AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.6.1.3

Collision theory and activation energy

Past-paper questions

Tier	**Higher**
Question groups	**17**
Available paper years	**2008–2024**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.6.1.3 Collision theory and activation energy

Question 01

January 2008 | CHY2H | Original Q1 | Legacy

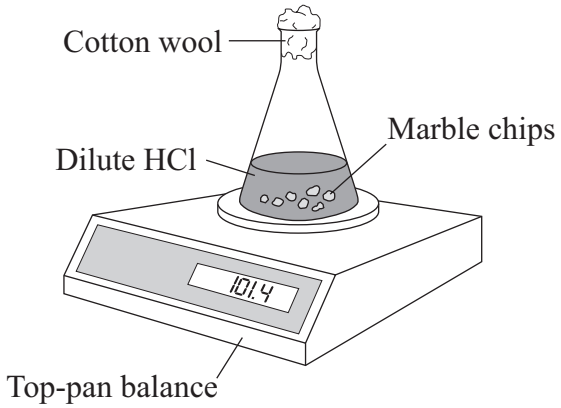
1 A student investigated the rate of reaction between marble and hydrochloric acid.

The student used an excess of marble.

The reaction can be represented by this equation.

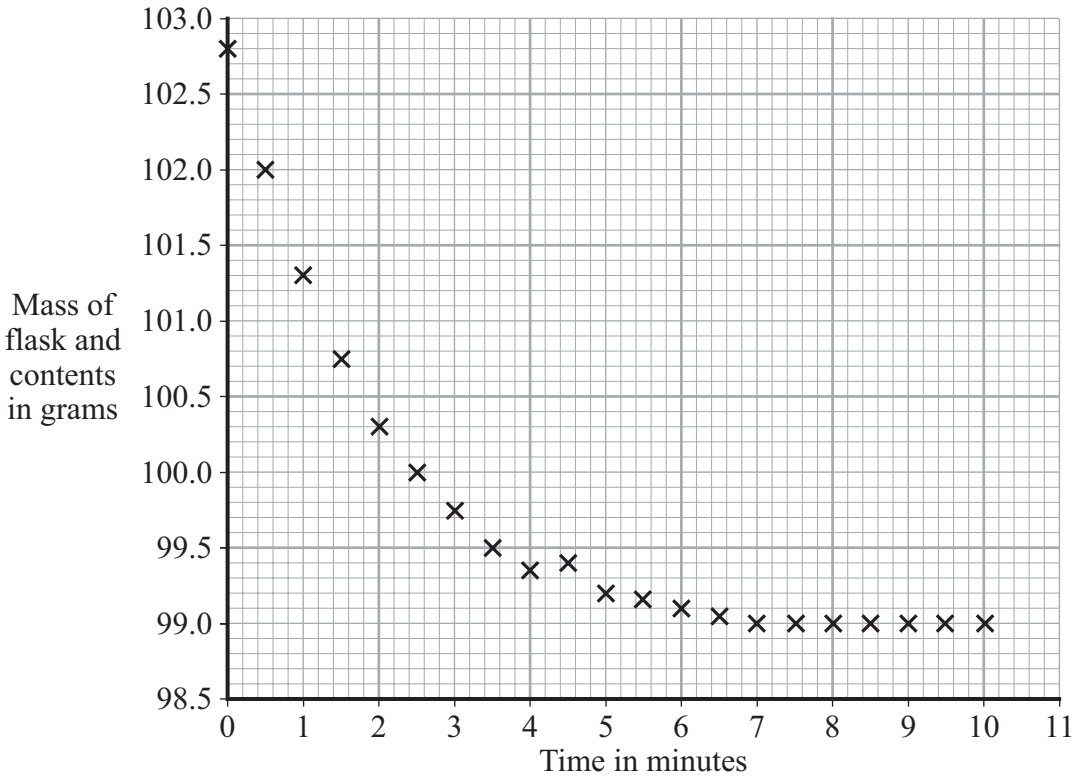
$CaCO_3$ (s) + 2HCl (aq) → $CaCl_2$ (aq) + H_2O (l) + CO_2 (g)

The student used the apparatus shown in the diagram.



The student measured the mass of the flask and contents every half minute for ten minutes.

The results are shown on the graph. Use the graph to answer the questions.



4.6.1.3 Collision theory and activation energy

Question 01 · continued

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(a) **Complete the graph** opposite by drawing a line of best fit.

(1 mark)

(b) Why did the mass of the flask and contents decrease with time?

.....

.....

(1 mark)

(c) After how many minutes had all the acid been used up?

..... minutes

(1 mark)

(d) The student repeated the experiment at a higher temperature. All other variables were kept the same as in the first experiment. The rate of reaction was much faster.

(i) Draw a line **on the graph** opposite to show what the results for this second experiment might look like.

(2 marks)

(ii) Why does an increase in temperature increase the rate of reaction?

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(3 marks)

8

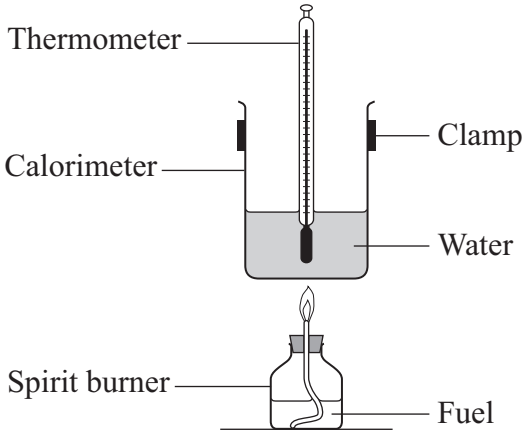
4.6.1.3 Collision theory and activation energy

Question 02

January 2008 | CHY3H | Original Q1 | Legacy

1 A student burned four fuels and compared the amounts of energy they produced.

The student set up the apparatus as shown in the diagram.



The heat produced when each fuel was burned was used to raise the temperature of 100 g of water. The student noted the mass of fuel burned, the increase in temperature and whether the flame was smoky.

The results are shown in the table.

Fuel	Mass of fuel burned (g)	Temperature increase (°C)	Type of flame
Ethanol	4	24	Not smoky
Methanol	3	9	Not smoky
Peanut oil	2	20	Smoky
Vegetable oil	1	15	Smoky

(a) The student suggested that the vegetable oil was the best fuel for producing heat.

Explain why.

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(2 marks)

4.6.1.3 Collision theory and activation energy

Question 02 · continued

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(b) Suggest an environmental problem that could be caused when large amounts of vegetable oil are burned. Suggest how the problem could be overcome.

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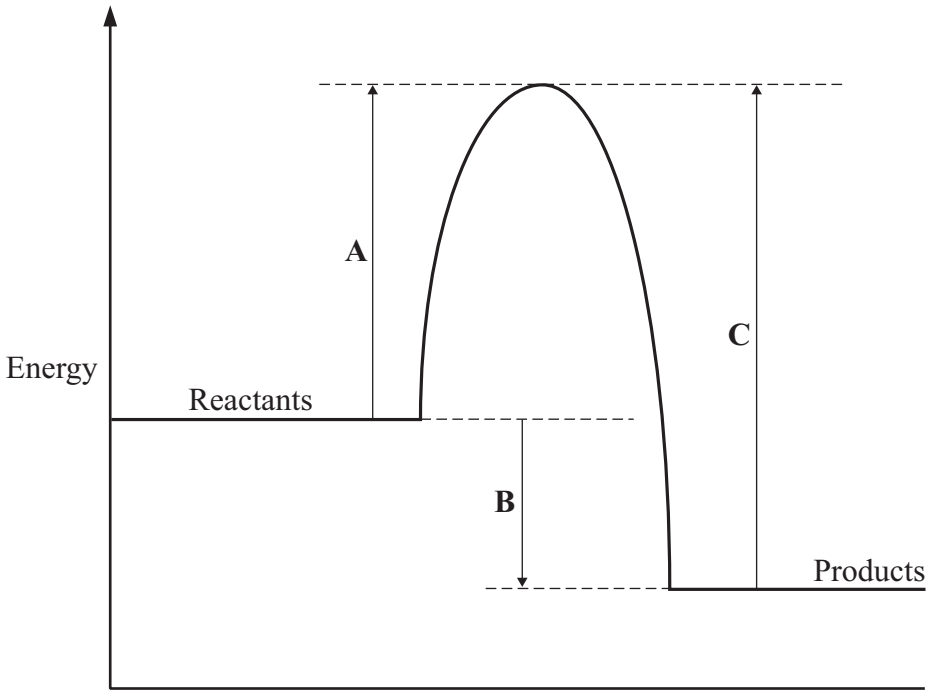
(2 marks)

(c) An energy level diagram for the burning of vegetable oil is shown below.



Which of the energy changes **A**, **B** or **C**:

(i) represents the activation energy .....
(1 mark)

(ii) shows the amount of energy given out during the reaction? .....
(1 mark)

6

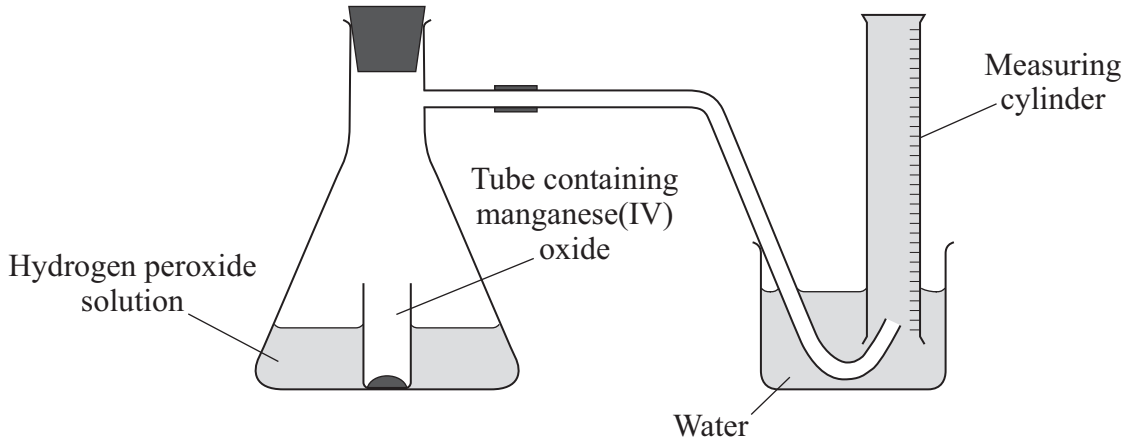
4.6.1.3 Collision theory and activation energy

Question 03

5 A student investigated the effect of temperature on the decomposition of hydrogen peroxide. Hydrogen peroxide decomposes to oxygen and water when a manganese(IV) oxide catalyst is added.

The student measured the time taken to collect 5 cm^3 of oxygen gas.

The apparatus shown below was used for the investigation. The reaction was started by shaking the flask so that the manganese(IV) oxide and hydrogen peroxide were mixed.



The student did the investigation at two different temperatures. All the other variables were kept constant.

The student's results are shown in the table.

Temperature of the hydrogen peroxide solution in °C	Volume of oxygen collected in cm^3	Time taken to collect the oxygen in seconds	Rate of reaction in cm^3 per second
20	5	40	0.125
25	5	25	

5 (a) (i) Calculate the rate of reaction at 25 °C.

.....

Rate of reaction = ... cm^3 per second

(2 marks)

5 (a) (ii) The teacher said that the student should repeat the investigation to get more results.

Suggest why.

.....

.....

(1 mark)

4.6.1.3 Collision theory and activation energy

Question 03 · continued

for mark

5 (b) The student concluded that:

'the rate of reaction increases when the temperature is increased'.

Explain, in terms of particles, why the rate of reaction increases.

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(2 marks)

5

Turn over for the next question

4.6.1.3 Collision theory and activation energy

Question 04

January 2010 | CHY3H | Original Q6 | Legacy

6 During a thunderstorm lightning strikes the Eiffel Tower.

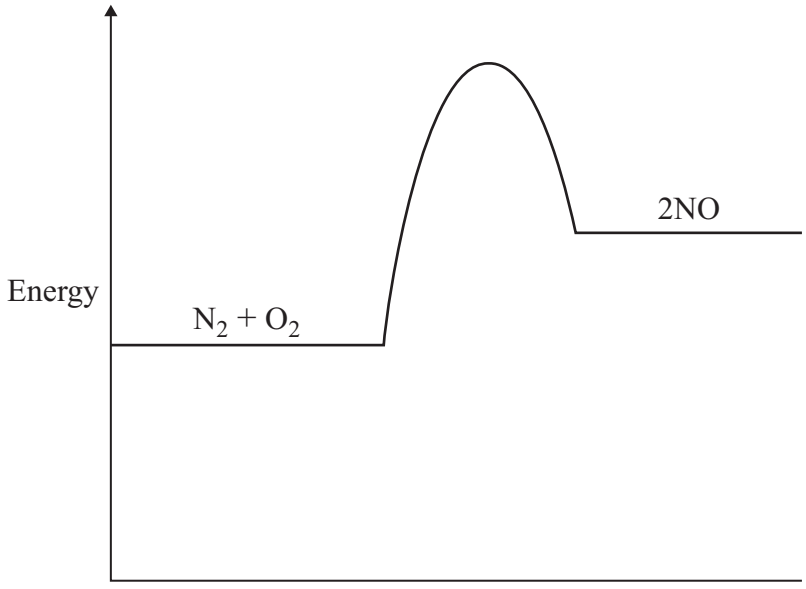


In lightning the temperature can reach 30 000 °C. This causes nitrogen and oxygen in the air to react, producing nitrogen oxide. This reaction has a high *activation energy* and is *endothermic*.

An equation that represents this endothermic reaction is:

$$N_2 + O_2 \rightarrow 2NO$$

The energy level diagram for this reaction is given below.



6 (a) The energy level diagram shows that this reaction is *endothermic*.

Explain how.

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(1 mark)

4.6.1.3 Collision theory and activation energy

Question 04 · continued

for mark

6 (b) What is meant by the term *activation energy*?

.....

.....

(1 mark)

6 (c) The equation showing the structural formulae of the reactants and products is

$$N \equiv N \quad + \quad O = O \quad \rightarrow \quad 2\ N = O$$

Bond	Bond energy in kJ
N ≡ N	945
O = O	498
N = O	630

6 (c) (i) Use the bond energies in the table to calculate the energy change for this reaction.

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Energy change = ... kJ

(3 marks)

6 (c) (ii) In terms of bond energies, explain why this reaction is endothermic.

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(1 mark)

6

4.6.1.3 Collision theory and activation energy

Question 05

June 2010 | CHY2H | Original Q6 | Legacy

6 The equation for a reaction to produce hydrogen is:

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

6 (a) Explain why changing the pressure does **not** affect the yield of hydrogen at equilibrium.

.....

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(1 mark)

6 (b) Suggest why the best yield of hydrogen at equilibrium is obtained at **low** temperatures.

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(1 mark)

6 (c) The temperature used in industry needs to be high enough for the reaction to take place quickly. Explain, in terms of particles, why the rate of reaction increases when the temperature is increased.

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(3 marks)

6 (d) Scientists have developed catalysts which allow the reaction to take place quickly at lower temperatures. How could this be good for the manufacturer and for the environment?

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(2 marks)

7

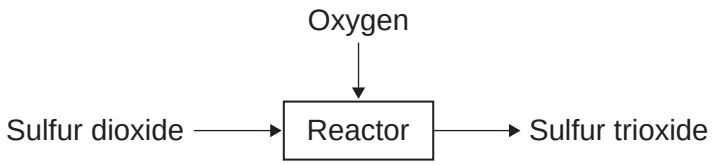
4.6.1.3 Collision theory and activation energy

Question 06

June 2014 | CH2HP | Original Q3 | Legacy

3 **Figure 2** represents a reaction in the production of sulfuric acid.

Figure 2



3 (a) Complete and balance the equation for the reaction.

[2 marks]

..... $SO_2(g)$ + ... (g) $\rightleftharpoons$ ..... $SO_3(g)$

3 (b) The conditions can affect the rate of the reaction.

3 (b) (i) The pressure of the reacting gases was increased.

State the effect of increasing the pressure on the rate of reaction.

Explain your answer in terms of particles.

[3 marks]

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4.6.1.3 Collision theory and activation energy

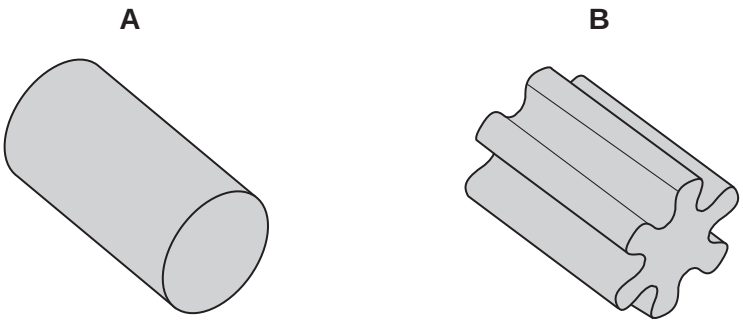
Question 06 · continued

3 (b) (ii) A catalyst is used for the reaction.

The gases pass through a layer containing pieces of the catalyst.

Figure 3 shows the shapes of pieces of catalyst.

Figure 3



Suggest and explain why shape **B** is more effective as a catalyst than shape **A**.

[2 marks]

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3 (c) The reaction is carried out at a high temperature to provide the reactants with the **activation energy**.

What is meant by the **activation energy**?

[1 mark]

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4.6.1.3 Collision theory and activation energy

Question 06 · continued

3 (d) Sulfuric acid reacts with metals to produce salts.

3 (d) (i) A student concluded that potassium would **not** be a suitable metal to react with sulfuric acid.

Explain why.

[2 marks]

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3 (d) (ii) A student reacted zinc metal with sulfuric acid to produce a salt and another product.

Complete the equation for this reaction.

[2 marks]

$Zn + H_2SO_4 \longrightarrow$ ..... + ...

3 (d) (iii) The student wanted to increase the rate of the reaction between the zinc and sulfuric acid.

State **one** way, other than using a catalyst, that the student could increase the rate of the reaction.

[1 mark]

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.....

13

4.6.1.3 Collision theory and activation energy

Question 07

June 2014 | CH3HP | Original Q6 | Legacy

6 Some cars are powered by hydrogen fuel cells.

Figure 6



6 (a) What type of energy is released by hydrogen fuel cells?

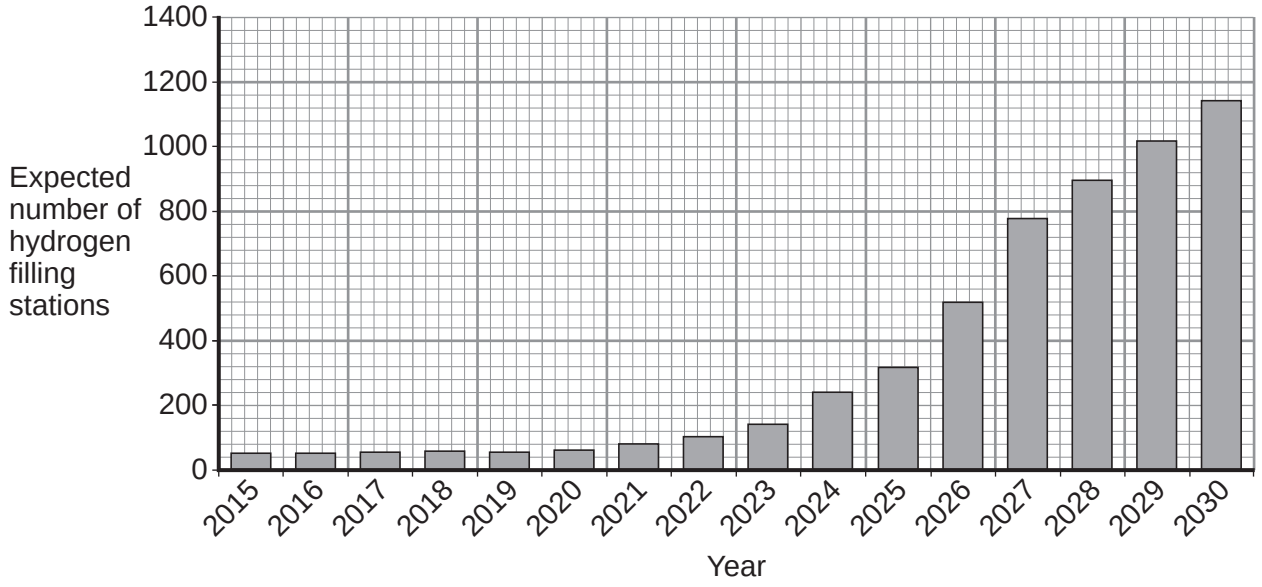
[1 mark]

.....

6 (b) Owners of cars powered by fuel cells buy hydrogen from hydrogen filling stations.

Figure 7 shows how the number of hydrogen filling stations in the UK is expected to increase up to the year 2030.

Figure 7



4.6.1.3 Collision theory and activation energy

Question 07 · continued

Use the information in **Figure 7** and your own knowledge to answer this question.

Suggest **two** reasons why the UK government might encourage the building of more hydrogen filling stations.

[2 marks]

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Question 6 continues on the next page

Question 07 · continued

6 (c) The equation for the reaction of hydrogen with oxygen is:

$$2H_2 + O_2 \longrightarrow 2H_2O$$

During the reaction, energy is used to break the bonds of the reactants.

Energy is released when new bonds are made to form the product.

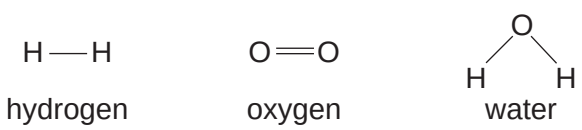
Bond energies for the reaction are given in **Table 1**.

Table 1

Bond	Bond energy in kJ
H—H	436
O=O	498
O—H	464

The structures of the reactants and product are shown in **Figure 8**.

Figure 8



6 (c) (i) Calculate the energy change for the reaction:

$$2H_2 + O_2 \longrightarrow 2H_2O$$

[3 marks]

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Energy change = ... kJ

4.6.1.3 Collision theory and activation energy

Question 07 · continued

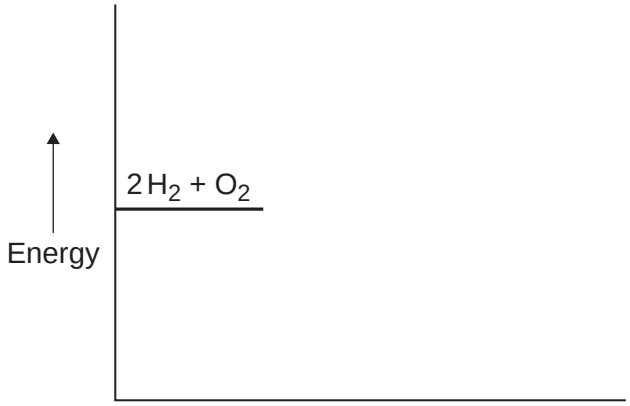
6 (c) (ii) The reaction of hydrogen with oxygen is exothermic.

Complete the energy level diagram for this reaction on **Figure 9**.

Clearly label the activation energy.

[3 marks]

Figure 9



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4.6.1.3 Collision theory and activation energy

Question 08

June 2015 | CH3HP | Original Q6 | Legacy

6 This question is about reversible reactions and chemical equilibrium.

6 (a) Reversible reactions can reach equilibrium in a closed system.

6 (a) (i) What is meant by a closed system?

[1 mark]

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6 (a) (ii) Explain why, when a reversible reaction reaches equilibrium, the reaction appears to have stopped.

[2 marks]

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4.6.1.3 Collision theory and activation energy

Question 08 · continued

6 (b) In the Haber process, the reaction of nitrogen with hydrogen to produce ammonia is reversible.

$$N_2(g) + 3\,H_2(g) \rightleftharpoons 2\,NH_3(g)$$

6 (b) (i) Name a natural resource from which hydrogen is produced.

[1 mark]

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6 (b) (ii) The Haber process uses a catalyst to speed up the reaction.

Explain how a catalyst speeds up a reaction.

[2 marks]

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.....

6 (b) (iii) What happens to the amount of ammonia produced at equilibrium if the pressure is increased?

Give a reason for your answer.

[2 marks]

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Question 6 continues on the next page

4.6.1.3 Collision theory and activation energy

Question 08 · continued

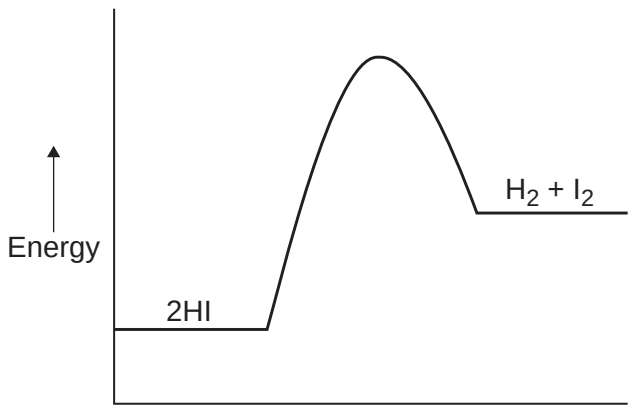
6 (c) The decomposition of hydrogen iodide into hydrogen and iodine is reversible.

$$2HI(g) \rightleftharpoons H_2(g) + I_2(g)$$

The forward reaction is endothermic.

The energy level diagram in **Figure 3** is for the forward reaction.

Figure 3



6 (c) (i) Draw an arrow to show the activation energy on the diagram in **Figure 3**.

[1 mark]

4.6.1.3 Collision theory and activation energy

Question 08 · continued

6 (c) (ii) How does the diagram in **Figure 3** show that the reaction is endothermic?

[1 mark]

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6 (c) (iii) Suggest what effect, if any, increasing the temperature will have on the amount of hydrogen iodide at equilibrium.

Give a reason for your answer.

[2 marks]

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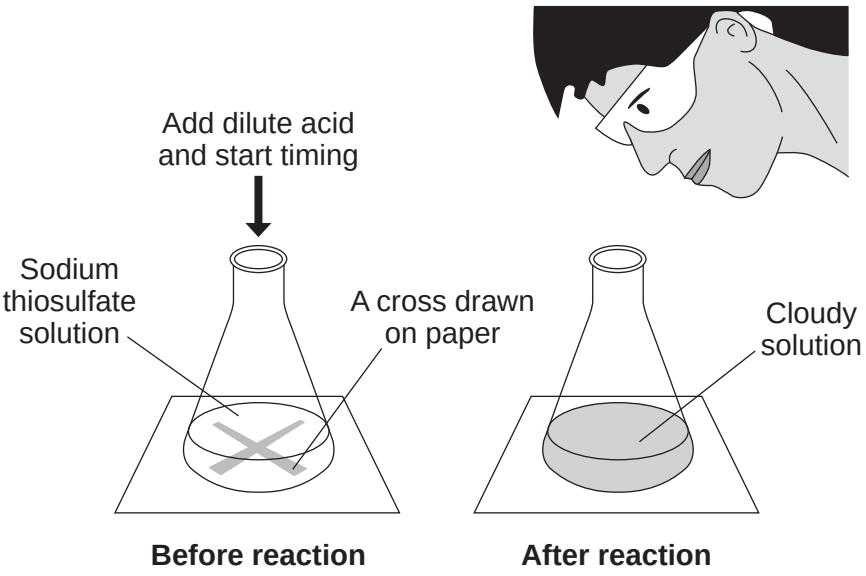
12

4.6.1.3 Collision theory and activation energy

Question 09

4 A student investigated the effect of temperature on the rate of a reaction.
Figure 4 shows an experiment.

Figure 4



The student:

- put sodium thiosulfate solution into a conical flask
- heated the sodium thiosulfate solution to the required temperature
- put the flask on a cross drawn on a piece of paper
- added dilute hydrochloric acid and started a stopclock
- stopped the stopclock when the cross could no longer be seen
- repeated the experiment at different temperatures.

The equation for the reaction is:

$$Na_2S_2O_3(aq) + 2HCl(aq) \longrightarrow 2NaCl(aq) + H_2O(l) + SO_2(g) + S(s)$$

sodium thiosulfate	hydrochloric acid	sodium chloride	water	sulfur dioxide	sulfur

4.6.1.3 Collision theory and activation energy

Question 09 · continued

4 (a) Explain why the solution goes cloudy.

[2 marks]

4 (b) Give **two** variables the student must control to make the investigation a fair test.

[2 marks]

1 _____

2 _____

4 (c) State the effect that increasing the temperature of the sodium thiosulfate solution has on the rate of the reaction.
Explain this effect in terms of particles and collisions.

[4 marks]

4 (d) Suggest how the student should change the method to investigate the rate of reaction at 5 °C.

[1 mark]

9

4.6.1.3 Collision theory and activation energy

Question 10

June 2016 | CH3HP | Original Q5 | Legacy

5 This question is about energy changes in chemical reactions.

5 (a) Balance the chemical equation for the combustion of methane.

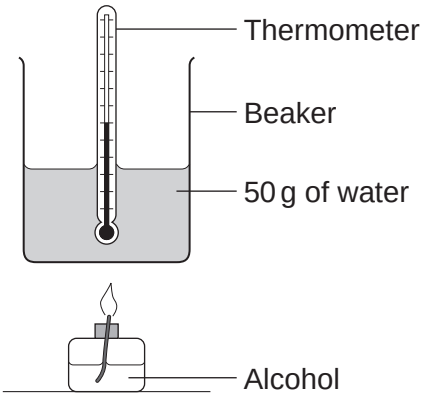
[1 mark]

$$CH_4 \quad + \quad O_2 \quad \longrightarrow \quad CO_2 \quad + \quad H_2O$$

5 (b) Alcohols are used as fuels.

A group of students investigated the amount of energy released when an alcohol was burned. The students used the apparatus shown in **Figure 5**.

Figure 5



In one experiment the temperature of 50 g of water increased from 22.0 °C to 38.4 °C. The mass of alcohol burned was 0.8 g.

Calculate the heat energy (Q) in joules, released by burning 0.8 g of the alcohol.
Use the equation:

$$Q = m \times c \times \Delta T$$

Specific heat capacity (c) = 4.2 J/g/°C

[3 marks]

Heat energy (Q) = _____ J

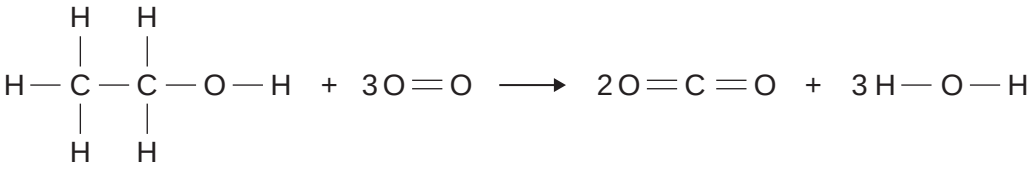
4.6.1.3 Collision theory and activation energy

Question 10 · continued

5 (c) The chemical equation for the combustion of ethanol is:

$$C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$$

5 (c) (i) The equation for the reaction can be shown as:



Bond	Bond energy in kJ per mole
C — H	413
C — C	347
C — O	358
C = O	799
O — H	467
O = O	495

Use the bond energies to calculate the overall energy change for this reaction.

[3 marks]

Overall energy change = _____ kJ per mole

Question 5 continues on the next page

4.6.1.3 Collision theory and activation energy

Question 10 · continued

5 (c) (ii) The reaction is exothermic.
Explain why, in terms of bonds broken and bonds formed.

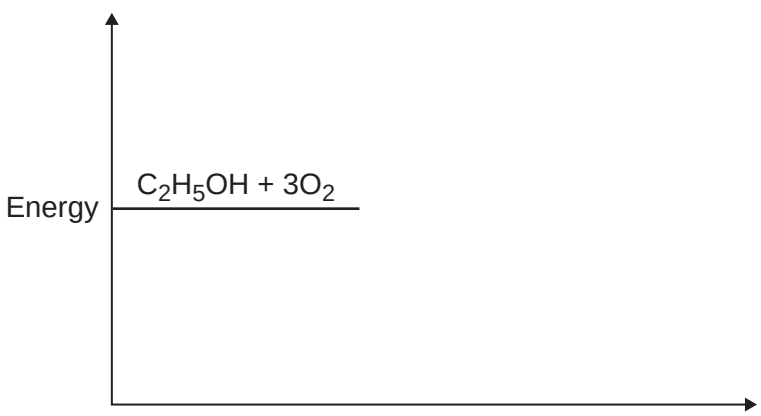
[2 marks]

5 (c) (iii) Complete the energy level diagram for the combustion of ethanol.

[3 marks]

On the completed diagram, label:

- activation energy
- overall energy change.



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4.6.1.3 Collision theory and activation energy

Question 11

June 2019 | 8462/1H | Original Q5

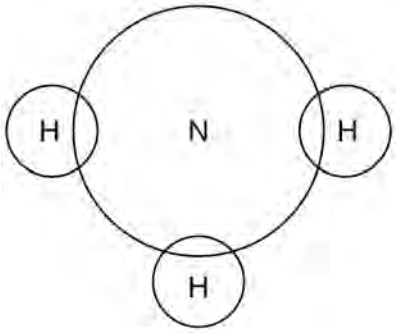
0 5 This question is about ammonia, NH_3

0 5 . 1 Complete the dot and cross diagram for the ammonia molecule shown in **Figure 6**.

Show only the electrons in the outer shell of each atom.

[2 marks]

Figure 6



0 5 . 2 Give **one** limitation of using a dot and cross diagram to represent an ammonia molecule.

[1 mark]

0 5 . 3 Explain why ammonia has a low boiling point.

You should refer to structure and bonding in your answer.

[3 marks]

Question 11 · continued

Ammonia reacts with oxygen in the presence of a metal oxide catalyst to produce nitrogen and water.

0 5 . 4 Which metal oxide is most likely to be a catalyst for this reaction?

[1 mark]

Tick (✓) **one** box.

- CaO ☐
- Cr_2O_3 ☐
- MgO ☐
- Na_2O ☐

Figure 7 shows the displayed formula equation for the reaction.

Figure 7

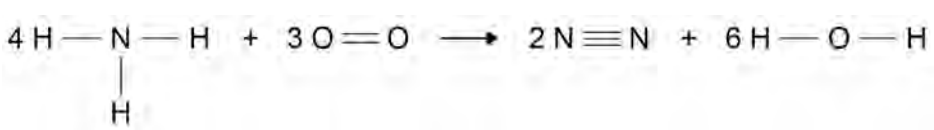


Table 3 shows some bond energies.

Table 3

Bond	N — H	O = O	N ≡ N	O — H
Bond energy in kJ/mol	391	498	945	464

4.6.1.3 Collision theory and activation energy

Question 11 · continued

0 5 . 5 Calculate the overall energy change for the reaction.

Use **Figure 7** and **Table 3**.

[3 marks]

Overall energy change = _____ kJ

0 5 . 6 Explain why the reaction between ammonia and oxygen is exothermic.

Use values from your calculation in Question **05.5**

[2 marks]

Question 5 continues on the next page

4.6.1.3 Collision theory and activation energy

Question 11 · continued

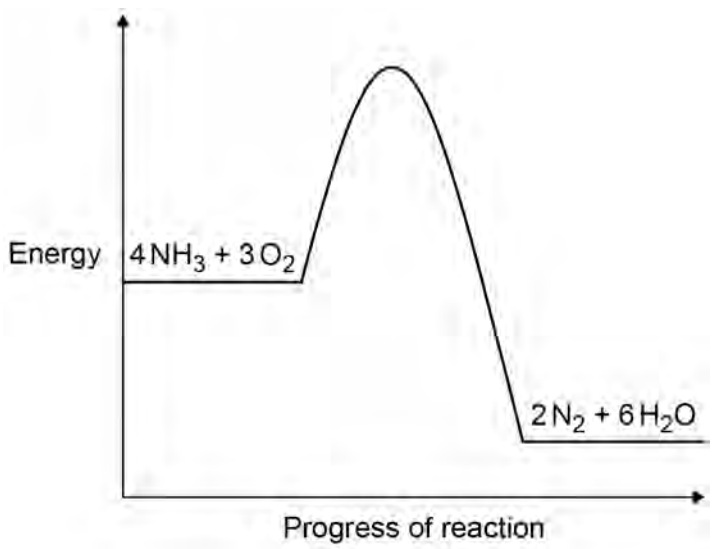
0 5 . 7 **Figure 8** shows the reaction profile for the reaction between ammonia and oxygen.

Complete **Figure 8** by labelling the:

- activation energy
- overall energy change.

[2 marks]

Figure 8



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4.6.1.3 Collision theory and activation energy

Question 12

June 2019 | 8462/2H | Original Q9

0 9 Some students investigated the rate of decomposition of hydrogen peroxide, H_2O_2

The equation for the reaction is:

$$2\,H_2O_2(aq) \rightarrow 2\,H_2O(l) + O_2(g)$$

The catalyst for the reaction is manganese dioxide.

0 9 . 1 Describe a test to identify the gas produced in the reaction.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

_____

4.6.1.3 Collision theory and activation energy

Question 12 · continued

Student **A** investigated the effect of the particle size of manganese dioxide on the rate of the reaction.

This is the method used.

1. Measure 25 cm^3 of 0.3 mol/dm^3 hydrogen peroxide solution into a conical flask.

2. Add a spatula of fine manganese dioxide powder to the conical flask.

3. Measure the volume of gas produced every minute for 10 minutes.

4. Repeat steps 1 to 3 with some coarse manganese dioxide lumps.

0 9 . 2 The method student **A** used did **not** give valid results.

What **two** improvements could student **A** make to the method to give valid results?

[2 marks]

Tick (✓) **two** boxes.

- Measure the increase in mass of the conical flask and contents. ☐
- Measure the volume of gas produced every 2 minutes. ☐
- Place the conical flask in a water bath at constant temperature. ☐
- Use 0.05 mol/dm^3 hydrogen peroxide solution. ☐
- Use a mass of 1 g manganese dioxide each time. ☐

Question 9 continues on the next page

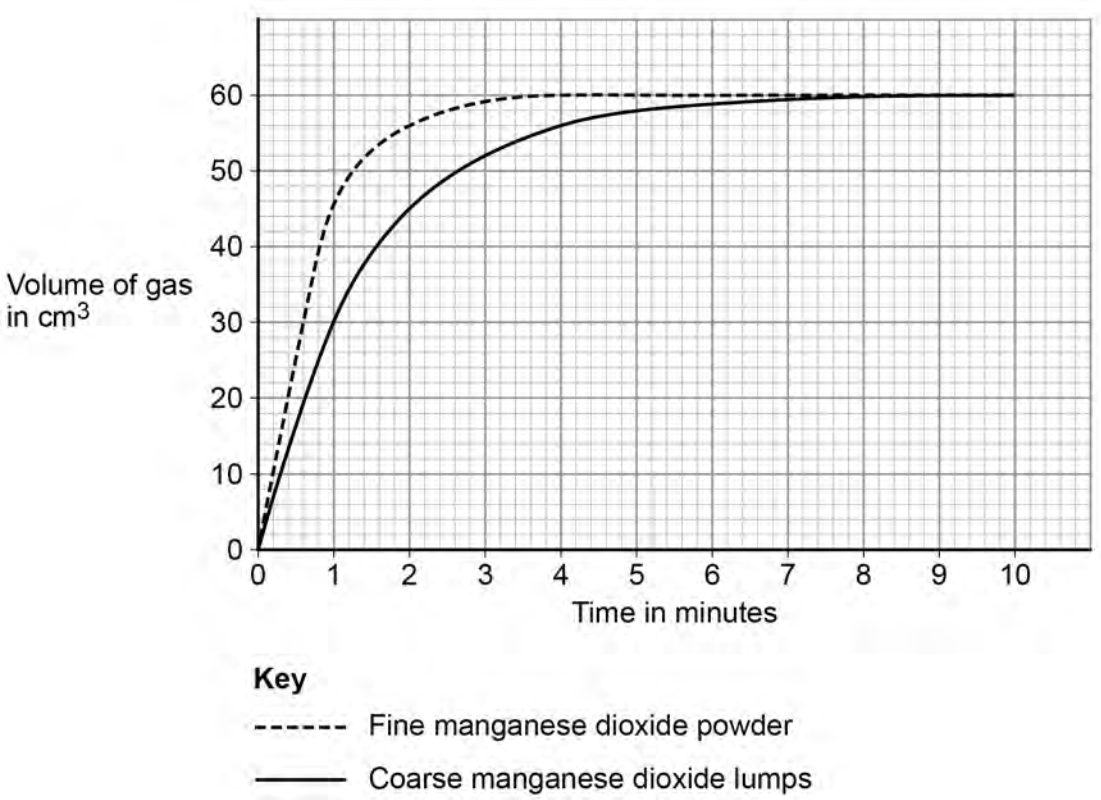
4.6.1.3 Collision theory and activation energy

Question 12 · continued

Student **B** used a method which gave valid results.

Figure 9 shows student **B**'s results.

Figure 9



0 9 . 3 Determine the mean rate of reaction in cm^3/s between 2 and 4 minutes for coarse manganese dioxide lumps.

Give your answer to 2 significant figures.

Use data from **Figure 9**.

[3 marks]

Mean rate of reaction = _____ cm^3/s

4.6.1.3 Collision theory and activation energy

Question 12 · continued

Hydrogen peroxide molecules must collide with manganese dioxide particles for catalysis to take place.

0 9 . 4 Student **B** repeated the experiment with coarse lumps of manganese dioxide.

Student **B** used the same volume of 0.2 mol/dm^3 hydrogen peroxide instead of 0.3 mol/dm^3 hydrogen peroxide.

Sketch on **Figure 9** the curve you would expect to see.

Assume that the reaction is complete after 9 minutes.

[2 marks]

0 9 . 5 The rate of reaction is different when manganese dioxide is used as a fine powder rather than coarse lumps.

Explain why.

You should answer in terms of collision theory.

[2 marks]

11

4.6.1.3 Collision theory and activation energy

Question 13

November 2020 | 8462/1H | Original Q6

0 6 This question is about displacement reactions.

0 6 . 1 The displacement reaction between aluminium and iron oxide has a high activation energy.

What is meant by 'activation energy'?

[1 mark]

0 6 . 2 A mixture contains 1.00 kg of aluminium and 3.00 kg of iron oxide.

The equation for the reaction is:

$$2\,Al + Fe_2O_3 \rightarrow 2\,Fe + Al_2O_3$$

Show that aluminium is the limiting reactant.

Relative atomic masses (A_r): O = 16 Al = 27 Fe = 56

[4 marks]

4.6.1.3 Collision theory and activation energy

Question 13 · continued

Magnesium displaces zinc from zinc sulfate solution.

0 6 . 3 Complete the ionic equation for the reaction.

You should include state symbols.

[2 marks]

$$Mg(s) + Zn^{2+}(aq) \rightarrow _____ + _____$$

0 6 . 4 Explain why the reaction between magnesium atoms and zinc ions is both oxidation and reduction.

[2 marks]

9

4.6.1.3 Collision theory and activation energy

Question 14

November 2021 | 8462/1H | Original Q8

0 8 This question is about the reaction between hydrogen sulfide (H_2S) and oxygen.

The equation for the reaction is:

$$2\,H_2S(g) + 3\,O_2(g) \rightarrow 2\,H_2O(g) + 2\,SO_2(g)$$

0 8 . 1 What does $H_2O(g)$ represent?

[1 mark]

0 8 . 2 Calculate the volume of oxygen required to react with 50 cm^3 of hydrogen sulfide.

[1 mark]

Volume = _____ cm^3

0 8 . 3 **Figure 6** shows part of the reaction profile for the reaction.

The reaction is exothermic.

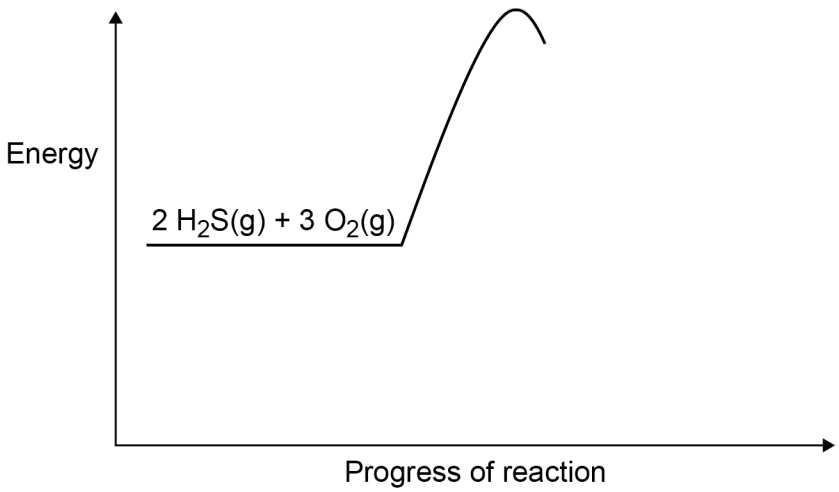
Complete **Figure 6**.

You should:

- complete the profile line
- label the activation energy
- label the overall energy change.

[3 marks]

Figure 6



4.6.1.3 Collision theory and activation energy

Question 14 · continued

0 8 . 4 **Figure 7** shows the displayed formula equation for the reaction of hydrogen sulfide with oxygen.

Figure 7

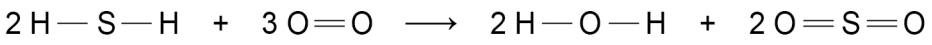


Table 5 shows some of the bond energies.

Table 5

Bond	H — S	O = O	H — O	S = O
Energy in kJ/mol	364	498	464	**X**

In the reaction the energy released forming new bonds is 1034 kJ/mol greater than the energy needed to break existing bonds.

Calculate the bond energy **X** for the S = O bond.

Use **Figure 7** and **Table 5.**

[5 marks]

X = _____ kJ/mol

10

4.6.1.3 Collision theory and activation energy

Question 15

November 2021 | 8462/2H | Original Q9

0 9 A student investigated how a change in concentration affects the rate of the reaction between zinc powder and sulfuric acid.

The equation for the reaction is:

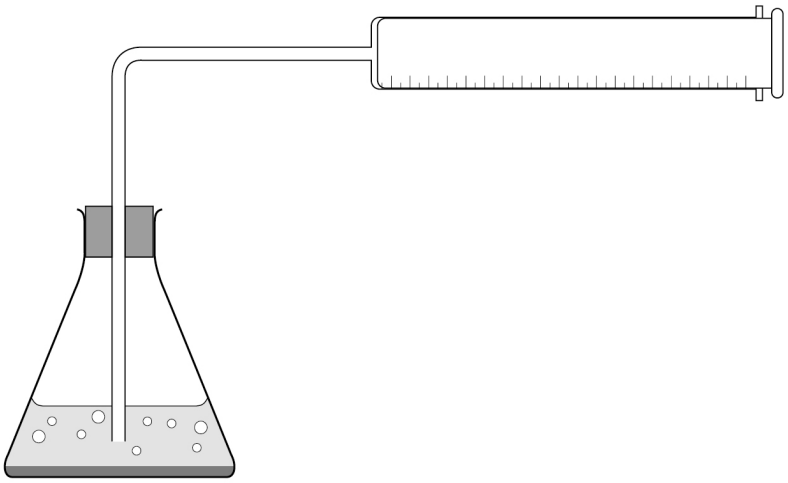
$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

This is the method used.

1. Pour 50 cm^3 of sulfuric acid of concentration 0.05 mol/dm^3 into a conical flask.
2. Add 0.2 g of zinc powder to the conical flask.
3. Put the stopper in the conical flask.
4. Measure the volume of gas collected every 30 seconds for 5 minutes.
5. Repeat steps 1 to 4 with sulfuric acid of concentration 0.10 mol/dm^3

Figure 8 shows the apparatus used.

Figure 8



0 9 . 1 The student made an error in setting up the apparatus in **Figure 8**.

What error did the student make?

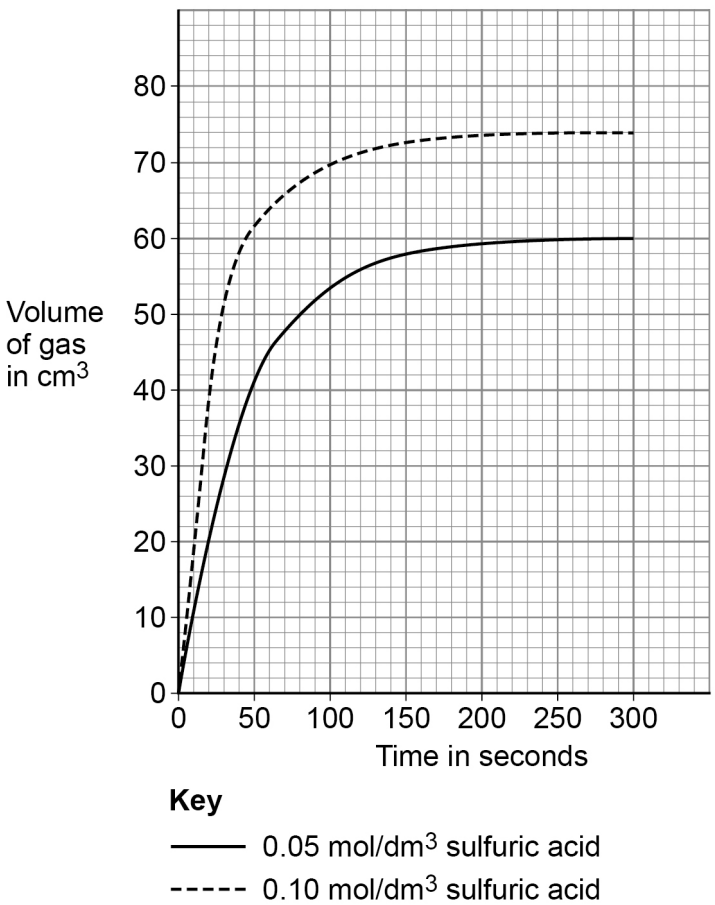
[1 mark]

Question 15 · continued

The student corrected the error.

Figure 9 shows the student's results.

Figure 9



0 9 . 2 Explain why the lines of best fit on **Figure 9** become horizontal.

[2 marks]

0 9 . 3 How does **Figure 9** show that zinc powder reacts more slowly with 0.05 mol/dm^3 sulfuric acid than with 0.10 mol/dm^3 sulfuric acid?

[1 mark]

4.6.1.3 Collision theory and activation energy

Question 15 · continued

0 9 . 4 Determine the rate of the reaction for 0.05 mol/dm^3 sulfuric acid at 80 seconds.

Show your working on **Figure 9**.

Give your answer to 2 significant figures.

[5 marks]

Rate of reaction (2 significant figures) = _____ cm^3/s

0 9 . 5 The activation energy for the reaction between zinc and sulfuric acid is lowered if a solution containing metal ions is added.

What is the most likely formula of the metal ions added?

[1 mark]

Tick (✓) **one** box.

Al^{3+} ☐

Ca^{2+} ☐

Cu^{2+} ☐

Na^{+} ☐

10

4.6.1.3 Collision theory and activation energy

Question 16

June 2023 | 8462/1H | Original Q4

0 4 This question is about hydrogen and compounds of hydrogen.

Figure 3 shows the displayed formulae for the reaction between hydrogen and chlorine.

Figure 3

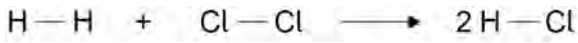


Table 4 shows the bond energies.

Table 4

Bond	H — H	Cl — Cl	H — Cl
Bond energy in kJ/mol	436	346	432

0 4 . 1 Which expression shows how to calculate the overall energy change for the reaction in **Figure 3**?

Use **Table 4**.

[1 mark]

Tick (✓) **one** box.

436 + 346 + 432 kJ/mol ☐

436 + 346 + (2 × 432) kJ/mol ☐

436 + 346 − 432 kJ/mol ☐

436 + 346 − (2 × 432) kJ/mol ☐

Question 16 · continued

The reaction between hydrogen and chlorine is exothermic.

0 4 . 2 Explain why this reaction releases energy to the surroundings.

[2 marks]

0 4 . 3 **Figure 4** shows part of a reaction profile for the reaction between hydrogen and chlorine.

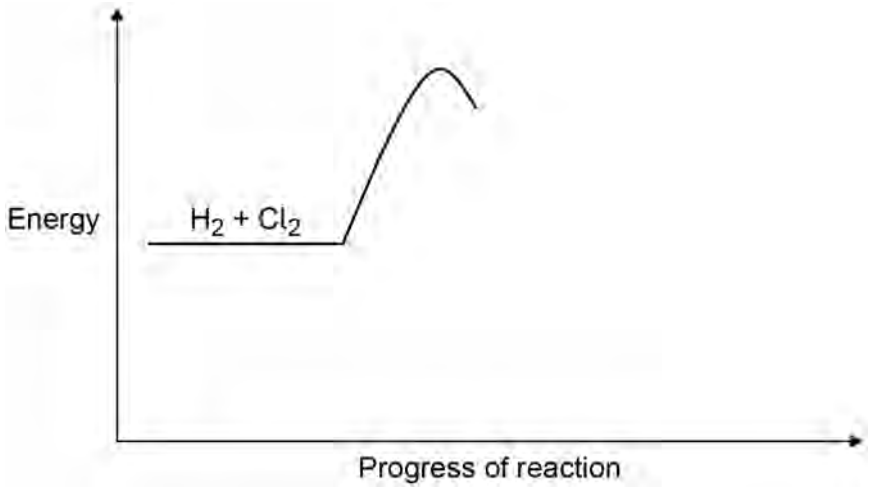
Complete the reaction profile in **Figure 4**.

You should:

- label the activation energy
- label the overall energy change.

[3 marks]

Figure 4



Question 4 continues on the next page

4.6.1.3 Collision theory and activation energy

Question 16 · continued

0 4 . 4 Draw a dot and cross diagram for a molecule of hydrogen chloride (HCl).

Show the outer shell electrons only.

[2 marks]

4.6.1.3 Collision theory and activation energy

Question 16 · continued

0 4 . 5 **Figure 5** represents molecules of methane and of poly(ethene).

Figure 5



Methane is a gas at room temperature but poly(ethene) is a solid at room temperature.

Explain why methane and poly(ethene) exist in different states at room temperature.

[4 marks]

12

4.6.1.3 Collision theory and activation energy

Question 17

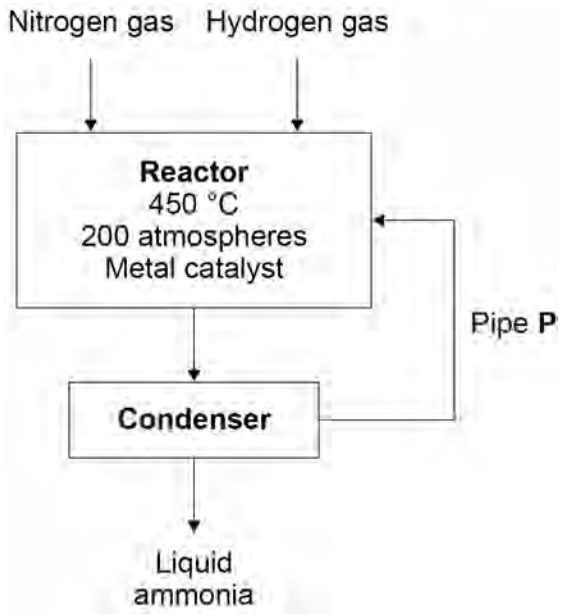
June 2024 | 8462/2H | Original Q2

0 2 This question is about ammonia and nitric acid.

In the Haber process ammonia is produced from nitrogen and hydrogen.

Figure 1 represents the Haber process.

Figure 1



0 2 . 1 Pipe **P** links the condenser to the reactor.

Why is the condenser linked to the reactor?

Use **Figure 1**.

[1 mark]

0 2 . 2 Which metal is used as a catalyst in this reaction?

[1 mark]

Question 17 · continued

Nitric acid is produced by reacting ammonia with oxygen.

The word equation for the production of nitric acid is:

ammonia + oxygen → water + nitric acid

Platinum is a catalyst in this reaction.

0 2 . 3 Describe the test for oxygen gas.

Give the result if oxygen gas is present.

[2 marks]

Test _____

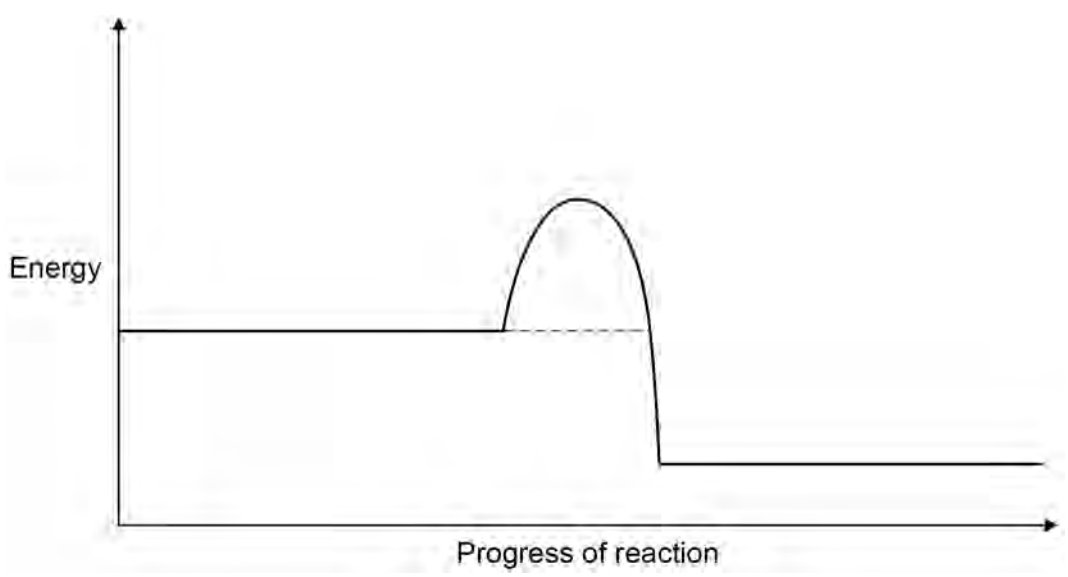
_____

Result _____

_____

Figure 2 represents the reaction profile of the catalysed reaction between ammonia and oxygen.

Figure 2



4.6.1.3 Collision theory and activation energy

Question 17 · continued

0 2 . 4 Complete the reaction profile for the catalysed reaction in **Figure 2**.

You should:

- label the activation energy
- label the reactants and products, using the names of the reactants and products.

[2 marks]

0 2 . 5 How would **Figure 2** be different if **no** catalyst was used?

[1 mark]

Tick (✓) **one** box.

The final energy level would be higher. ☐

The final energy level would be lower. ☐

The line would reach a higher peak. ☐

The line would reach a lower peak. ☐

0 2 . 6 Ammonia and nitric acid react to produce the salt, ammonium nitrate.

Ammonium ions and nitrate ions both contain nitrogen.

Suggest **one** use of ammonium nitrate.

[1 mark]

_____

_____

8