1.1
05.2	72 (cm^3)		1	AO2 5.4.3.1 5.4.3.4 RPA9
05.3	exothermic		1	AO2 5.5.1.2

5.5.1.1 Energy transfer during exothermic and endothermic reactions

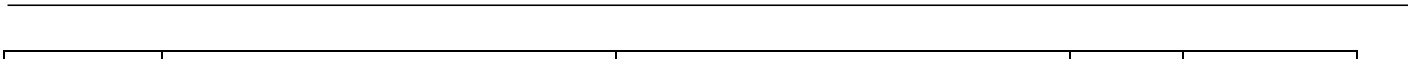
Answer 09 · Mark scheme

05.4	(increase in temperature =) 50 (°C) increase in mass = 6 (g) (gradient =) $\frac{50}{6}$ = 8.33 (°C per g)	 allow a value in the range 5.8 – 6 (g) allow correct use of incorrectly determined value(s) for temperature and/or mass 	1 1 1 1	AO2 5.4.3.1 5.4.3.4 RPA9
05.5	extends line on graph to 10 g of zinc any **one** from: • temperature (change) of 84 (°C) • (so the solution will be) too hot • (so the solution will be) over 100 (°C) • (so the solution will) boil	 allow a temperature (change) over 80 (°C) 	1 1	AO2 AO3 5.4.3.1 5.4.3.4 RPA9
Total			**11**	

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 09 · Mark scheme

November 2021 | 8464/C/1F | Original Q5



5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 10 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec.
06.1	**independent** concentration (of hydrochloric acid)		1	AO1 5.6.1 RPA11
	control any **one** from: • temperature (of hydrochloric acid) • volume of (hydrochloric) acid • length of magnesium • surface area of magnesium	allow same mass of magnesium allow same form of magnesium ignore amount	1	
06.2	all points correctly plotted	allow a tolerance of ± ½ a small square allow 1 mark for 4 or 5 points correctly plotted	2	AO2 5.6.1 RPA11
	line of best fit	must include 0,0	1	
06.3	the rate decreases		1	AO3 5.6.1 RPA11
06.4	the magnesium reacted more quickly		1	AO3 5.6.1.2

5.5.1.1 Energy transfer during exothermic and endothermic reactions

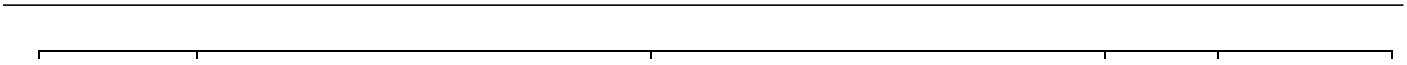
Answer 10 · Mark scheme

06.5	rate increases (because) particles have more energy (so) more frequent collisions	allow reaction happens faster allow (because) particles move faster allow (because) more particles have energy greater than the activation energy	1 1 1	AO1 5.6.1.2 5.6.1.3
Total			**10**	

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 10 · Mark scheme

November 2021 | 8464/C/2F | Original Q6

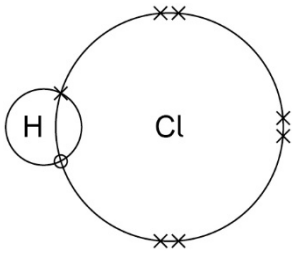


5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 11 · Mark scheme

June 2022 | 8464/C/1F | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	one shared pair in overlap	allow any combination of circles, dots, crosses or $e^{(-)}$	1	AO1 5.1.2.6 5.2.1.4
	6 non-bonding electrons in outer shell of chlorine	do **not** accept extra electron(s) on outer shell of hydrogen ignore any inner shell electrons	1	
		an answer of  scores **2** marks		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	sodium chloride	allow NaCl	1	AO2 5.4.2.2

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 11 · Mark scheme

June 2022 | 8464/C/1F | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	5.85 (g)		1	AO2 5.3.1.1 5.4.2.2 5.5.1.1 RPA10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	17.6 (°C)		1	AO2 5.4.2.2 5.5.1.1 RPA10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	exothermic (reaction)	allow neutralisation (reaction)	1	AO2 5.5.1.1 RPA10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	Na^+ OH^-		1 1	AO1 AO2 5.4.2.2 5.4.2.4 5.5.1.1

Total Question 2		**8**

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 12 · Mark scheme

June 2022 | 8464/C/1F | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	any **three** from: • green solid / powder • colourless solution • blue solution formed • copper carbonate disappears • fizzing / effervescence **or** bubbles (of gas) • stops fizzing • solid / powder left at the end **or** copper carbonate left at the end	 ignore green copper carbonate allow colour (of solution) changes allow solid disappears ignore gas allow fizzing slows down allow (container) gets hot **or** allow temperature increases	3	AO2 AO3 5.4.2.2 5.4.2.3 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	filtration **or** filter		1	AO1 5.4.2.3 RPA8

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 12 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	7		1	AO1 5.4.2.3 5.4.2.4 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	neutralisation	allow exothermic	1	AO1 5.4.2.2 5.4.2.4 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	83 (g at 80 °C)	allow a value in range 82–84 (g at 80 °C)	1	AO2
	32 (g at 20 °C)	allow a value in range 32–33 (g at 20 °C)	1	AO2
	(83–32 =) 51 (g)	allow a correct calculation using incorrectly read values for mass at 80 °C and/or 20 °C	1	AO3 5.4.2.3

Total Question 5		**9**

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 13 · Mark scheme

June 2022 | 8464/C/1F | Original Q7

Question 7

Question	Answers	Mark	AO / Spec. Ref.
07	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO3
	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	AO3
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	AO1
	No relevant content.	0	
	Indicative Content • measure volume of (hydrochloric) acid • into a suitable container eg polystyrene cup • measure the initial temperature (of hydrochloric acid) • with a thermometer • add stated mass of one metal • stir • measure the highest temperature reached of the solution **or** measure temperature reached after a set time period • determine the temperature difference • repeat • repeat for each metal • with same mass • in same physical state (powder, lump, etc) • with the same volume and / or concentration of (hydrochloric) acid • use results to arrange metals in order of reactivity • most reactive metal has the largest temperature change to access level 3 there must be an indication of how the temperature change is determined with the same mass of the 3 different metals reacted with the same volume of (hydrochloric) acid		5.1.4.2 RPA2

Total Question 7		**6**

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 14 · Mark scheme

June 2022 | 8464/C/2F | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	hydrogen chloride	allow hydrochloric acid	1	AO1 5.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	(g)		1	AO1 5.2.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	⇌	allow reversible sign / arrow	1	AO1 5.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	exothermic		1	AO1 5.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	rate		1	AO1 5.6.2.3

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 14 · Mark scheme June 2022 | 8464/C/2F | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	C		1	AO1 5.6.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.7	any **one** from: • increases rate of reaction • reduces energy required • lower temperature can be used		1	AO1 5.6.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.8	formulation		1	AO1 5.8.1.2

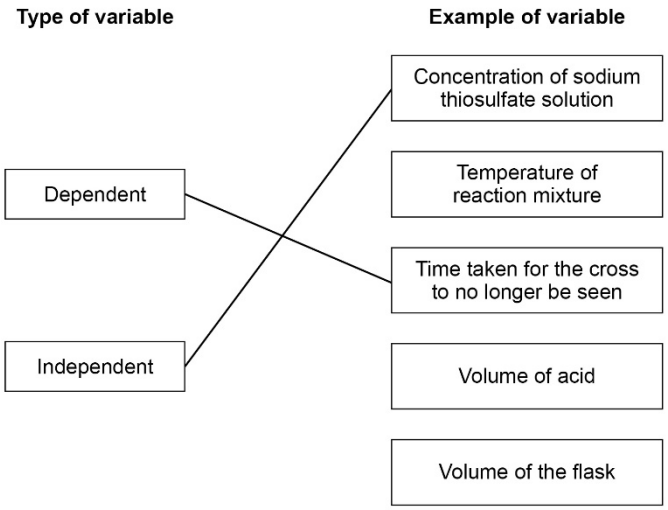
Total Question 3		**8**

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 15 · Mark scheme

June 2022 | 8464/C/2F | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	 do **not** accept more than one line from a box on the left		1 1	AO2 5.6.1.1 RPA11

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	19.5 (°C)		1	AO2 5.6.1.2 RPA11

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	all points correctly plotted line of best fit	allow a tolerance of ± ½ a small square allow **1** mark for 3 / 4 / 5 points correctly plotted	2 1	AO2 5.6.1.1 RPA11

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 15 · Mark scheme

June 2022 | 8464/C/2F | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	7 (s)	allow ecf from question **04.3** allow a tolerance of ± ½ a small square	1	AO3 5.6.1.1 RPA11

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	decreases		1	AO2 5.6.1.1 RPA11

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	(mean =) $\frac{0.725}{20}$ = 0.03625	 ignore units	1 1	AO2 5.6.1.1 RPA11

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7	g/s		1	AO1 5.6.1.1 RPA11

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 15 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.8	(mean =) $\frac{60.5 + 63.2 + 65.7}{3}$ = 63.13333 (s)	allow for **1** mark $\frac{60.5 + 63.2 + 65.7 + 82.3}{4} = 67.925$	1 1	AO3 AO2
	= 63.1 (s)	allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses the values in the question	1	AO2 5.6.1.1 RPA11

Total Question 4		**14**

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 16 · Mark scheme

June 2023 | 8464/C/1F | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	thermometer		1	AO1 5.4.1.2 5.5.1.1 RPA10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	measuring cylinder		1	AO1 5.4.1.2 5.5.1.1 RPA10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	(**Y** =) $\frac{7.6 + 7.3 + 7.6}{3}$ **or** $\frac{22.5}{3}$ = 7.5 (°C)	allow for **2** marks (**Y** =) $\frac{7.6 + 7.6}{2}$ = 7.6 (°C)	1 1	AO2 5.4.1.2 5.5.1.1 RPA10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	(temperature increase =) $\frac{0.40}{1.2} \times 9.0$ = 3.0 (°C)		1 1	AO2 5.4.1.2 5.5.1.1 RPA10

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 16 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	exothermic		1	AO1 5.5.1.1 RPA10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	copper did not react (with zinc sulfate) **or** copper is less reactive (than zinc)	allow copper is less reactive (than magnesium)	1	AO3 5.4.1.2 5.5.1.1 RPA10

Total Question 2	**8**

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 17 · Mark scheme

June 2024 | 8464/C/1F | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	independent		1	AO1 5.4.1.2 5.5.1.1 RPA10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	zinc sulfate	allow $ZnSO_4$	1	AO2 5.4.1.2 5.5.1.1 RPA10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3		ignore references to temperature / fizzing		AO2 5.4.1.2 5.5.1.1 RPA10
	solution becomes colourless	allow solution changes colour	1	
	(brown / orange) solid produced	allow zinc changes colour	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	(highest temperature =) 36 (°C)		1	AO2 5.4.1.2 5.5.1.1 RPA10
	(temperature increase = 36 – 21 =) 15 (°C)	allow correct use of an incorrectly determined value for highest temperature ignore minus sign	1	

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 17 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	(**B** =) $\frac{7.8 + 7.3 + 7.7}{3}$ **or** $\frac{22.8}{3}$ = 7.6 (°C) **OR** (**B** =) $\frac{7.8 + 7.7}{2}$ **or** $\frac{15.5}{2}$ (1) = 7.75 (°C) (1)	allow 7.8 (°C) if working shown for calculation of the mean using 7.8 and 7.7 (°C)	1 1	AO2 5.4.1.2 5.5.1.1 RPA10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	(range =) 13.1 (°C to) 13.8 (°C)	allow (range =) 13.8 (°C to) 13.1 (°C)	1	AO2 5.3.1.4 5.4.1.2 5.5.1.1 RPA10

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 17 · Mark scheme

June 2024 | 8464/C/1F | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.7		MP2 is dependent on MP1 being awarded		AO3 5.4.1.2 5.5.1.1 RPA10
	(result) 12.9 (°C)	allow (result / experiment) 2	1	
	any **one** from: • (the result is) much lower than the other two results		1	
	• (used) less than 3 g zinc	allow (used) incorrect mass of zinc		
	• (used) more than 50 cm^3 of copper sulfate (solution)	allow (used) incorrect volume of copper sulfate (solution)		
	• the mixture was not stirred			

Total Question 3	11

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 18 · Mark scheme

June 2024 | 8464/C/2F | Original Q7

Question 7

Question	Answers	Mark	AO / Spec. Ref.
07.1	**Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5–6	AO3
	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	AO3
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	AO2
	No relevant content	0	
	Indicative content • measure volume of (hydrochloric) acid • using a measuring cylinder • measure mass of calcium carbonate • using a balance • **add (hydrochloric) acid to calcium carbonate in conical flask** • **put stopper and delivery tube into conical flask** • **start a timer** • **record volume of gas collected at set time intervals or time how long it takes for a fixed volume of gas to be collected** • **repeat using different sized pieces of calcium carbonate** • use same mass of calcium carbonate • use same volume of (hydrochloric) acid • use same concentration of (hydrochloric) acid • use same temperature of (hydrochloric) acid • repeat each experiment		5.6.1.2

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 18 · Mark scheme

June 2024 | 8464/C/2F | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	(increasing the temperature) increases the rate of reaction		1	AO1 5.6.1.2 5.6.1.3
	(because) particles have more energy	allow (because) particles move faster	1	
	(so) the frequency of collisions increases	allow (so) a greater proportion of collisions have enough energy to react	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	(a substance that) increases the rate of reaction	allow (a catalyst) increases / changes the rate of reaction	1	AO1 5.6.1.4
	and is not used up during the reaction	ignore does not take part in the reaction	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	enzymes		1	AO1 5.6.1.4

Total Question 7	12

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 19 · Mark scheme

June 2025 | 8464/C/1F | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	(a reaction) which transfers energy to the surroundings	allow heat for energy allow (a reaction) which releases energy (to the surroundings)	1	AO1 5.5.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	(mass of oxygen = 2 × 16 =) 32		1	AO2 5.3.1.2
	(percentage =) $\frac{32}{74}$ × 100	allow correct use of an incorrectly determined mass of oxygen	1	
	= 43.2 (%)	allow 43.2432 (%) correctly rounded to at least 2 significant figures	1	

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 19 · Mark scheme

June 2025 | 8464/C/1F | Original Q7

Question	Answers	Mark	AO / Spec. Ref.
07.3	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO1 5.5.1.1 RPA10
	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
	• measure volume of water
	  ○ using a measuring cylinder
	  ○ pour into a suitable container eg insulated cup
	• measure initial temperature of water
	  ○ using a thermometer
	• add known mass of calcium oxide
	  ○ measured with a balance
	  ○ stir
	• measure the highest temperature reached by the mixture
	or
	measure temperature reached after set time period
	  ○ determine the temperature change
	• repeat with different masses of calcium oxide
	or
	add successive masses to the same mixture
	• use the same volume of water
	  ○ use the same initial temperature of water
	
	for **Level 3** all key steps should be described and the control variable the same volume of water must be given		

Total Question 7	**10**

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 20 · Mark scheme June 2025 | 8464/C/2F | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	formulation		1	AO1 5.8.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	14		1	AO2 5.1.1.1 5.8.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	carbon monoxide is a toxic gas		1	AO1 5.9.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	$2\,CH_4O + 3\,O_2 \rightarrow 2CO_2 + 4\,H_2O$	allow multiples	1	AO2 5.1.1.1 5.3.1.1 5.7.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	(test) add a burning splint (result) (hydrogen burns with) a pop sound	do **not** accept glowing splint MP2 is dependent on MP1 being awarded	1 1	AO1 5.8.2.1

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 20 · Mark scheme

June 2025 | 8464/C/2F | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	any **two** from: • melting ice caps • rising sea levels • more flooding • extremes of weather • increase in droughts • increase in wildfires • loss of habitats • reduction in biodiversity • change in migration patterns	allow increase in frequency of storms allow desertification ignore global warming do **not** accept acid rain do **not** accept global dimming do **not** accept deforestation do **not** accept natural disasters do **not** accept references to ozone	2	AO1 5.9.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.7	colour change (from blue to pink)		1	AO2 5.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.8	endothermic	allow (thermal) decomposition	1	AO2 5.6.2.2

Total Question 3	10

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 01 · Examiner comments June 2018 | 8464/C/1F | Original Q2

Question 2 (low & standard demand)

02.4 47% of students knew that the type of reaction between chlorine and potassium bromide solution is called displacement.

02.5 73% of students knew that chlorine is more reactive than bromine because chlorine gains electrons more easily.

02.6 60% of students understood that a chlorine atom is smaller than a bromine atom.

Answer 02 · Examiner comments June 2018 | 8464/C/1F | Original Q4

Question 4 (low & standard demand)

04.2 Even though the stem informed students that the products were a metal oxide and a gas, very few students (6%) could name both of the products formed when calcium carbonate ($CaCO_3$) is heated.

04.3 63% of students knew that the type of reaction when a compound breaks down is called decomposition.

04.4 60% of students knew that the type of reaction that takes in energy from the surroundings is called an endothermic reaction.

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 02 · Examiner comments June 2018 | 8464/C/1F | Original Q4

04.7 This question discriminated between students well. The two mistakes made in the student's calculation were often poorly expressed or ambiguous such as, 'the calculation is wrong'; 'used the wrong numbers'; 'the volume is wrong'; and 'readings are taken from the wrong place'.

Many students correctly identified at least one of the mistakes but several of these students continued to use either the incorrect mass or the inverse formula for their calculation.

13% of students expressed the mistakes well and correctly calculated the gradient. There were 12% of students who did not attempt to answer this question.

Answer 03 · Examiner comments

June 2018 | 8464/C/1F | Original Q6

Question 6 (standard demand)

06.1 This question discriminated well with 27% of students achieving some degree of credit. Many students did not consider the most obvious difference and similarity in the electronic structures of sodium and chlorine. Students often used the periodic table shown in the stem of the question to answer this question, but most of these students referred to periods or rows and groups or columns and so failed to gain any marks.

06.2 This question discriminated well. 23% of students achieved all four marks, often with concise statements about the transfer of the outer electron of sodium to chlorine.

Some students contradicted their description by mentioning covalent bonding, or the sharing of electrons, which restricted the number of marks they could attain. Poor expression and the use of incorrect terms were the main problem for most students. It was common to see the term ‘atom’ used instead of ‘electron’. 19% of students did not attempt to answer this question.

06.3 This question discriminated well. 26% of students achieved both marks; whereas 185 of students achieved a single mark. It was common for students to have incomplete reaction profile diagrams, by failing to include a horizontal line for the products.

Some students confused the two types of energy changes (endothermic and exothermic), while others provided a wide range of incorrect diagrams. Labels were ignored because they were not required to answer the question. 20% of students did not attempt to answer this question.

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 09 · Examiner comments

November 2021 | 8464/C/1F | Original Q5

Question 5 (low and standard demand)

05.1 This question was based on the required practical activity of investigating the variables that affect temperature changes. Students had difficulty in identifying improvements from the given method or from the diagram of the apparatus; just over two fifths of students gained one or more marks.

05.2 More than four fifths of students were able to determine the volume of solution in the measuring cylinder.

05.3 Nearly three fifths of students either used the fact that the temperature increased or the reaction profile to identify this as an exothermic reaction.

05.4 This calculation was very well answered by most students; nearly four fifths of students gained all four marks. They were able to use the graph to read an increase in mass with the corresponding increase in temperature and then use these values to evaluate the gradient.

05.5 A small number of students did not follow the rubric of the question to extend the line. A few students did not use a ruler or did not extrapolate the line correctly. Approximately one third of students correctly extended the line and recognised that if 10 g of zinc was used a temperature change of 84 °C would occur or that the temperature of the solution would be approximately 100 °C.

Answer 10 · Examiner comments

November 2021 | 8464/C/2F | Original Q6

Question 6 (standard demand)

Very few students were able to identify the variables. Most copied out the stages of the experiment from the rubric and did not go on to elaborate.

Graphs were usually accurately plotted and an appropriate line of best fit drawn. No credit was given for a bar chart as the first point had already been plotted for the students to follow.

The last part of the question required students to explain the effect of increasing the temperature on the reaction rate. Most students gained the first marking point for stating how temperature affected the rate of reaction but many did not go further to give a reason for this change. The idea of a higher temperature increasing the frequency of particle collisions was rarely seen.

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 11 · Examiner comments June 2022 | 8464/C/1F | Original Q2

Question 2 (Low demand)

02.1 More than a third of students correctly drew a dot and cross diagram for hydrogen chloride. The most commonly awarded mark was for the two shared electrons in the overlap between the atoms. Many failed to show that there are six unshared electrons.

02.2 Only 20% of students gained this mark for correctly identifying sodium chloride as one of the products of the reaction between hydrochloric acid and sodium hydroxide. The most common error was identifying the product as sodium chlorine. Some students also attempted to add other products to the equation.

02.3 Only 20% of students gained the mark for calculating the correct mass. Many students added the three masses together rather than recognising that in a reaction the mass of reactants equals the mass of products.

02.4 More than three-quarters of the students correctly read the temperature reading on the thermometer scale.

Answer 11 · Examiner comments June 2022 | 8464/C/1F | Original Q2

02.5 Just under a quarter of students knew that when the temperature of a reaction increases an exothermic reaction is taking place. The most common error described the reaction as endothermic.

02.6 30% of students correctly identified that Na^+ and OH^- ions are present in sodium hydroxide.

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 12 · Examiner comments June 2022 | 8464/C/1F | Original Q5

Question 5 (Standard demand)

05.1 Students were asked to state observations made when copper carbonate is added to sulfuric acid. Many students appeared to misunderstand what an observation is and instead either wrote instructions on how to carry out the preparation of copper sulfate or stated what to look for such as ‘check the pH level’ or ‘did anything change’. Just over a quarter gave at least one correct observation. The most common responses were ‘colour changes’ or ‘fizzing’.

05.2 More than a third of students knew that filtration is used to separate unreacted copper carbonate after a reaction between sulfuric acid and excess copper carbonate.

05.3 Just over 20% of students knew the pH of the solution after a reaction between sulfuric acid and excess copper carbonate.

05.4 Just over 10% of students knew that the reaction between sulfuric acid and copper carbonate is neutralisation.

05.5 The question required students to read the masses of ammonium nitrate that dissolve at 80 °C and 20 °C from a graph and to then carry out a subtraction to determine the mass of solid that crystallises on cooling. Just over 15% of students were able to gain all 3 marks.

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 13 · Examiner comments

June 2022 | 8464/C/1F | Original Q7

Question 7 (Standard demand)

07 This question discriminated well with around 20% of students achieving level two or above. It was based upon Required Practical Activity 10. Students were asked to plan an investigation to find the order of reactivity of three metals using the temperature change recorded when each metal reacts with hydrochloric acid.

To access level 3, the method would need to lead to a valid outcome. This required students controlling variables such as the mass of metal and the volume of acid reacting, determining a temperature change having recorded the initial and final temperatures and repeating the method for each metal.

To access level 2 the method would not necessarily lead to a valid outcome. Common omissions were to add the metal to the acid before taking the initial temperature or failing to take the initial temperature altogether or not to control variables which would not ensure a fair test. Weaker responses could gain credit for either correctly identifying apparatus or for explaining the link between the expected results and the reactivity of the metal.

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 13 · Examiner comments

June 2022 | 8464/C/1F | Original Q7

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 14 · Examiner comments

June 2022 | 8464/C/2F | Original Q3

Question 3

The equilibrium identified in this question is detailed in the specification, however, many students found the questions challenging.

03.1 Around half of the students were able to identify hydrogen chloride or hydrochloric acid as the other product.

03.2 Students were told that ammonia is a gas in the stem of the question. However only half of the students gained the mark on this item.

03.3 Nearly two thirds of students were able to either draw the equilibrium symbol or describe the symbol with sufficient clarity.

03.4 Three quarters of students identified the reverse reaction as exothermic.

03.5 Approximately 60% of students were able to identify rate in this item. Nearly all the incorrect responses were concentration.

Answer 14 · Examiner comments

June 2022 | 8464/C/2F | Original Q3

03.6 Less than a third of students identified C correctly. The most common incorrect responses were B and D with similar numbers identifying each.

03.7 Approximately one third of students gained a mark here. The most common correct response was for increasing the rate. Responses such as catalysts were not used up or catalysts could be reused did not answer the question.

03.8 In this open question only 1 in 20 students were able to identify a formulation. Bleach was the most seen incorrect response.

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 15 · Examiner comments

June 2022 | 8464/C/2F | Original Q4

Question 4

The skills tested in this question led to some good responses from students, particularly when reading scales, graph plotting and in guided calculations.

04.1 Identifying variables from a practical procedure is still one of the skills that students find challenging. Only 1 in 5 scored both marks, with a further quarter of these students correctly identifying one of the variables.

04.2 Nearly 95% of students were able to read the thermometer to give the temperature.

04.3 A quarter of students gained all the marks for plotting the graph, including a curved line of best fit. Fewer than 1 in 5 gained no marks. The common error was the line of best fit, with many drawing a straight line. Students need to realise that lines of best fit can be curved or straight and they need to make that judgement.

04.4 A quarter of students were able to successfully extrapolate the graph to find the value requested. Students should be encouraged to extrapolate the lines and read from that line, as opposed to estimating where the line crosses the point.

04.5 Two thirds of students correctly completed the sentence.

04.6 Guided calculations with no manipulation of the equation are well understood by students, and this one was no exception, with nearly 4 in 5 achieving both marks for the calculation. Transposition errors (both written and putting into calculators) accounted for a number of the incorrect responses.

04.7 The units were correctly identified by nearly 80% of students.

04.8 Around 1 in 4 students achieved all three marks for this calculation. The two most frequently seen errors were including the anomalous result and not rounding to 3 significant figures. This is another example where students need to read the whole question, perhaps highlighting the requirements, before embarking on the solution.

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 16 · Examiner comments June 2023 | 8464/C/1F | Original Q2

Question 2 (low demand)

02.1 The piece of equipment was correctly identified as a thermometer by nearly all the students.

02.2 More than 85% of students knew that a measuring cylinder is the best piece of equipment to measure volumes of solution.

02.3 This calculation was well answered with more than three-quarters of students correctly evaluating the mean temperature increase. A number of students believed that the value at 7.3 was anomalous; those who showed that they calculated the mean of the other two values were credited provided they showed their working.

02.4 Just under a third of students obtained full marks on this calculation. Some students successfully used their data from Question 02.3.

02.5 Just under half of the students knew that an exothermic reaction is one when the temperature increases. Endothermic proved to be a very popular distractor.

02.6 This question was a good discriminator. Just over a third of students answered this correctly. The temperature did not increase because copper is less reactive than zinc. Note that ‘copper is not very reactive’ is not a comparative.

Answer 17 · Examiner comments

June 2024 | 8464/C/1F | Original Q3

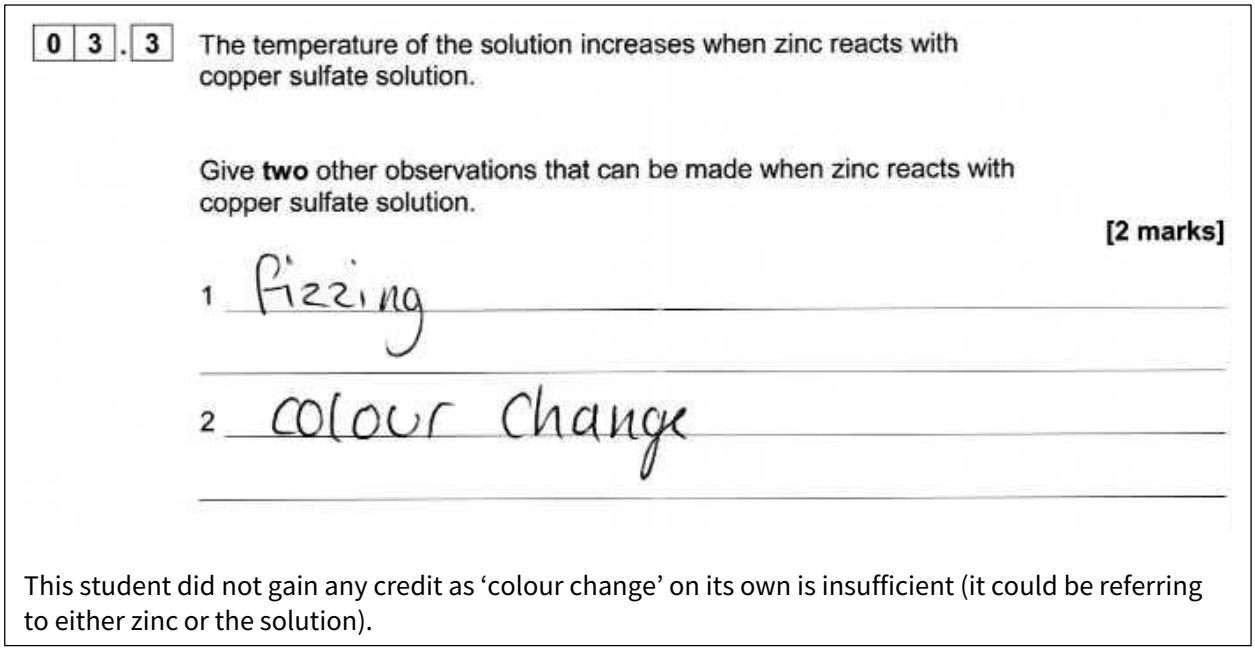
Question 3 (low & standard demand)

03.1 In an investigation the independent variable is the one that is changed, the dependent variable is the one that is measured, and all other variables must be controlled. If a student investigates the temperature change when different masses of zinc are added to copper sulfate solution the independent variable is the mass of zinc and the dependent variable is the temperature change. Just under half of the students answered this correctly. Control (variable) was a slightly more common incorrect response than dependent (variable).

03.2 A word equation was provided to help students identify that the salt zinc sulfate is produced when zinc reacts with copper sulfate solution. A quarter of students gave the correct answer.

03.3 Students found this question challenging. When a question asks for observations students should be encouraged to think 'before', 'during' and 'after'. In the reaction between zinc and copper sulfate solution, zinc is replaced by brown/orange copper solid and the blue colour of the copper sulfate solution fades as colourless zinc sulfate is produced. The colours are not required in the specification, hence the allow statements where there is just reference to the solution/zinc changing colour. 'Colour change' is too vague to gain credit as it does not refer to either the zinc solid or the copper sulfate solution.

The equation for the reaction was provided to help and, although it does not contain any gaseous products, many students gave 'bubbles' or 'fizzing' as an observation.



This student did not gain any credit as 'colour change' on its own is insufficient (it could be referring to either zinc or the solution).

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5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 17 · Examiner comments June 2024 | 8464/C/1F | Original Q3

03.4 The temperature shown on the diagram of the thermometer scale showed 36 °C. Most students read this correctly and then subtracted the starting temperature to give a temperature increase of 15 °C. A number of students did not use the temperature scale correctly and did not score marking point 1 but could access marking point 2 for a correct subtraction from their highest temperature.

03.5 The calculation of the mean temperature increase was correctly carried out by nearly three-quarters of students. Most students achieved either 2 or 0 marks.

Table 4

Mass of zinc in grams	Temperature increase in °C			
	Experiment 1	Experiment 2	Experiment 3	Mean
1.0	7.8	7.3	7.7	**B**
2.0	13.1	13.8	13.3	13.4
3.0	20.4	12.9	20.2	20.3

0 3 . 5 Calculate value **B** in **Table 4**.

[2 marks]

7.8 + 7.3 + 7.7 = 17.666666667

B = 17.6 °C

This student did not gain any credit. They divided only the last number (7.7) by 3, then added, rather than dividing the sum of all three numbers (ie 22.8) by 3.

03.6 The range of results is the 'minimum value to the maximum value'. In the data set the lowest value is 13.1 °C and the highest value is 13.8 °C. 60% of students gained this mark.

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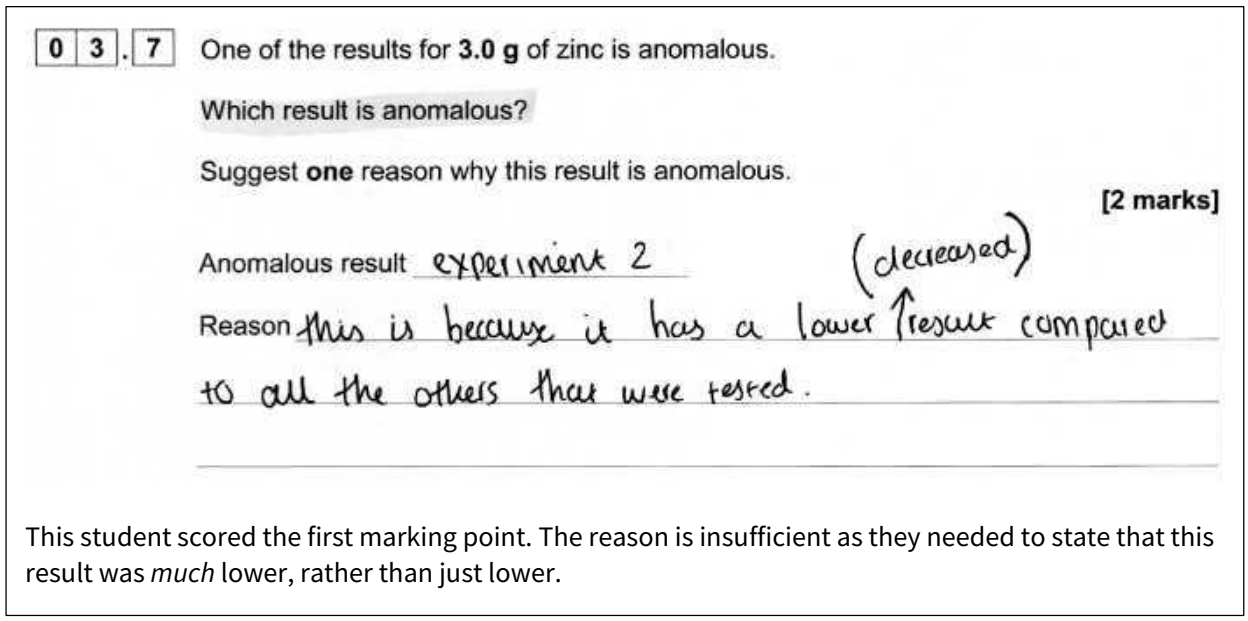
5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 17 · Examiner comments June 2024 | 8464/C/1F | Original Q3

03.7 More than half of students correctly identified the anomalous result as 12.9 °C. Reasons why this result is anomalous were not well expressed, however: this result is *much* lower than the other two results (20.4 °C and 20.2 °C).

Alternative answers giving a reason why the result is anomalous such as 'used less than 3 g zinc', 'used more than 50 cm^3 of copper sulfate (solution)' or 'the mixture was not stirred' were much less common.



0 3 . 7 One of the results for **3.0 g** of zinc is anomalous.

Which result is anomalous?

Suggest **one** reason why this result is anomalous.

[2 marks]

Anomalous result experiment 2 (decreased)

Reason this is because it has a lower result compared to all the others that were tested.

This student scored the first marking point. The reason is insufficient as they needed to state that this result was *much* lower, rather than just lower.

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5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 18 · Examiner comments

June 2024 | 8464/C/2F | Original Q7

Question 7 (standard demand)

07.1 This AO2 and AO3 variation of one of the rates Required Practical Activities proved challenging to most students, with over a quarter of students not attempting it. Of the 30% of responses that did gain any marks most were limited to Level 1. To reach Level 2, three key steps, or two with control variables, were required. To achieve Level 3 marks, all key steps and control variables were needed.

The two most common steps identified were adding the hydrochloric acid to the calcium carbonate in the conical flask and then attaching the stopper and delivery tube. Many students made no further progress as they often referred to 'counting bubbles' or to 'reading the volume when the reaction had finished' with no link to timing so that calculating a rate would be impossible. Another common response was to 'repeat with a different mass of calcium carbonate' instead of using different sized pieces.

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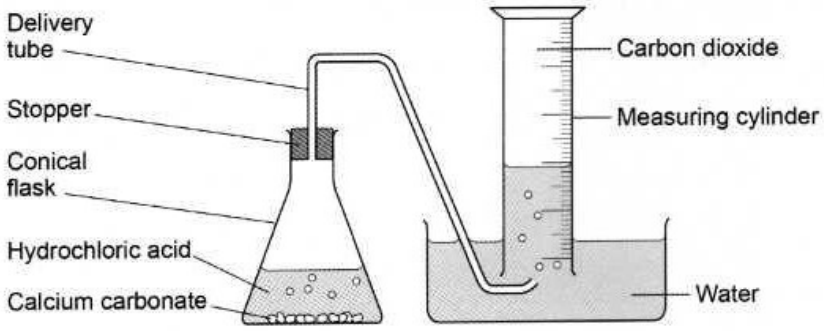
5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 18 · Examiner comments June 2024 | 8464/C/2F | Original Q7

0 7 . 1 A student investigated the effect of changing the particle size of calcium carbonate on the rate of reaction with hydrochloric acid.

Figure 6 shows the apparatus.

Figure 6



Describe a method the student could use to produce valid results.

[6 marks]

Add hydrochloric acid to a conical flask and add calcium carbonate. Then add a stopper and put in a delivery tube and put that in some water. Calculate the calcium carbonate that the gas has forced to move in the measuring cylinder.

This student has described the two most common key steps but has not gone on to add anything further so has not met the Level 2 descriptor: 1 mark was awarded.

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5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 18 · Examiner comments June 2024 | 8464/C/2F | Original Q7

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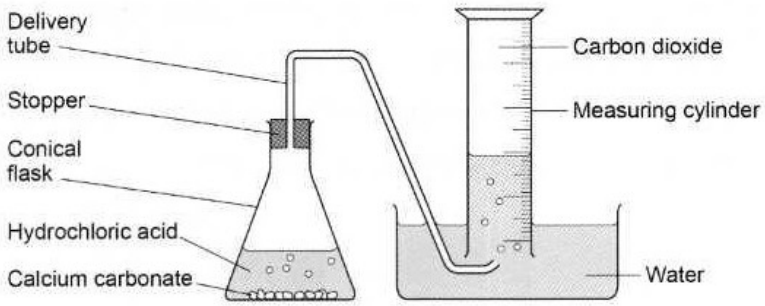

Describe a method the student could use to produce valid results.

[6 marks]

1.) Measure the mass of the calcium carbonate

2.) Add 50 cm^3 of hydrochloric acid into the conical flask and put the ~~delivery~~ stopper over to trap the gasses in.

3.) connect the delivery tube to the water so that the gasses can enter it.

4.) Measure the ~~amount of~~ ~~put into~~ amount of carbon dioxide.

5.) ~~Also measure the amount of~~ ~~Repeat the experi~~ Record the results of carbon dioxide and how much calcium carbonate was used.

6.) Repeat steps 1-5 ~~but~~ with different masses of calcium

Turn over ▶

This student has achieved the first two key steps; however, they have not described what they are going to measure or change in the repeats to achieve the other key steps.

The student has specified 50 cm^3 of hydrochloric acid and done repeats (of something) so that they have given a control variable. This would therefore just place this answer into Level 2 and 3 marks are awarded.

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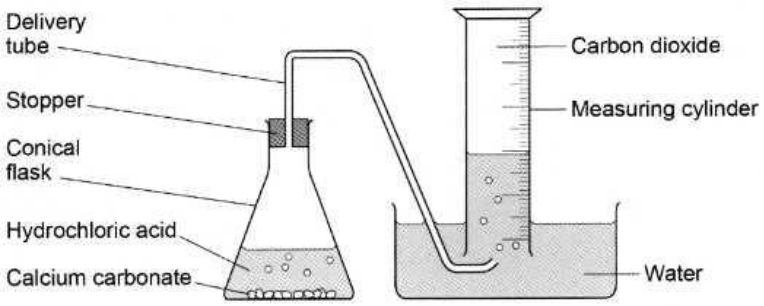
5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 18 · Examiner comments June 2024 | 8464/C/2F | Original Q7

0 2 . 1 A student investigated the effect of changing the particle size of calcium carbonate on the rate of reaction with hydrochloric acid.

Figure 3 shows the apparatus.

Figure 3



Describe a method the student could use to produce valid results. **[6 marks]**

- Use a balance to ~~find out the M~~ make sure your using the correct mass of calcium carbonate
- then place the calcium carbonate into the hydrochloric acid and place the stopper with the delivery tube on very quickly.
- record the amount of carbon dioxide in the measuring cylinder every 30 seconds ~~repeat this~~ until the calcium carbonate stops bubbling.
- repeat this method but with bigger particle size of calcium carbonate but they have to be the same mass as the smaller particles.

In this response the student has suggested that the 'correct mass' of calcium carbonate should be used in the first bullet point. This is insufficient for a control variable, but in the final bullet point the 'same mass' has been identified, so there is one control variable here. The first two key steps are identified in the second bullet point. Key steps 3 and 4 are given in the third bullet point. 'Amount' would not be acceptable in a points-based mark scheme, but this response should be marked holistically as it is an extended response. There is no explicit mention of starting a stopwatch; however, it is implied in the statement 'every 30 seconds.' The final bullet point gives the repeats with a different particle size and one control variable.

Therefore, there are all five key steps, and one control variable so this is a Level 3 response and is awarded 5 marks. An additional control variable is needed for 6 marks.

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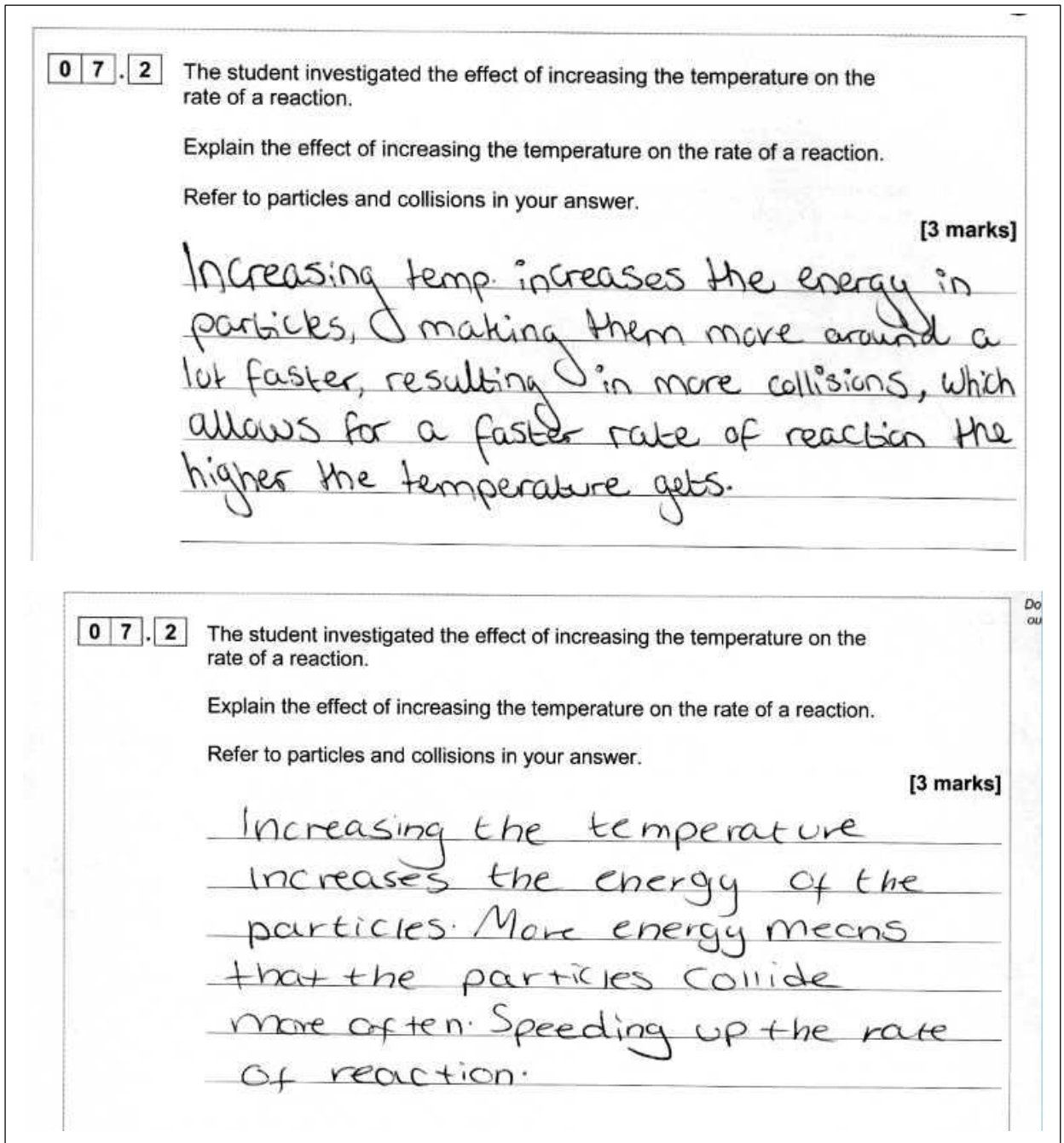
5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 18 · Examiner comments June 2024 | 8464/C/2F | Original Q7

07.2 Over half of the students gained at least 1 mark on this AO1 question, with 40% gaining 2 or more. The first two marking points were the more commonly awarded marks. Linking an increase in temperature to an increase in rate was the most common. However, very few students linked rate to the *frequency* of collisions, ie the more collisions per second, and are more likely to just talk about more collisions.



0 7 . 2 The student investigated the effect of increasing the temperature on the rate of a reaction.

Explain the effect of increasing the temperature on the rate of a reaction.

Refer to particles and collisions in your answer.

[3 marks]

Increasing temp. increases the energy in particles, making them move around a lot faster, resulting in more collisions, which allows for a faster rate of reaction the higher the temperature gets.

0 7 . 2 The student investigated the effect of increasing the temperature on the rate of a reaction.

Explain the effect of increasing the temperature on the rate of a reaction.

Refer to particles and collisions in your answer.

[3 marks]

Increasing the temperature increases the energy of the particles. More energy means that the particles collide more often. Speeding up the rate of reaction.

The first student has achieved the first two marking points, but 'more collisions' is insufficient for marking point 3.

The second student has achieved all 3 marks. In addition to identifying that the energy of the particles increases, speeding up the reaction, 'particles collide more often' is equivalent to' more frequent collisions' as the collisions are linked to time.

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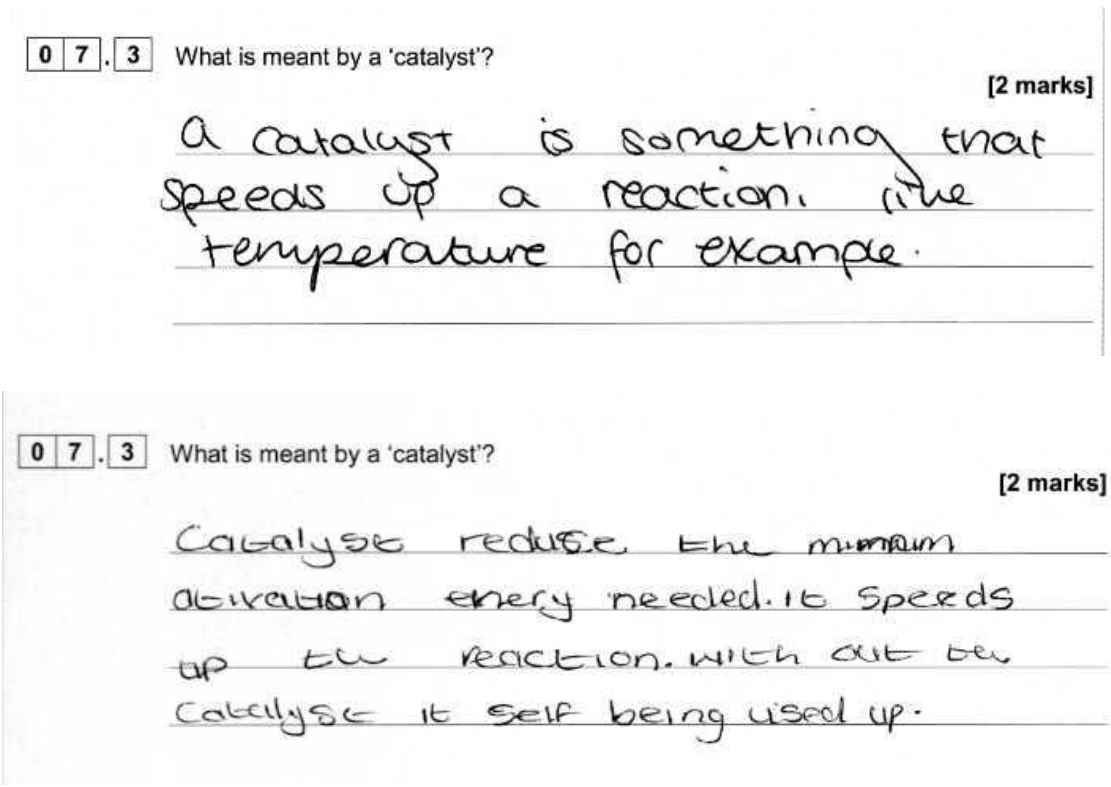
5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 18 · Examiner comments June 2024 | 8464/C/2F | Original Q7

07.3 Over 40% of students were able to gain at least 1 mark for the AO1 definition of a catalyst. The first marking point was most seen; however, many misconceptions were also seen. One common misconception is that a catalyst is *any* change that speeds up the reaction. This contradicts what a catalyst is, so the first mark cannot be awarded.



0 7 . 3 What is meant by a 'catalyst'?

[2 marks]

A catalyst is something that speeds up a reaction. like temperature for example.

0 7 . 3 What is meant by a 'catalyst'?

[2 marks]

Catalyst reduce the minimum activation energy needed. It speeds up the reaction. without the catalyst it self being used up.

The first student starts off well; however, they suggest that temperature is a catalyst, so the mark is not awarded.

The second student clearly defines a catalyst for 2 marks, but includes information which is unnecessary, the idea that a catalyst reduces the activation energy. This would be required in an 'Explain' question, rather than the much simpler 'What is?', but does not affect the marks awarded.

07.4 Enzymes are in both the Chemistry and Biology sections of the specification; however, very few students were able to recall that biological catalysts are called enzymes.

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Answer 18 · Examiner comments

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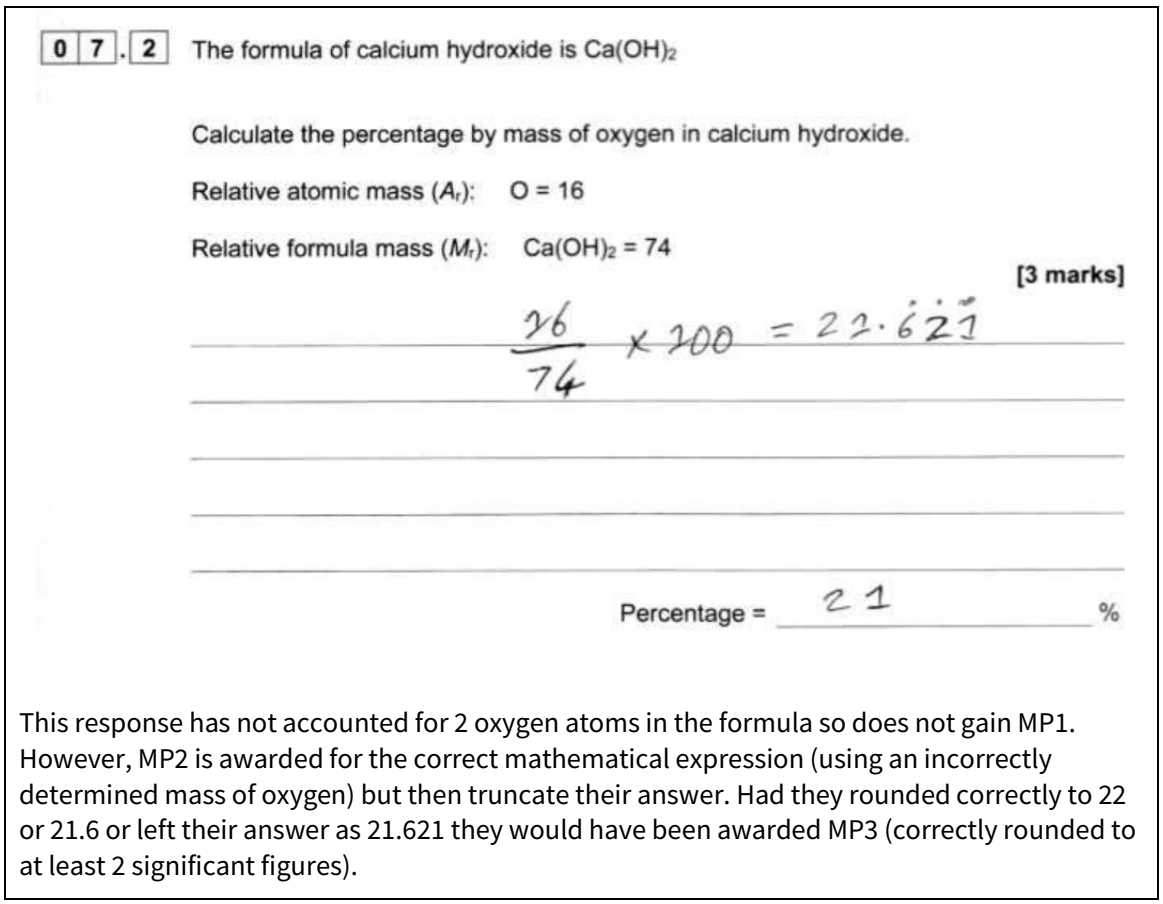
Answer 19 · Examiner comments

June 2025 | 8464/C/1F | Original Q7

Question 7 (Standard demand)

07.1 The definition for an 'exothermic' reaction was not well known. Students rarely stated that energy or heat was released or transferred to 'the surroundings'. Answers were mostly general explanations, describing how energy or heat were 'given off' or 'released'. Common non-creditworthy responses referred to energy or heat being *produced*, the idea of heat or energy being 'lost' or references to an increase in temperature. Some answers stated that 'oxygen' or 'a gas' was given off by the reaction.

07.2 This question was poorly answered, and 20% of students did not attempt this question. The majority of students didn't understand the use of brackets in a formula as they ignored the subscript 2. Evidence of 32 in their answers was not commonly seen. Students were unclear about how to calculate a percentage. Lots of different variations on the use of 16 and 74 were often seen such as 74+16, 74-16 or 74÷16. Many students attempted to calculate the M_r when it was already given.



0 7 . 2 The formula of calcium hydroxide is $Ca(OH)_2$

Calculate the percentage by mass of oxygen in calcium hydroxide.

Relative atomic mass (A_r): O = 16

Relative formula mass (M_r): $Ca(OH)_2$ = 74

[3 marks]

$\frac{16}{74} \times 100 = 22.621$

Percentage = 21 %

This response has not accounted for 2 oxygen atoms in the formula so does not gain MP1. However, MP2 is awarded for the correct mathematical expression (using an incorrectly determined mass of oxygen) but then truncate their answer. Had they rounded correctly to 22 or 21.6 or left their answer as 21.621 they would have been awarded MP3 (correctly rounded to at least 2 significant figures).

07.3 This was an 'extended response' style of question. Such questions are marked holistically. There are overall generic descriptions for the three levels of response at the top of the mark scheme, giving a hierarchy of response. Within each level there are 2 marks.

Students were asked to plan a method to investigate how changing the mass of calcium oxide affects the temperature change of the reaction when calcium oxide is added to water. The indicative content includes 5 key steps and the control variable, along with some additional information.

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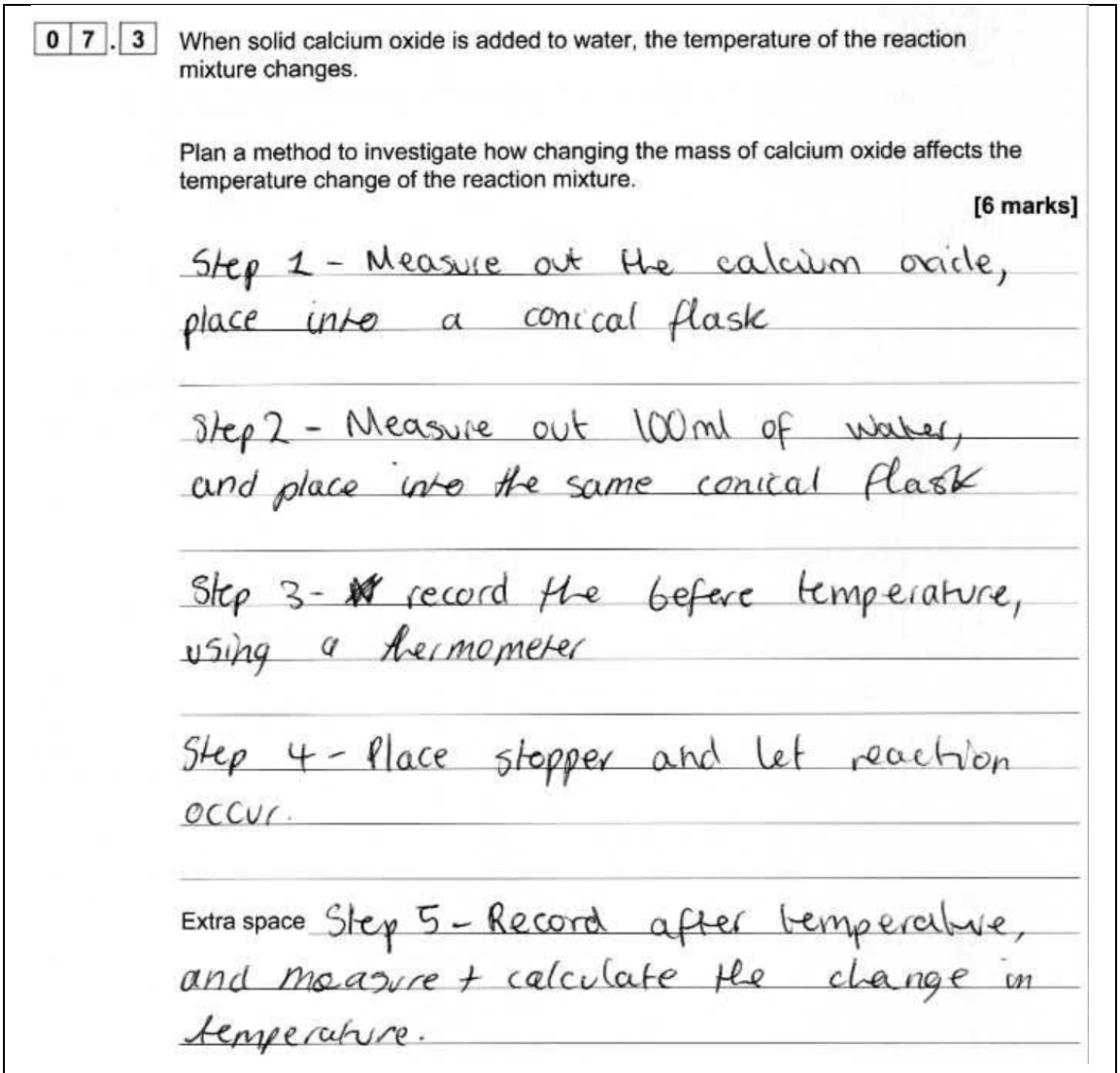
5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 19 · Examiner comments June 2025 | 8464/C/1F | Original Q7

At Level 1, students needed to identify some relevant steps. To enter Level 2, three key steps, or two with the control variable, were required. To achieve marks in Level 3, all 5 key steps and the control variable were needed. Only a very small minority of students were able to obtain 6 marks.



0 7 . 3 When solid calcium oxide is added to water, the temperature of the reaction mixture changes.

Plan a method to investigate how changing the mass of calcium oxide affects the temperature change of the reaction mixture.

[6 marks]

Step 1 - Measure out the calcium oxide, place into a conical flask

Step 2 - Measure out 100ml of water, and place into the same conical flask

Step 3 - record the before temperature, using a thermometer

Step 4 - Place stopper and let reaction occur.

Extra space Step 5 - Record after temperature, and measure + calculate the change in temperature.

In this response, the student has stated a valid volume of water but omitted 'mass' of calcium oxide. In step 3 they record the 'before' temperature, but this is after both reactants have been added to the conical flask so is not credited with taking the initial temperature. They have not stated when the subsequent temperature is measured nor described how the temperature change is determined. Had the student 'repeated the experiment with different masses of calcium oxide' they would have been credited with the control variable as this would imply fixing the volume stated. The students uses a thermometer which is a valid point in the mark scheme.

Only one key step is stated with some additional information (correct use of a thermometer) so this is a Level 1 response and is awarded 1 mark.

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5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 19 · Examiner comments June 2025 | 8464/C/1F | Original Q7

Most students added calcium oxide to water but many omitted either volume (of water) or mass (of solid) although 'amount' was creditworthy for both here. Students usually described taking the 'initial' temperature (but often after they had added solid to water). Many were less clear on when and how the subsequent temperature or temperatures were to be taken. Too frequently it was stated that the 'temperature change' was to be measured which is not creditworthy, as this requires a calculation. The need for a control variable, whilst rarely stated as such, was often found in a Level 2 response due to the students realising that the volume of water needed to be fixed along with the experiment being repeated in some way. An indication of how the temperature change was to be determined was rarely seen.

0 7 . 3 When solid calcium oxide is added to water, the temperature of the reaction mixture changes.

Plan a method to investigate how changing the mass of calcium oxide affects the temperature change of the reaction mixture.

[6 marks]

- Place water in a polystegrene cup with a thermometer and lid
- ~~Add in~~ measure out different masses of calcium oxide
- add smallest mass to cup, place lid on top and measure maximum temperature and temperature change
- repeat with increasing masses of calcium oxide
- repeat previous steps to make sure investigation is accurate
- ~~Measure~~ find the mean temperature of each reaction of increasing calcium oxide mass and water.

Extra space

In this response, the student has omitted volume of water but stated mass of calcium oxide. The initial temperature is not recorded but the maximum temperature is. They repeat for accuracy and then repeat with different masses of calcium oxide. They have not stated how the temperature change is determined nor that they need to use the same volume of water when repeating. The student uses a suitable container (an insulated cup) and a thermometer which are valid ideas from the mark scheme.

There are three key steps with some additional information (thermometer and insulated cup) so this is a Level 2 response and is awarded 3 marks.

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5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 19 · Examiner comments June 2025 | 8464/C/1F | Original Q7

0 2 . 3 When solid calcium oxide is added to water, the temperature of the reaction mixture changes.

Plan a method to investigate how changing the mass of calcium oxide affects the temperature change of the reaction mixture.

[6 marks]

1. Measure 25cm^3 of water using a measuring cylinder and pour into a polystyrene cup.
2. Place the cup into a beaker and measure initial temperature using a thermometer
3. Measure 4g of calcium oxide using a balance
4. Add the calcium oxide and put on a lid
5. Once the temperature has come to a stable point take final temperature reading using a thermometer
6. calculate temperature change by doing final temp - initial temp
7. Repeat steps 1-6 with different masses of calcium oxide e.g 6g, 8g. and compare results.

(for more accurate results use cotton wool in the beaker as an insulater and use a digital thermometer)

In this response (from a Higher tier paper), the student has stated a valid volume of water and mass of calcium oxide. The initial temperature (before the solid is added) and final temperature are recorded. They repeat with different masses of calcium oxide and are using the same volume of water so are credited with having a control variable. They have shown how the temperature change is determined. The student uses a measuring cylinder, suitable container (an insulated cup), balance and a thermometer which are additional valid points in the mark scheme.

There are all five key steps, a control variable, how the temperature change is determined with lots of additional information, so this is a Level 3 response and is awarded 6 marks.

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5.5.1.1 Energy transfer during exothermic and endothermic reactions

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Tel: 01483 477756
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5.5.1.1 Energy transfer during exothermic and endothermic reactions

Answer 20 · Examiner comments June 2025 | 8464/C/2F | Original Q3

Question 3 (Low and Standard demand)

03.1 Well over half of all students recognised screenwash as a formulation.

03.2 Nearly three quarters of students were able to work out the number of atoms in one molecule of glycerol correctly as 14.

03.3 Most students could state that carbon monoxide is a toxic gas. The most common incorrect response was that carbon monoxide is a greenhouse gas.

03.4 Many students were able to correctly balance the equation. A significant number however incorrectly added an H or CH in front of the CO_2
There was clear evidence of many pupils working out the numbers of individual atoms to correctly balance the equation.

03.5 Many students remembered that hydrogen burns with a pop or squeaky pop however far fewer identified that a burning/lit splint was needed in order for that to happen, therefore neither mark could be awarded.

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Answer 20 · Examiner comments June 2025 | 8464/C/2F | Original Q3

The most common incorrect response referred to using a glowing splint, confusing the test for oxygen and hydrogen.
When students correctly identified a burning/lit splint as the correct test, most also then went on to state the correct result and gained both marks.

03.6 Many students were able to correctly give one effect of global climate change, but fewer were able to correctly give two. The most common creditworthy responses were for identifying 'melting ice caps' and 'rising sea levels'.
Many responses referring to floods, storms and wildfires but could not gain credit as they were not comparative. The question was looking for the idea that there would be '*more* floods' for example, as floods happen without climate change.
Very few students answered in terms of a reduction in biodiversity or changes to migration patterns.

03.7 Many students correctly recognised that the anhydrous cobalt chloride would change colour or described the correct colour change. Incorrect responses often referred to the water or solution changing colour, or included additional observations, such as 'fizzing' or 'bubbles'.

03.8 Many students correctly identified the type of reaction as being endothermic.