AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.2.2.2

State symbols

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**5**
Available paper years	**2008–2024**

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.

4.2.2.2 State symbols

Answer 01 · Mark scheme

June 2008 | CHY2H | Original Q3 | Legacy

question	answers	extra information	mark
3(a)(i)	sulfuric	accept $\underline{H_2SO_4}$ accept sulphuric allow phonetic spellings	1
3(a)(ii)	$CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$	**1** mark for reactants **1** mark for products ignore state symbols max **1** mark for incorrect balancing	2
3(b)	any **two** from: • particles gain energy **or** particles have more energy • particles move faster • collide more often • collide more energetically • more of the collisions are successful **or** more particles have the activation energy	allow have more activation energy allow they collide faster / quicker ignore move / vibrate more allow more collisions **NB** more successful collisions alone = **1** mark if particles are identified as electrons = max **1** mark	2
Total			**5**

4.2.2.2 State symbols

Answer 01 · Mark scheme June 2008 | CHY2H | Original Q3 | Legacy

COMPONENT NUMBER: CHY2H

COMPONENT NAME: Additional Science / Chemistry

STATUS: Final

DATE: June 2008

4.2.2.2 State symbols

Answer 02 · Mark scheme

June 2019 | 8462/2H | Original Q3

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

4.2.2.2 State symbols

Answer 03 · Mark scheme

November 2020 | 8462/1H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	the (minimum) energy needed for particles to react **or** the (minimum) energy needed for a reaction to occur	allow the (minimum) energy needed to start a reaction	1	AO1 4.5.1.2
06.2	(M_r of Fe_2O_3 =) 160		1	AO2 4.3.1.2 4.3.2.1 4.3.2.2 4.3.2.4
	(moles $Fe_2O_3 = \frac{3000}{160}$ =) 18.75 (mol)	allow correct use of incorrectly calculated M_r	1	
	(moles Al $= \frac{1000}{27}$ =) 37.0 (mol)	allow 37.037037 (mol) correctly rounded to at least 2 significant figures if both MP2 and MP3 are not awarded allow **1** mark for 0.01875 mol Fe_2O_3 **and** 0.037 mol Al	1	
	(aluminium is limiting because) 37.0 mol is less than the (2 x 18.75 =) 37.5 mol (aluminium needed) **or** iron oxide is in excess because 18.75 mol is more than the ($\frac{37.0}{2}$ =) 18.5 mol (iron oxide needed)	allow correct use of incorrect number of moles from steps 2 and/or 3	1	

4.2.2.2 State symbols

Question 6 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2 ctd	**alternative approaches:** **approach 1:** **(finding required mass of aluminium by moles method)** (M_r of Fe_2O_3 =) 160 (1) (moles $Fe_2O_3 = \frac{3000}{160}$ =) 18.75 (mol) (1) (moles Al needed =18.75 × 2 =) 37.5 (mol) **and** (mass Al needed = 37.5 × 27 =) 1012.5 (g) **or** 1.0125 kg (1) (so) 1.00 kg of aluminium is not enough (1) **approach 2:** **(finding required mass of aluminium by proportion method)** (M_r of Fe_2O_3 =) 160 (1) (3.00 kg Fe_2O_3 needs) $\frac{3.00}{160}$ × 2 × 27 (kg Al) (1) (=) 1.0125 (kg) (1) (so) 1.00 kg of aluminium is not enough (1)	allow correct use of incorrectly calculated M_r allow correct use of incorrectly calculated moles of iron oxide allow correct use of incorrectly calculated moles of aluminium needed dependent on calculated mass of aluminium needed being greater than 1.00 (kg) allow correct use of incorrectly calculated M_r dependent on calculated mass of aluminium needed being greater than 1.00 (kg)		AO2 4.3.1.2 4.3.2.1 4.3.2.2 4.3.2.4

Question 6 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2 ctd	**alternative approaches:** **approach 3:** **(finding required mass of iron oxide by moles method)** M_r of Fe_2O_3 =) 160 (1) (moles Al $= \frac{1000}{27}$ =) 37.0 (mol) (1) (moles Fe_2O_3 needed) $= \frac{37.0}{2}$) = 18.5 (mol) **and** (mass Fe_2O_3 needed = 18.5 × 160 =) 2960 (g) **or** 2.96 (kg) (1) (so) 3.00 kg of iron oxide is an excess (1) **approach 4:** **(finding required mass of iron oxide by proportion method)** (M_r of Fe_2O_3 =) 160 (1) (1.00 kg Al needs) $\frac{1.00}{2 \times 27} \times 160$ (kg Fe_2O_3) (1) (=) 2.96 (kg) (1) (so) 3.00 kg of iron oxide is an excess (1)	allow 37.037037 (mol) correctly rounded to at least 2 significant figures allow correct use of incorrectly calculated moles of aluminium allow correct use of incorrectly calculated moles of iron oxide needed allow correct use of incorrectly calculated M_r dependent on calculated mass of iron oxide needed being less than 3.00 (kg) allow correct use of incorrectly calculated M_r dependent on calculated mass of iron oxide needed being less than 3.00 (kg)		AO2 4.3.1.2 4.3.2.1 4.3.2.2 4.3.2.4

4.2.2.2 State symbols

Question 6 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	$Mg(s) + Zn^{2+}(aq) \rightarrow Mg^{2+}(aq) + Zn(s)$	allow multiples allow **1** mark for $Mg^{2+} + Zn$ with missing or incorrect state symbols	2	AO2 4.1.1.1 4.2.2.2 4.4.1.4
06.4	magnesium (atoms) are oxidised because they lose electrons (and) zinc (ions) are reduced because they gain electrons	 if no other marks awarded allow **1** mark for magnesium (atoms) lose electrons and zinc (ions) gain electrons	1 1	AO2 4.4.1.4
Total			**9**	

4.2.2.2 State symbols

Answer 04 · Mark scheme

November 2021 | 8462/2H | Original Q10

Question 10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	(steam / catalytic) cracking	allow thermal decomposition	1	AO1 4.7.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.2	high temperature steam / catalyst	allow a temperature in the range 300 – 900 °C	1 1	AO1 4.7.1.4

Question 10 continued

Question	Answers	Mark	AO/ Spec. Ref
10.3	**Level 3:** Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO2 4.6.1.3 4.6.2.4 4.6.2.6 4.6.2.7 4.7.2.2
	Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	
	No relevant content	0	
	Indicative content **Rate** • higher temperature gives higher rate • because more frequent collisions • higher pressure gives higher rate • because more frequent collisions • a catalyst can be used to give a higher rate • because the activation energy is reduced **Yield** • higher temperature gives lower yield • because the reaction is exothermic • higher pressure gives higher yield • because there are more molecules on left hand side **Other factors** • higher temperatures use more energy so costs increase • higher pressures use more energy so costs increase • higher pressures require stronger reaction vessels so costs increase **Compromise** • chosen temperature is a compromise between rate and yield • chosen temperature is a compromise between rate and cost (of energy used) • chosen pressure is a compromise between rate and cost (of energy used) • chosen pressure is a compromise between yield and cost (of energy used)		

Question 10 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.4	fermentation	allow ferment(ing)	1	AO1 4.7.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.5	warm anaerobic (conditions)	allow a value in the range 25 °C to 45 °C allow without oxygen / air	1 1	AO2 4.7.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.6	(conversion) 200 km = 200,000 m (moles =) $\frac{200000 \times 1.95 \text{ (mol)}}{1300}$ = 300 (mol)	 allow correct use of incorrect / no conversion for distance	1 1 1	AO2 4.7.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.7	$C_4H_9OH + 6\,O_2 \rightarrow 4\,CO_2 + 5\,H_2O$	allow $C_4H_{10}O$ for C_4H_9OH allow multiples allow **1** mark for $C_4H_9OH + O_2 \rightarrow CO_2 + H_2O$ with incorrect / no multipliers ignore state symbols	2	AO2 4.1.1.1 4.3.1.1 4.7.2.3

Total			17

4.2.2.2 State symbols

Answer 05 · Mark scheme

June 2024 | 8462/1H | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	line of best fit using the first five points	max **1** mark if the lines do not intersect	1	AO3 4.5.1.1 RPA4
	line of best fit using the last four points		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	the temperature rises because the reaction is exothermic **or** the temperature rises because energy is transferred to the surroundings	allow heat for energy	1	AO2
	until 0.8 g (zinc) is added	allow a tolerance of ± ½ a small square allow until the temperature reaches 47 °C allow a correctly determined value for mass of zinc or temperature from the intersection of drawn lines of best fit	1	AO2
	(so) there is no additional reaction	allow (when) the reaction has finished	1	AO3
	(because) zinc is in excess **or** (because) copper sulfate is used up		1	AO3 4.5.1.1 RPA4

4.2.2.2 State symbols

Answer 05 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	polystyrene is a better (thermal) insulator	allow converse statements for glass	1	AO1 4.5.1.1 RPA4
	(so) there is less energy transfer to the surroundings	allow (so) less energy is lost (to the surroundings) allow heat for energy	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$ allow **1** mark for $Zn^{2+} + Cu$		2	AO2 4.1.1.1 4.2.2.2 4.4.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	(mean highest temperature =) $\frac{37.6 + 37.2 + 37.8 + 37.4}{4}$	allow (mean highest temperature =) $\frac{150}{4}$	1	AO2 4.3.1.4
	= 37.5 (ºC)		1	
	37.5 (ºC) ± 0.3 (ºC)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	any **one** from: • starting temperature may be different • inconsistent stirring	ignore room temperature allow inconsistent use of a lid	1	AO3 4.5.1.1 RPA4

Total Question 4	14

4.2.2.2 State symbols

Answer 03 · Examiner comments November 2020 | 8462/1H | Original Q6

Question 6 (standard, standard / high and high demand)

06.1 Most students were able to express the idea that activation energy is the minimum energy required to start a reaction. One common error was to say that it is the energy needed to make particles collide.

06.2 A variety of approaches was seen. The majority of students calculated the number of moles of both aluminium and of iron oxide and then attempted with varying degrees of success to explain why the number of moles of aluminium was insufficient for the iron oxide. Common errors were to omit to convert the mass from kilograms to grams, and/or using 54 as the 'M_r' of aluminium. Of those who did correctly calculate the number of moles of each reactant, some had difficulty in expressing clearly the idea of 2 moles of aluminium being needed to react with 1 mole of iron oxide, and therefore 37.0 moles of aluminium is less than the 37.5 moles required, or that 18.75 moles of iron oxide is more than the 18.5 moles required. Other students started with the mass of one reagent and calculated the required mass of the other, either by the moles method or by proportion. These students found it easier to express why there was insufficient aluminium or excess iron oxide.

06.3 Few students scored both marks. Aqueous zinc was often seen as a response. Many students did not understand the idea of an ionic equation and tried to include the sulfate ion.

06.4 Only a third of students scored both marks, but a lot of students were confused about which species gained electrons and which lost them. Definitions of oxidation and reduction in terms of gain and loss of oxygen were not appropriate here and were not credited.

Answer 04 · Examiner comments November 2021 | 8462/2H | Original Q10

Question 10 (standard, standard / high and high demand)

10.2 More than two thirds of students knew one condition (high temperature) and more than one third knew two.

10.3 There was a very wide range of marks but many did not score above Level 1. The main failure to reach Level 2 was that the question focuses on economics so that an answer which fails to mention energy, cost or a compromise in reaction conditions does not meet the level descriptor for Level 2. Similarly, the requirements for Level 3 were not usually met if the references did not mention the impact of reaction conditions on both rate and yield. Only a handful of students gave a Level 3 answer.

4.2.2.2 State symbols

10.4 Fermentation was well known.

10.5 Around half of students scored one mark by extending their knowledge of fermentation to this unfamiliar context, 'warm' was seen much more often than 'anaerobic'.

10.6 This was completely correct in the responses of nearly half of students. Where a mark was not obtained, this was usually caused by a failure to convert kilometres to metres.

10.7 A challenging concluding equation with no scaffolding which students found difficult.

Concluding Remarks

There is still some evidence that command words are misunderstood or ignored. This limits the marks awarded, especially in extended response questions. This is particularly true where a command word demands a reasoned judgement.

Students seemed well prepared for questions based on Organic Chemistry and Chemistry of the Atmosphere. In this series they seemed less equipped to deal with Chemical Analysis, Rate of Reaction and some aspects of Using Resources.

There were a number of instances of key reagents, techniques and colour changes still not being well known.

4.2.2.2 State symbols

Mark Ranges and Award of Grades

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

4.2.2.2 State symbols

Answer 05 · Examiner comments

Question 4 (standard and standard/high demand)

04.1 Just over two fifths of students correctly drew two straight lines, with the ascending line having an even scatter either side of the points, and the horizontal line avoiding the anomaly. Some lines were doubled or feathered so did not gain credit. Some drew two different curves, each encompassing all the points, and made them cross somewhere. This gained no credit. Students should be aware of the sort of graph produced by this required practical.

04.2 This question discriminated well, with a quarter of students scoring 3 or 4 marks and the great majority scoring at least one mark. The question asked students to explain the results, but many simply described them. It was not sufficient just to describe the temperature increasing with the addition of more zinc; reference to the reaction being exothermic was also needed. The fact that the maximum temperature change occurred when 0.80 g of zinc was added was the mark scored most often, but many students were also able to explain this turning point in terms of no further reaction being possible because the zinc was now in excess. There were some excellent answers in terms of the zinc being the limiting reactant up to 0.8 g, after which the copper sulfate became the limiting reactant.

04.3 Some excellent answers were seen; however, fewer than a quarter of students scored both marks and only three fifths scored at all. The question asked why a polystyrene cup gives a more accurate result, so answers needed to be phrased in comparative terms. Polystyrene is a better insulator than glass, but it is not true that polystyrene is 'an insulator' and glass is 'a conductor,' since both materials insulate and conduct thermal energy to different extents. Similarly, many answers implied that no energy is lost from a polystyrene cup, which is not true.

04.4 Nearly two fifths of students were able to give the correct formulae of the products but the state symbols were sometimes incorrect. A common incorrect formula was Zn^{2-}. There was sometimes no clear distinction between upper and lower case letters; the n and u need to be discernibly smaller than the Z and the C. Many students tried to give formulae of compounds rather than just the ion or atom.

04.5 The vast majority of students were able to calculate the mean. Fewer than half were also able to express the mean and the uncertainty correctly. Some students only averaged the highest and lowest values, which calculates the median rather than the mean. Although the mean and the median are the same in this particular set of values, this method did not gain credit. Some students calculated the uncertainty by halving the range. This calculates the range about the median, rather than the definition in the specification which is the range about the mean. This method was given credit on this occasion, although it is not strictly correct.

04.6 Students found this question difficult, with fewer than a quarter scoring the mark. Despite the information that there were no measurement errors, many students gave a type of measurement error as their answer. Reading the method carefully would have pointed out that the starting temperature was neither measured nor controlled, so may have fluctuated, and that stirring is inherently inconsistent. Some students had evidently done the practical using a lid and referred to it being replaced at different times; this was given credit.

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