AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.6.2.1

Reversible reactions

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**3**
Available paper years	**2020–2024**

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.

5.6.2.1 Reversible reactions

Answer 01 · Mark scheme November 2020 | 8464/C/2H | Original Q7

07.1	when a reversible reaction occurs in apparatus which prevents the escape of reactants and products (equilibrium is reached) when the forward and reverse reactions occur at (exactly) the same rate	allow when a reversible reaction occurs in a sealed system	1 1	AO1 5.6.2.3
07.2	(as pressure increases) the equilibrium position shifts to the right hand side (because) there are less moles / molecules (of dinitrogen tetroxide) on right hand side	allow (as pressure increases) the percentage of product / dinitrogen tetroxide / N_2O_4 increases allow (because) there are more moles / molecules (of nitrogen dioxide) on left hand side	1 1	AO2 5.6.2.4, 5.6.2.6 5.6.2.7
07.3	(as temperature increases) equilibrium position shifts to left hand side (because the forward) reaction is exothermic **or** (because) the backward reaction is endothermic (so) the percentage of product / dinitrogen tetroxide / N_2O_4 decreases		1 1 1	AO2 AO2 AO3 5.6.2.4 5.6.2.6 5.6.2.7
Total			**7**	

5.6.2.1 Reversible reactions

Answer 02 · Mark scheme

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	enzyme		1	AO1 5.6.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	provides a different reaction pathway (which) has a lower activation energy		1 1	AO1 5.6.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	the effects of changing conditions on the position of an equilibrium (in a closed system)	allow the effects of changing conditions on the yield of an equilibrium reaction (in a closed system)	1	AO1 5.6.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	(when) the forward and reverse reactions have the same rate in apparatus which prevents the escape of reactants and products	 allow in a closed system	1 1	AO1 5.6.2.3

5.6.2.1 Reversible reactions

Answer 02 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	yield increases (because) there are more moles (of gas) on the left hand side	 allow (because) there are fewer moles (of gas) on the right hand side	1 1	AO2 5.6.2.1 5.6.2.2 5.6.2.3 5.6.2.4 5.6.2.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.6	yield decreases (because) the system shifts in the endothermic direction		1 1	AO2 5.6.2.1 5.6.2.2 5.6.2.3 5.6.2.4 5.6.2.6

Total Question 6		10

5.6.2.1 Reversible reactions

Answer 03 · Mark scheme

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	= 198 kJ/mol		1	AO2 5.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	equilibrium position shifts to the right		1	AO2 5.6.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	equilibrium position shifts to the left		1	AO2 5.6.2.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	equilibrium position shifts to the left		1	AO2 5.6.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	(effect) (equilibrium position) does not change (reason) increases the rate of the forward reaction and reverse reaction equally		1 1	AO3 5.6.1.4 5.6.2.3

5.6.2.1 Reversible reactions

Answer 03 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	210 (s)	allow a value in the range 205 to 210 (s)	1	AO3 5.6.2.3
	lines become level / horizontal		1	
	(because) the rates of the forward reaction and reverse reaction are equal **or** (because) the number of moles (of all three gases) remain constant		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.7	tangent drawn at 60 s		1	AO2 5.6.1.1
	correct values for *y* step **and** *x* step from tangent	allow correct use of an incorrectly drawn tangent allow a tolerance of ± ½ a small square for each coordinate	1	
	(rate =) $\frac{\text{value for } y \text{ step}}{\text{value for } x \text{ step}}$	allow correct use of incorrectly determined value(s) from the tangent for *y* step and/or *x* step	1	
	correct calculation of rate (mol/s)		1	

Total Question 5	13

5.6.2.1 Reversible reactions

Answer 02 · Examiner comments

Question 6

Students struggled to identitify which parts of this question were about rates and which were about equilibria.

06.1 Students found this recall question fairly straightforward with around 85% recognising that a biological catalyst was an enzyme.

06.2 About half of students could describe that catalysts lower the activation energy, however, fewer than 20% could link that to an alternative reaction pathway. There were lots of references to energy and frequency of collisions, but the responses lacked context.

06.3 Only 5% of students were able to make the link between conditions changing and the way that the equilibrium moves accordingly.

06.4 About a third of students gained at least one mark for this item. The closed system and equal rates in the forward and reverse directions were both seen, however, fewer than 10% of students mentioned both conditions.

06.5 Just under a third of students identified the increase in yield, which scored one mark. An explanation in terms of number of moles on each side of the equation was seen on very few occasions.

06.6 Many students answered this question in terms of rates of reaction, and gave an increase in yield because ammonia is made quicker, which did not score.
An explanation in terms of movement in the endothermic direction was seen on very few occasions.

5.6.2.1 Reversible reactions

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.

Answer 03 · Examiner comments

Question 5 (standard/high & high demand)

05.1 Three-quarters of students correctly responded that the energy change in the backwards reaction was equal to the energy change in the forward reaction.

05.2 Half of students identified the correct equilibrium shift.

05.3 The multiple-choice questions at the beginning of question 5 become progressively harder, testing the students' understanding of Le Châtelier's principle. Fewer than half of all students correctly answered this question on the effect of pressure on the equilibrium.

05.4 Making the link from the stem that energy is released to the reaction being exothermic, and consequently the effect that a temperature change would have made on the position of this equilibrium, made this the most difficult of these multiple-choice questions. Fewer than 40% of students selected the correct answer.

05.5 Fewer than a third of students correctly gave the effect of a catalyst on equilibrium position for 1 mark. This was a high demand question and the small number of students who gained the second mark reflected this.

Many students had the same misconception that a catalyst only speeds up the forwards reaction. There were two common answers following this misconception: either that this meant the equilibrium would shift right as the forwards reaction had been sped up or that the equilibrium would therefore shift to the left to oppose this.

05.6 Most students were able to gain 1 mark, for the correct time. Common incorrect responses were 200 and 82.5 (seconds). If students put 82.5 then they had the misconception that the equilibrium was reached when the lines crossed and so were prevented from getting any further marks. Students often referred to equilibrium being where the moles were equal at 82.5 seconds.

The mark scheme identified where equilibrium was reached, how the graph showed this and what the graph meant in terms of moles of the three gases.

For the second marking point, a clear description of the line flattening out, not just straightening, was required as 'straightening' could be vertical.

The third marking point is for the number of *moles* not changing. Some students stated that the reaction had stopped, meaning that they could not be awarded the third marking point. Equally, if a student stated that the number of moles was equal, the mark could not be given.

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5.6.2.1 Reversible reactions

Answer 03 · Examiner comments June 2024 | 8464/C/2H | Original Q5

0 5 . 6 Determine the time taken for the reaction to reach equilibrium.

Explain your answer.

Use **Figure 5**.

[3 marks]

Time 210 s

Explanation All the lines go straight to show that the ~~mole~~ number of moles is not changing, ~~and the reaction is ready~~ meaning the reaction has reached equilibrium.

0 5 . 6 Determine the time taken for the reaction to reach equilibrium.

Explain your answer.

Use **Figure 5**.

[3 marks]

Time 210 s

Explanation This is where the line flattens out on the graph. The reaction has taken place and reached equilibrium because the number of moles of each gas is not changing, so therefore the reaction is no longer occuring.

In the first response the student gains the mark for the time, but the 'lines go straight' is insufficient for marking point 2. Marking point 3 is given for the number of moles not changing.

The second response gains marking point 1 for a correct time. Marking point 2 is also given for the '… line flattens out …'. The student would have been given the third marking point for '… the number of moles of each gas is not changing …'; however, this mark cannot be awarded as the student goes on to state that the '… reaction is no longer occurring'.

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5.6.2.1 Reversible reactions

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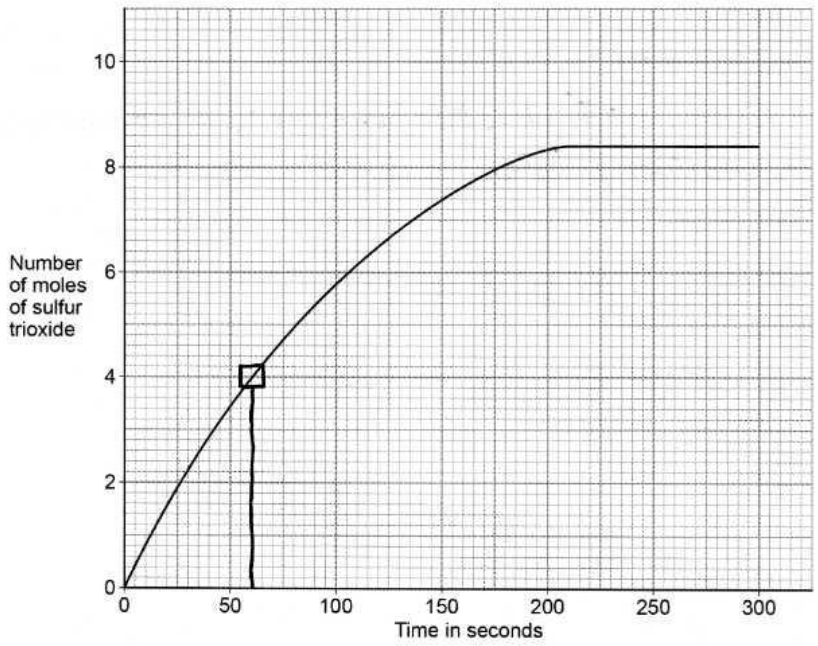
05.7 It is evident that students are becoming more familiar with drawing gradients to calculate rates, with a third of students gaining full marks on this high-demand calculation. It should be noted that students who do not draw a tangent cannot gain any marks since the fundamental chemical idea is not known and understood.

0 5 . 7 **Figure 6** shows the results for sulfur trioxide.

Figure 6



Determine the rate of reaction at 60 seconds.

[4 marks]

2÷50 = 0.04 mol/s

Rate = 0.04 mol/s

The student needs to first draw a tangent at 60 s in order to be able to calculate the rate. Here, no tangent has been drawn, so no marks are awarded.

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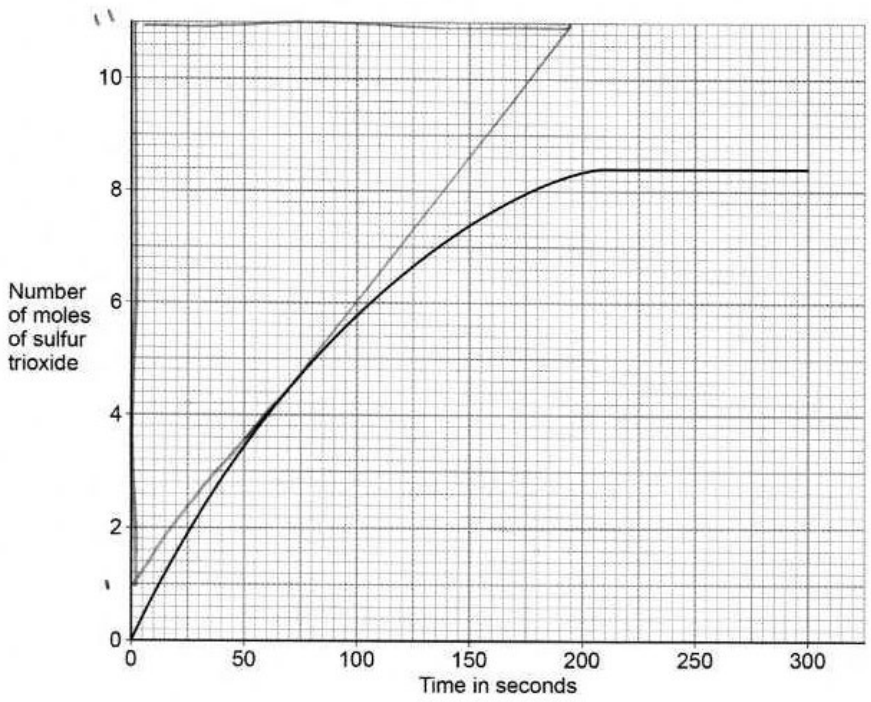
5.6.2.1 Reversible reactions

Answer 03 · Examiner comments June 2024 | 8464/C/2H | Original Q5

The most common errors were misreading the *x*-step and/or the *y*-step. Progress could still be made in the calculation if it was clear that the values had come from a tangent and had been used correctly. Substitution into the equation upside down meant that neither marking point 3 nor marking point 4 could be given.

0 5 . 7 **Figure 6** shows the results for sulfur trioxide.

Figure 6



Determine the rate of reaction at 60 seconds.

[4 marks]

11 − 1 = 10 $\frac{10}{195}$ = 0.051282

195 − 0 = 195

Rate = 0.051282 mol/s

This student has made a good attempt at drawing the tangent at 60 s, so marking point 1 can be awarded. They have drawn a triangle on the graph and substituted correct values for the *y*-step and the *x*-step into the expression (10 ÷ 195), which they have then correctly evaluated. The recurring dots can be ignored as there was no significant figures mark for this question. All 4 marks are awarded.

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