AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.5.1.2

Reaction profiles

Past-paper questions

Tier	**Higher**
Question groups	**20**
Available paper years	**2008–2025**

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.

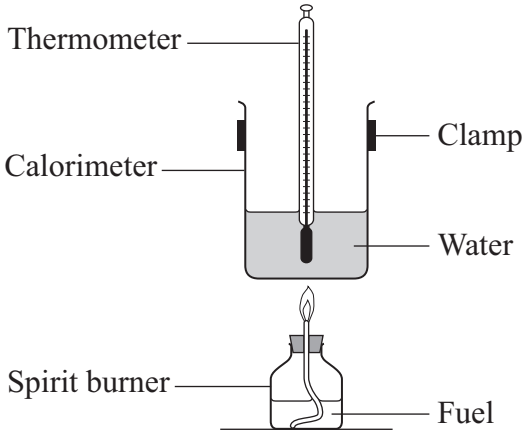
4.5.1.2 Reaction profiles

Question 01

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)

4.5.1.2 Reaction profiles

Question 01 · 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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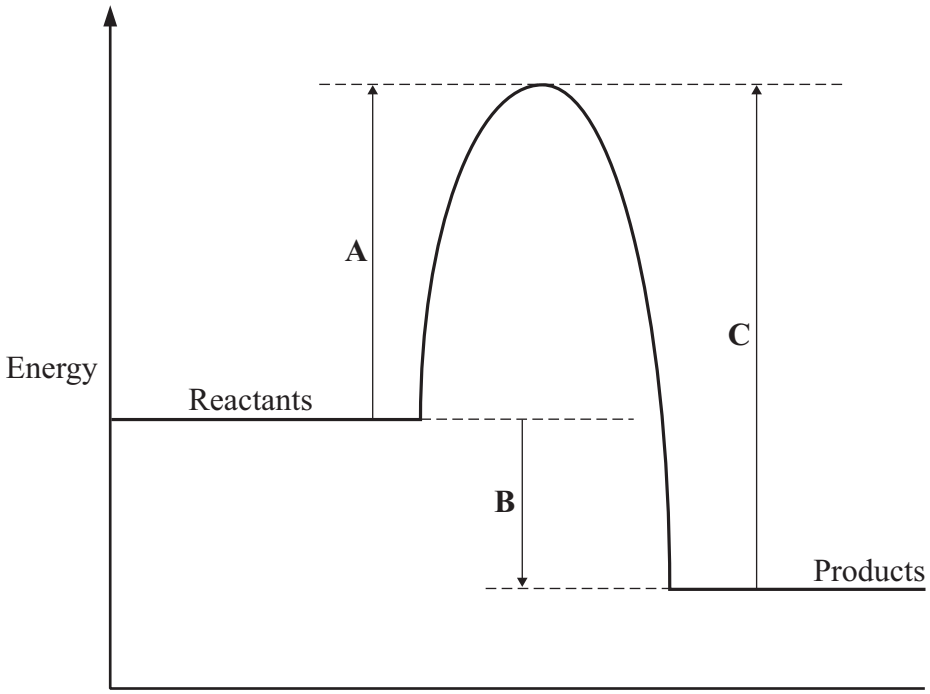
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(2 marks)

(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

4.5.1.2 Reaction profiles

Question 02

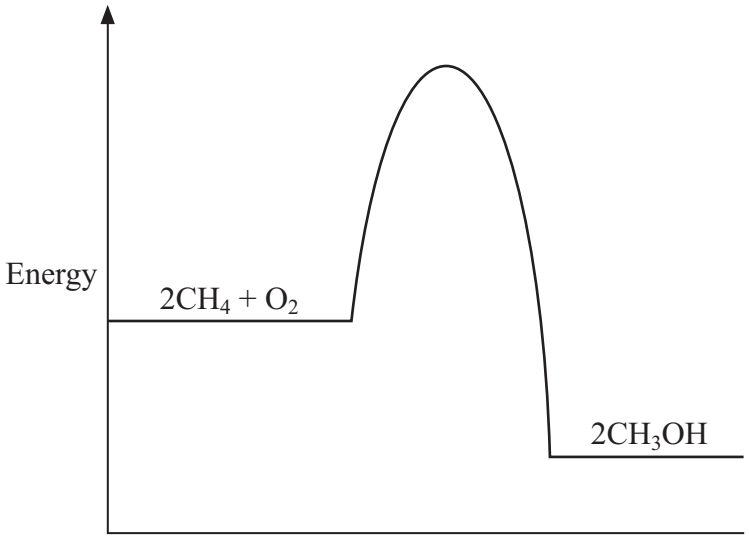
June 2008 | CHY3H | Original Q7 | Legacy

7 Methanol (CH_3OH) can be made by reacting methane (CH_4) and oxygen (O_2) in the presence of a platinum catalyst. The reaction is exothermic.

An equation that represents the reaction is:

$$2CH_4 + O_2 \rightarrow 2CH_3OH$$

7 (a) The energy level diagram for this reaction is given below.



7 (a) (i) Use the diagram to explain how you know that this reaction is exothermic.

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(1 mark)

7 (a) (ii) Explain, in terms of the energy level diagram, how the platinum catalyst increases the rate of this reaction.

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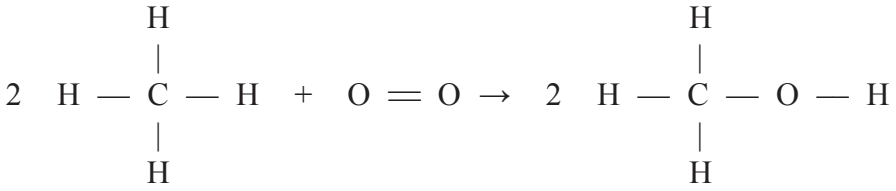
(1 mark)

4.5.1.2 Reaction profiles

Question 02 · continued

for mark

7 (b) The equation can also be written showing the structural formulae of the reactants and the product.



7 (b) (i) Use the bond energies given in the table to help you to calculate the energy change for this reaction.

Bond	Bond energy in kJ
C — H	435
O = O	498
C — O	805
O — H	464

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Energy change = ... kJ

(3 marks)

7 (b) (ii) In terms of the bond energies, explain why this reaction is exothermic.

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(1 mark)

6

4.5.1.2 Reaction profiles

Question 03

January 2010 | CHY3H | Original Q6 | Legacy

6 During a thunderstorm lightning strikes the Eiffel Tower.

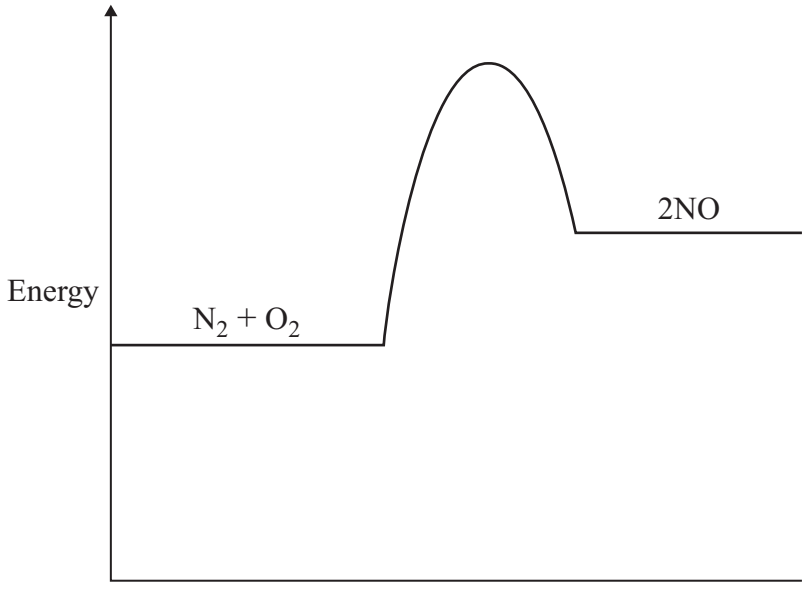


In lightning the temperature can reach 30 000 °C. This causes nitrogen and oxygen in the air to react, producing nitrogen oxide. This reaction has a high *activation energy* and is *endothermic*.

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)

4.5.1.2 Reaction profiles

Question 03 · continued

for mark

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

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(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

4.5.1.2 Reaction profiles

Question 04

June 2011 | CHY3H | Original Q4 | Legacy

4 Hydrogen peroxide decomposes to give water and oxygen.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

The reaction is *exothermic.*

4 (a) Explain, in terms of bond breaking and bond making, why the decomposition of hydrogen peroxide is *exothermic*.

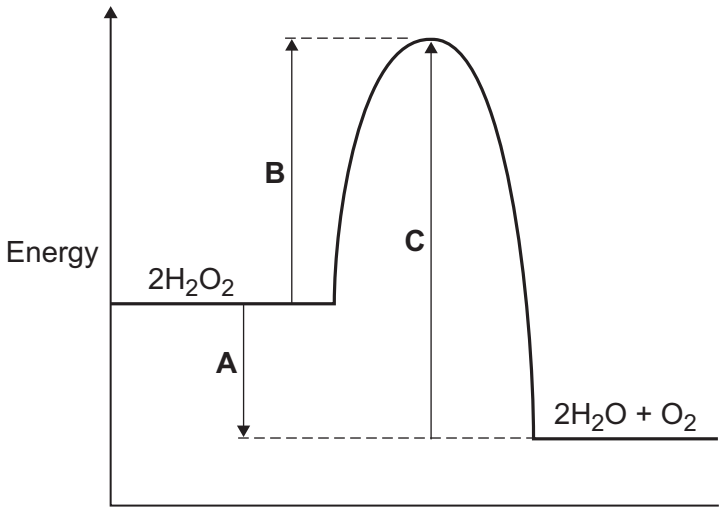
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(1 mark)

4 (b) The energy level diagram for this reaction is shown below.



The energy changes, **A**, **B** and **C**, are shown on the diagram.

Use the diagram to help you answer these questions.

4 (b) (i) How do you know that this reaction is *exothermic*?

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(1 mark)

4 (b) (ii) The decomposition of hydrogen peroxide is slow.
What does this suggest about energy change **B**?

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(1 mark)

4.5.1.2 Reaction profiles

Question 04 · continued

4 (b) (iii) Hydrogen peroxide decomposes quickly when a small amount of manganese(IV) oxide is added.

Explain why.

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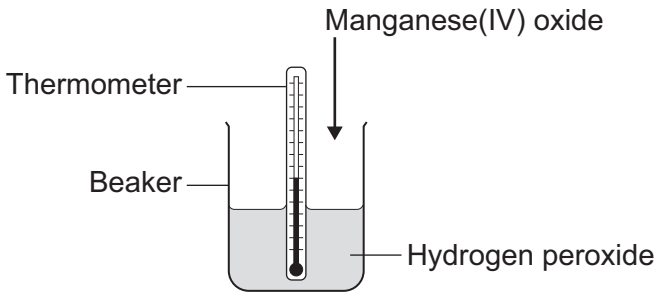
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(2 marks)

4 (c) A student did an experiment to find the amount of energy produced when hydrogen peroxide solution is decomposed using manganese(IV) oxide.

The apparatus the student used is shown in the diagram.



The student first measured the temperature of the hydrogen peroxide. Then the student added the manganese(IV) oxide and recorded the highest temperature.

The temperature rise was smaller than expected.

Suggest why.

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(2 marks)

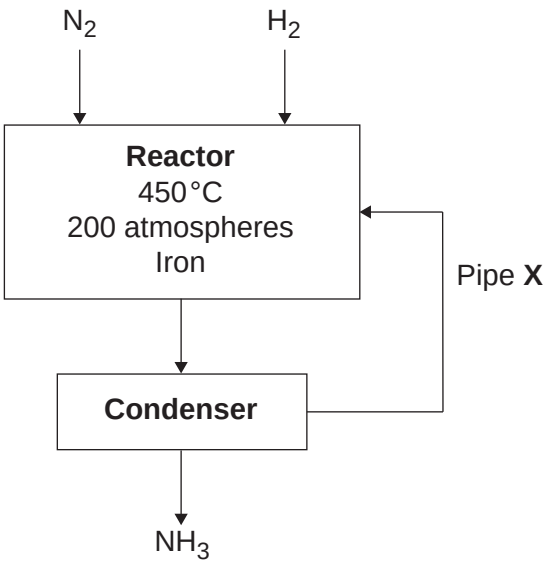
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4.5.1.2 Reaction profiles

Question 05

June 2013 | CH3HP | Original Q6 | Legacy

6 The flow diagram shows the Haber process. In the Haber process, ammonia (NH_3) is produced from nitrogen (N_2) and hydrogen (H_2).



6 (a) Which raw material is nitrogen obtained from?

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(1 mark)

6 (b) What is the purpose of Pipe **X**?

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(2 marks)

6 (c) Balance the chemical equation below for the production of ammonia.

N_2 + ...H_2 $\rightleftharpoons$ .....NH_3

(1 mark)

4.5.1.2 Reaction profiles

Question 05 · continued

6 (d) A temperature of 450 °C is used in the reactor.
The reaction of nitrogen with hydrogen is reversible.
The forward reaction is exothermic.

Explain why a temperature of 450 °C is the optimum temperature for the Haber process.

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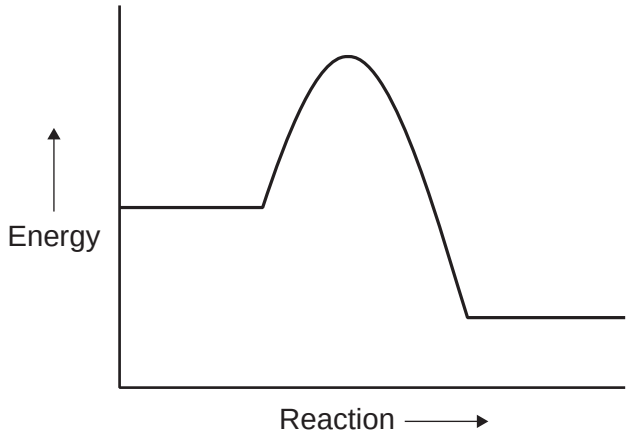
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(2 marks)

6 (e) An energy level diagram for the reaction between nitrogen and hydrogen is shown below.



6 (e) (i) How does the energy level diagram show this reaction is exothermic?

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(1 mark)

6 (e) (ii) In the Haber process iron is used as a catalyst.

Draw a line on the energy level diagram to show the effect of adding a catalyst.

(1 mark)

8

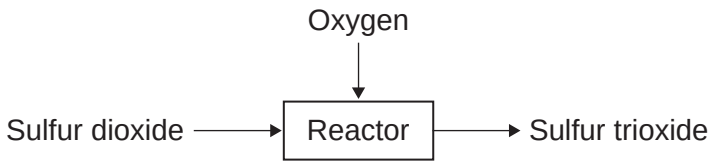
4.5.1.2 Reaction profiles

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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4.5.1.2 Reaction profiles

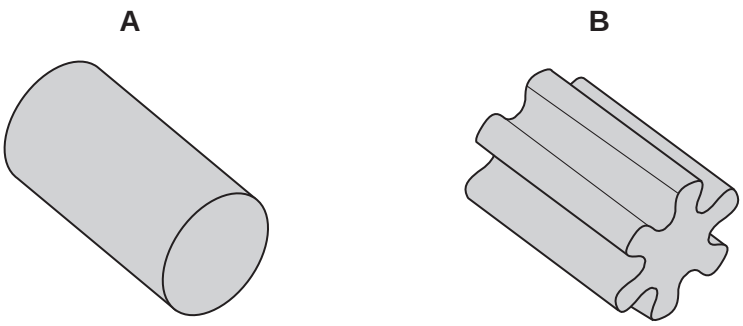
Question 06 · continued

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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4.5.1.2 Reaction profiles

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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4.5.1.2 Reaction profiles

Question 07

6 Some cars are powered by hydrogen fuel cells.

Figure 6



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

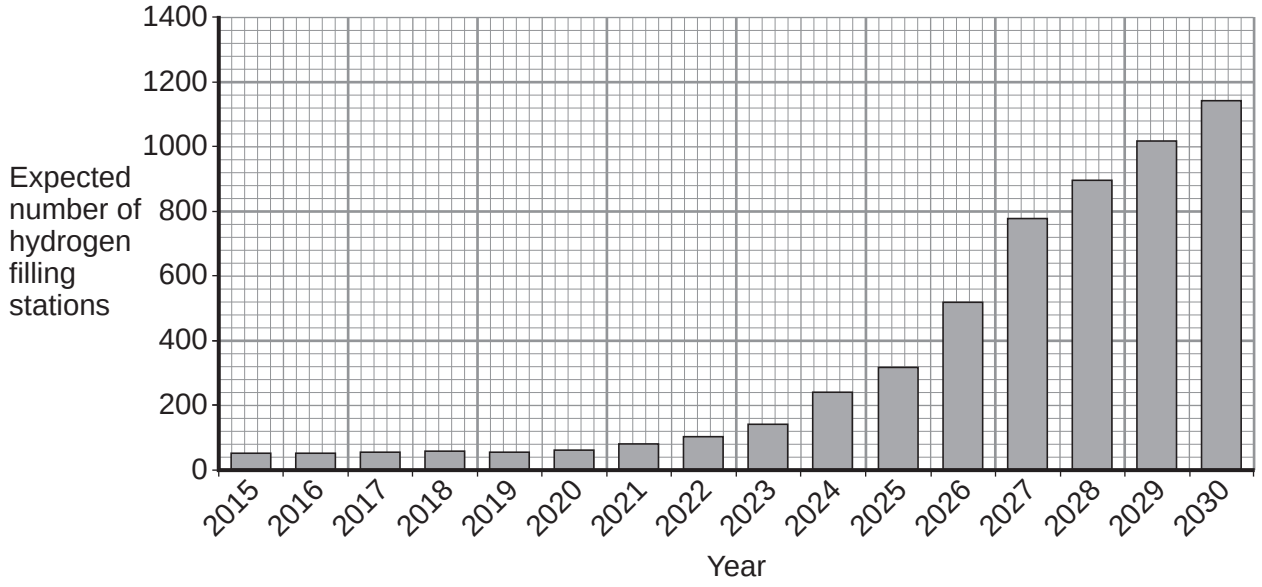
[1 mark]

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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



4.5.1.2 Reaction profiles

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.

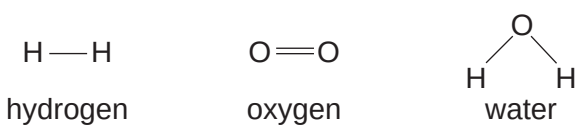
Bond energies for the reaction are given in **Table 1**.

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

4.5.1.2 Reaction profiles

Question 07 · continued

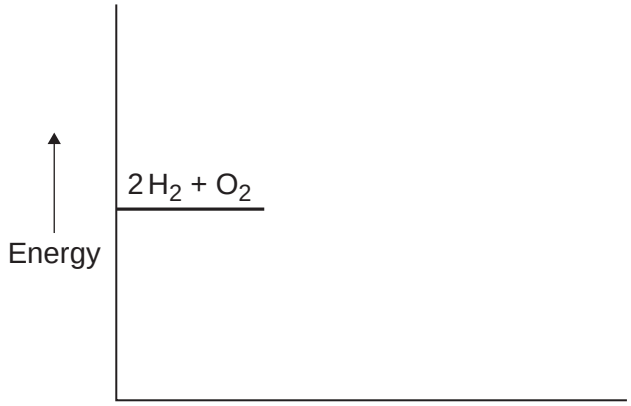
6 (c) (ii) The reaction of hydrogen with oxygen is exothermic.

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

Clearly label the activation energy.

[3 marks]

Figure 9



9

4.5.1.2 Reaction profiles

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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4.5.1.2 Reaction profiles

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

4.5.1.2 Reaction profiles

Question 08 · continued

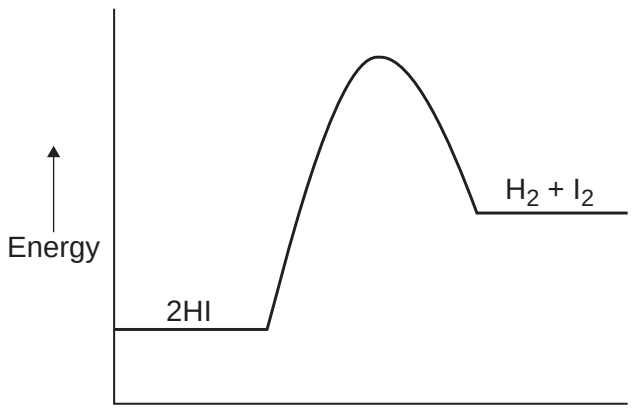
6 (c) The decomposition of hydrogen iodide into hydrogen and iodine is reversible.

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

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]

4.5.1.2 Reaction profiles

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

4.5.1.2 Reaction profiles

Question 09

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.

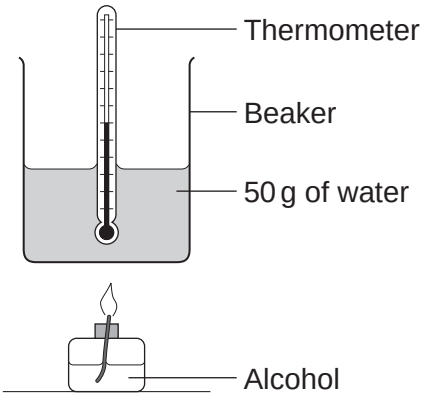
[1 mark]

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

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

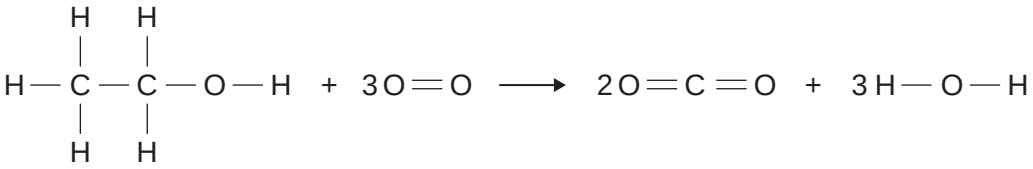
4.5.1.2 Reaction profiles

Question 09 · 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

4.5.1.2 Reaction profiles

Question 09 · continued

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

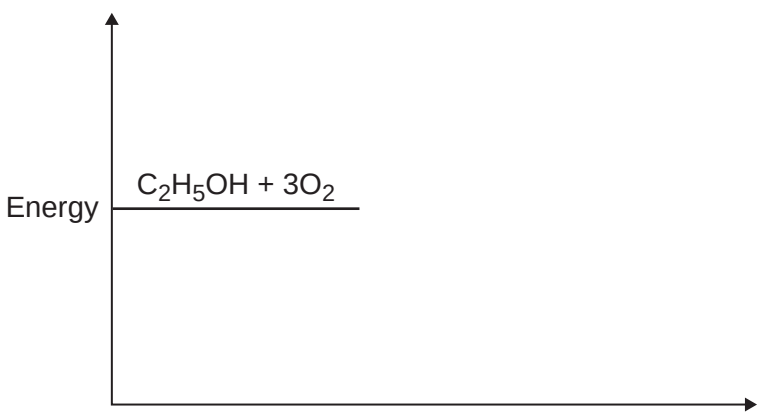
[2 marks]

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.



12

4.5.1.2 Reaction profiles

Question 10

June 2018 | 8462/1H | Original Q5

0 5 A student investigated the temperature change in displacement reactions between metals and copper sulfate solution.

Table 2 shows the student's results.

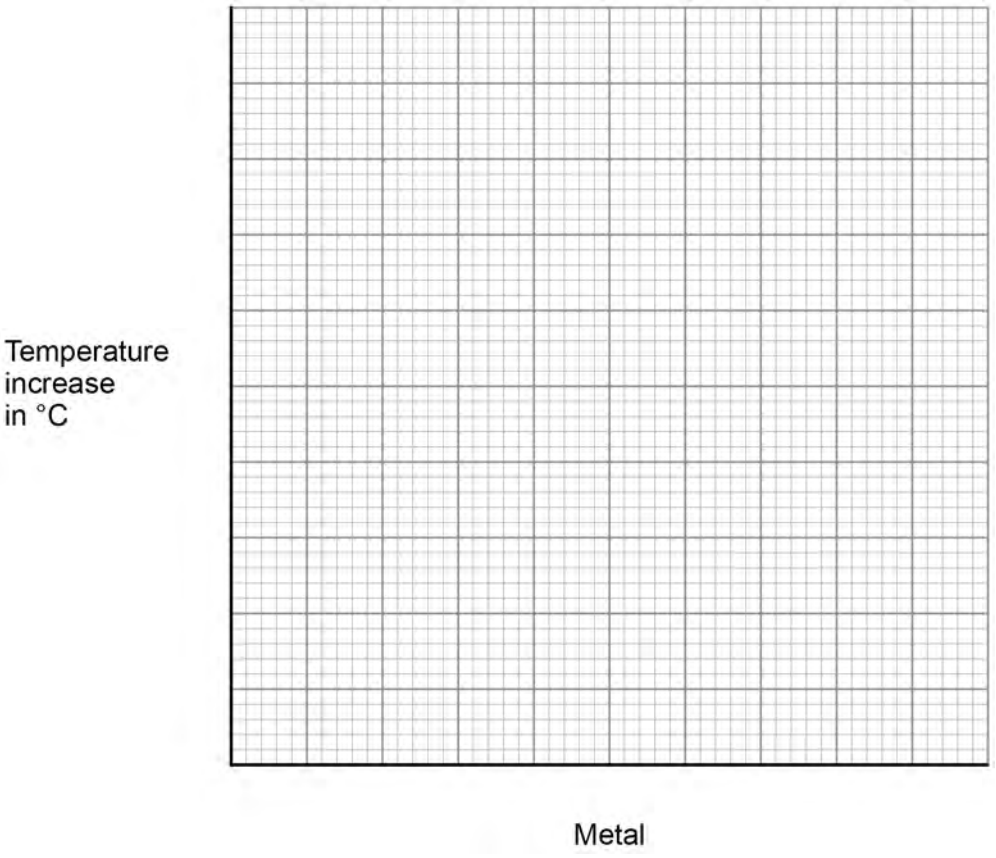
Table 2

Metal	Temperature increase in °C
Copper	0
Iron	13
Magnesium	43
Zinc	17

0 5 . 1 Plot the data from **Table 2** on **Figure 4** as a bar chart.

[2 marks]

Figure 4



4.5.1.2 Reaction profiles

Question 10 · continued

0 5 . 2 The student concluded that the reactions between the metals and copper sulfate solution are endothermic.

Give **one** reason why this conclusion is **not** correct.

[1 mark]

0 5 . 3 The temperature change depends on the reactivity of the metal.

The student's results are used to place copper, iron, magnesium and zinc in order of their reactivity.

Describe a method to find the position of an unknown metal in this reactivity series.

Your method should give valid results.

[4 marks]

Question 5 continues on the next page

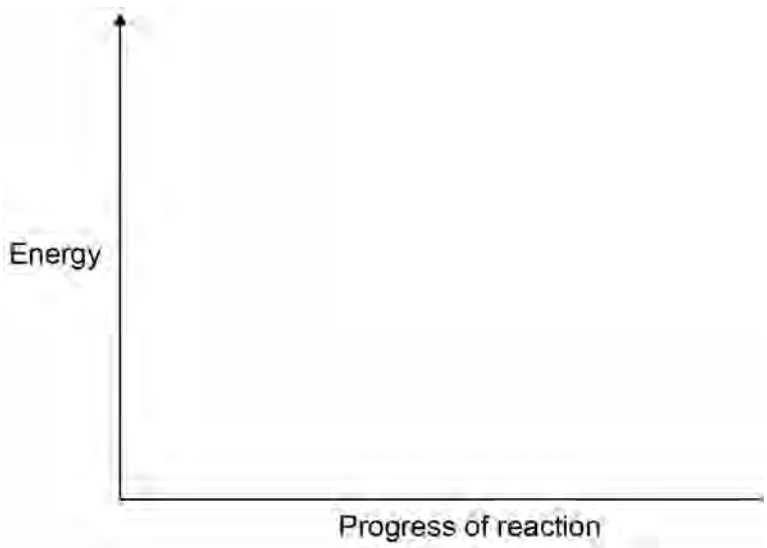
4.5.1.2 Reaction profiles

Question 10 · continued

0 5 . 4 Draw a fully labelled reaction profile for the reaction between zinc and copper sulfate solution on **Figure 5**.

[3 marks]

Figure 5



10

4.5.1.2 Reaction profiles

Question 11

June 2019 | 8462/1H | Original Q5

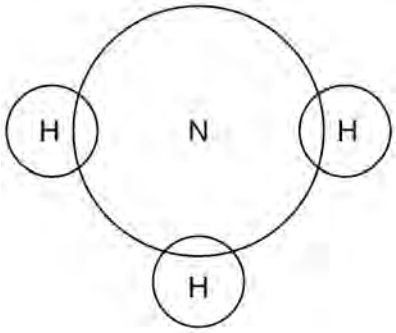
0 5 This question is about ammonia, NH_3

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

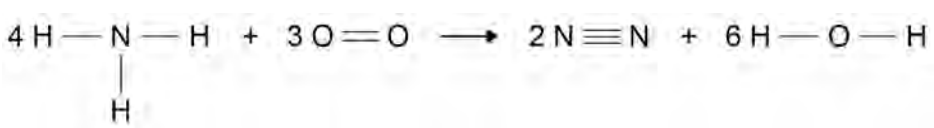


Table 3 shows some bond energies.

Table 3

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

4.5.1.2 Reaction profiles

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

4.5.1.2 Reaction profiles

Question 11 · continued

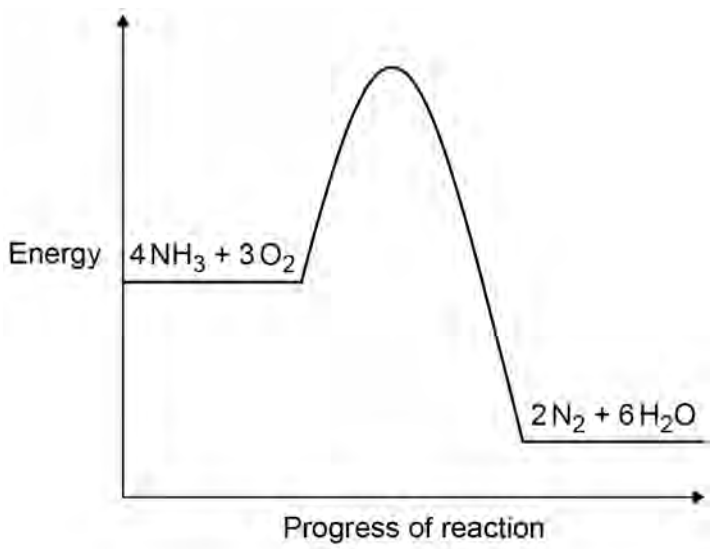
0 5 . 7 **Figure 8** shows the reaction profile for the reaction between ammonia and oxygen.

Complete **Figure 8** by labelling the:

- activation energy
- overall energy change.

[2 marks]

Figure 8



14

4.5.1.2 Reaction profiles

Question 12

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]

4.5.1.2 Reaction profiles

Question 12 · 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

4.5.1.2 Reaction profiles

Question 13

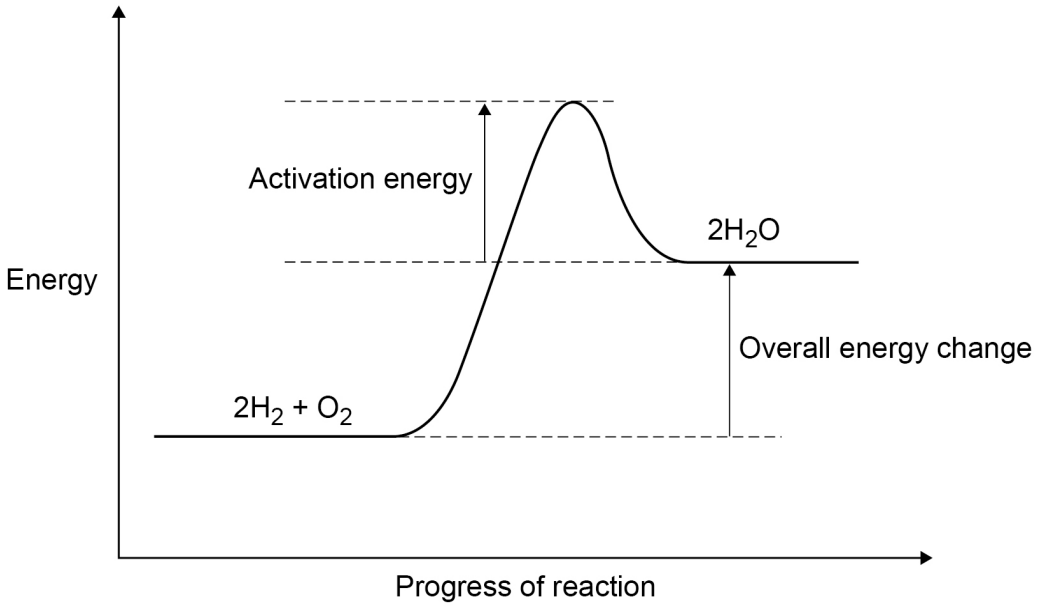
November 2020 | 8462/1H | Original Q7

0 7 The reaction between hydrogen and oxygen releases energy.

0 7 . 1 A student drew a reaction profile for the reaction between hydrogen and oxygen.

Figure 3 shows the student's reaction profile.

Figure 3



The student made **two** errors when drawing the reaction profile.

Describe the **two** errors.

[2 marks]

1 _____

_____

2 _____

_____

4.5.1.2 Reaction profiles

Question 13 · continued

0 7 . 2 The reaction between hydrogen and oxygen in a hydrogen fuel cell is used to produce electricity.

Hydrogen fuel cells and rechargeable cells are used to power some cars.

Give **two** advantages of using hydrogen fuel cells instead of using rechargeable cells to power cars.

[2 marks]

1 _____

_____

2 _____

_____

0 7 . 3 Reactions occur at the positive electrode and at the negative electrode in a hydrogen fuel cell.

Write a half equation for **one** of these reactions.

[1 mark]

_____

Question 7 continues on the next page

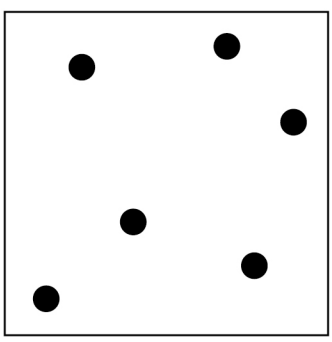
4.5.1.2 Reaction profiles

Question 13 · continued

0 7 . 4 The three states of matter can be represented by a simple particle model.

Figure 4 shows a simple particle model for hydrogen gas.

Figure 4



Give **two** limitations of this simple particle model for hydrogen gas.

[2 marks]

1 _____

_____

2 _____

_____

0 7 . 5 The hydrogen gas needed to power a car for 400 km would occupy a large volume.

Suggest **one** way that this volume can be reduced.

[1 mark]

_____

_____

4.5.1.2 Reaction profiles

Question 13 · continued

0 7 . 6 The energy needed for a car powered by a hydrogen fuel cell to travel 100 km is 58 megajoules (MJ).

The energy released when 1 mole of hydrogen gas reacts with oxygen is 290 kJ

The volume of 1 mole of a gas at room temperature and pressure is 24 dm^3

Calculate the volume of hydrogen gas at room temperature and pressure needed for the car to travel 100 km

[4 marks]

Volume of hydrogen gas = _____ dm^3

12

4.5.1.2 Reaction profiles

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.

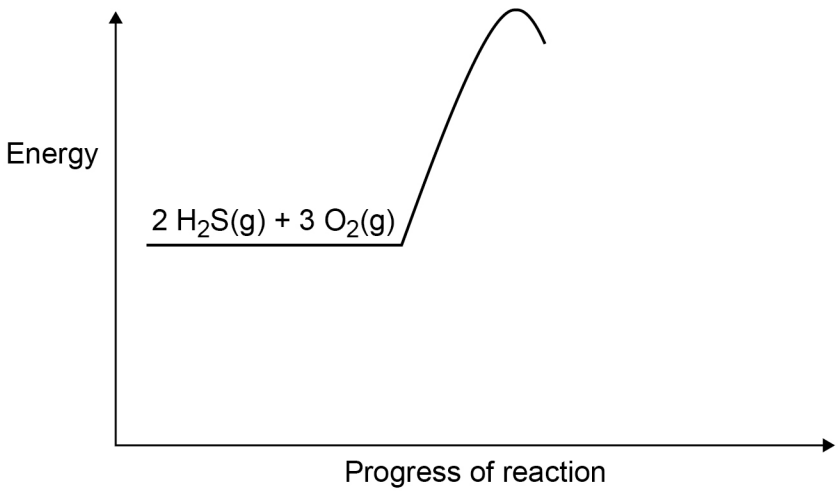
Complete **Figure 6**.

You should:

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

[3 marks]

Figure 6



4.5.1.2 Reaction profiles

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

Figure 7

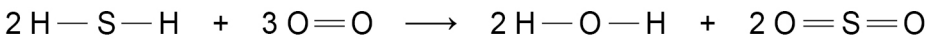


Table 5 shows some of the bond energies.

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

4.5.1.2 Reaction profiles

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:

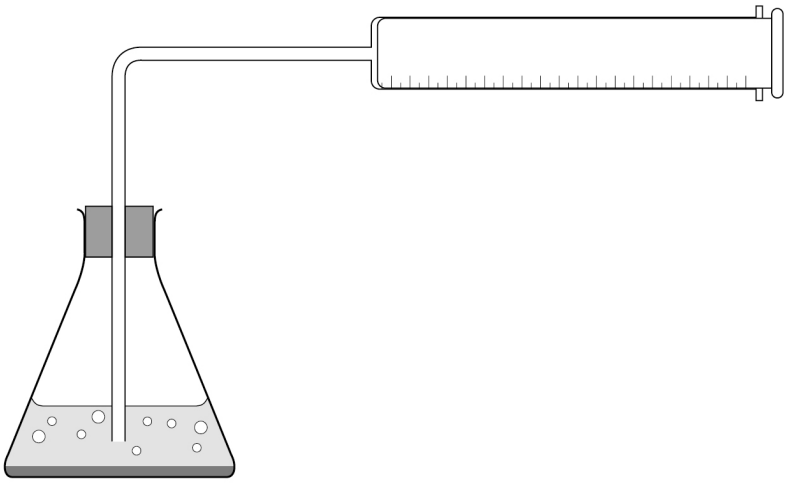
$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

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]

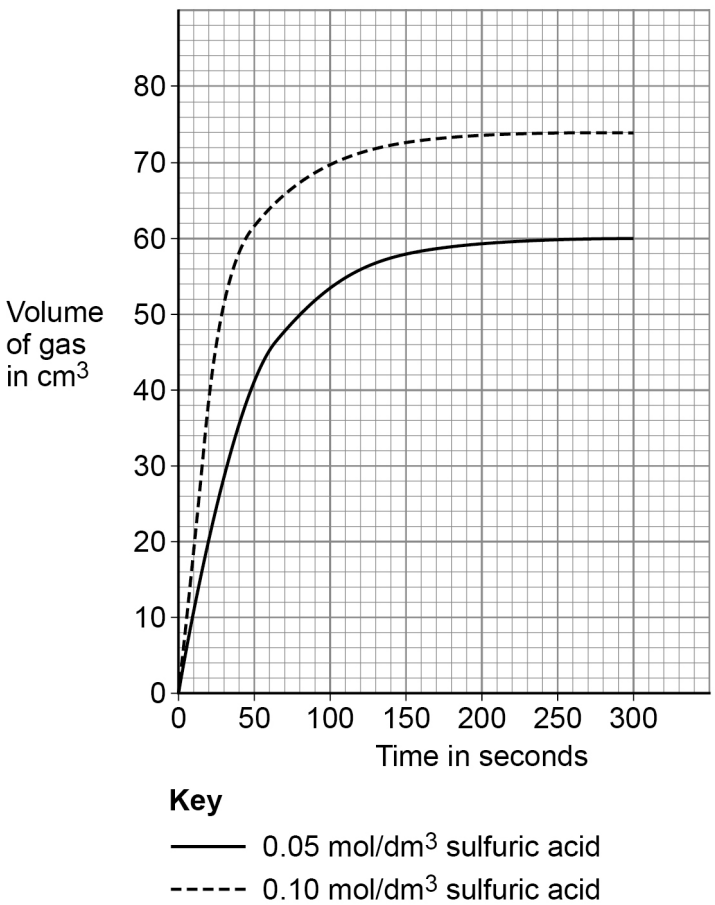
4.5.1.2 Reaction profiles

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]

4.5.1.2 Reaction profiles

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

4.5.1.2 Reaction profiles

Question 16

June 2022 | 8462/1H | Original Q2

0 2 Sodium carbonate reacts with hydrochloric acid in an exothermic reaction.

The equation for the reaction is:

$$Na_2CO_3(s) + 2\,HCl(aq) \rightarrow 2\,NaCl(aq) + CO_2(g) + H_2O(l)$$

A student investigated the effect of changing the mass of sodium carbonate powder on the highest temperature reached by the reaction mixture.

0 2 . 1 Plan a method to investigate the effect of changing the mass of sodium carbonate powder on the highest temperature reached.

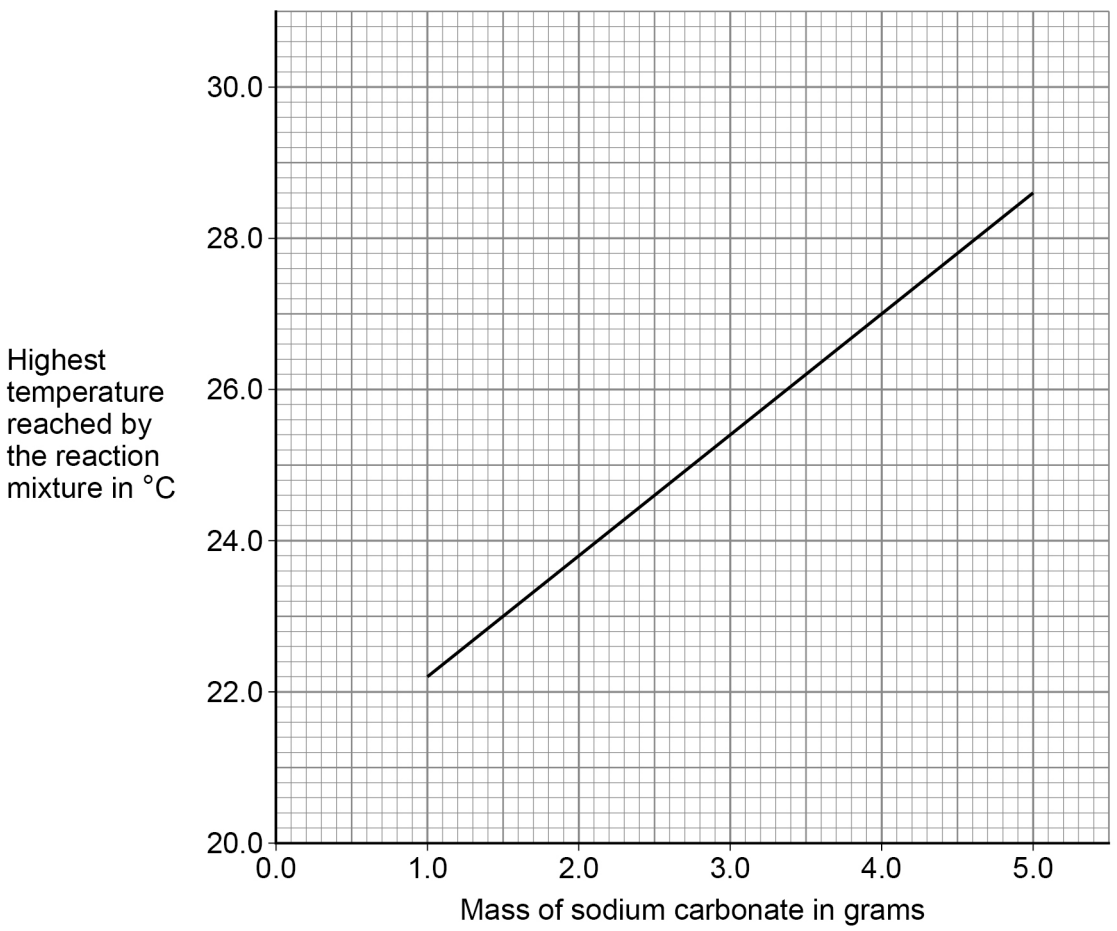
[6 marks]

4.5.1.2 Reaction profiles

Question 16 · continued

Figure 3 shows a line of best fit drawn through the student's results.

Figure 3



4.5.1.2 Reaction profiles

Question 16 · continued

0 2 . 2 Determine the gradient of the line of best fit in **Figure 3**.

Use the equation:

$$\text{Gradient} = \frac{\text{Change in highest temperature}}{\text{Change in mass}}$$

Give the unit.

[5 marks]

Gradient = _____ Unit _____

0 2 . 3 The initial temperature of the reaction mixture is where the line of best fit would meet the *y*-axis.

Determine the initial temperature of the reaction mixture.

Show your working on **Figure 3**.

[2 marks]

Initial temperature of the reaction mixture = _____ °C

4.5.1.2 Reaction profiles

Question 16 · continued

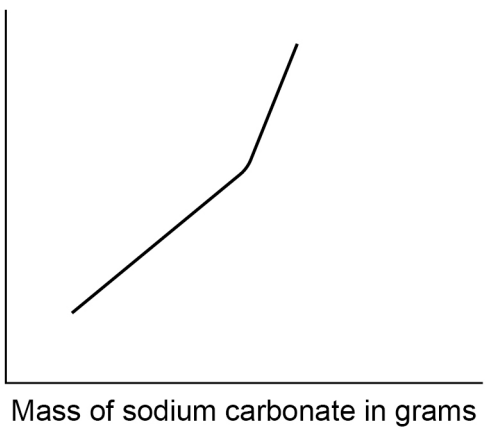
0 2 . 4 Another student repeated the investigation but added sodium carbonate until the sodium carbonate was in excess.

Which sketch graph shows the results obtained when sodium carbonate was added until in excess?

[1 mark]

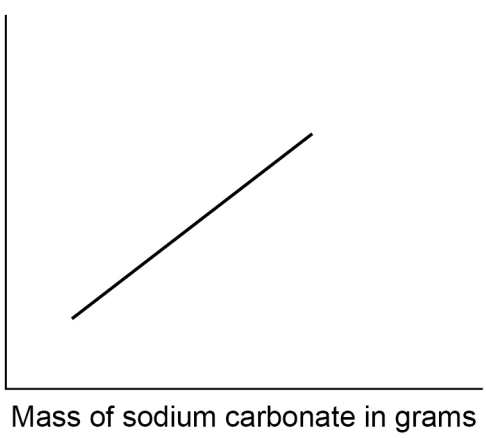
Tick (✓) **one** box.

A



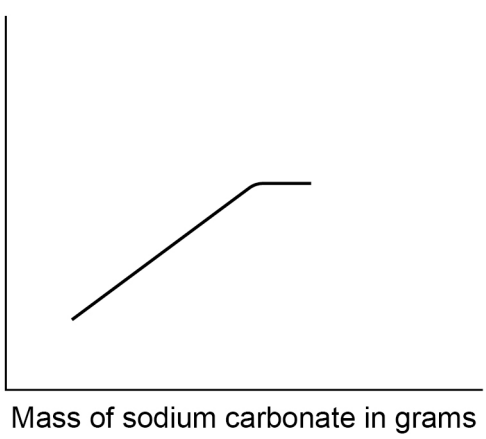
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B



☐

C



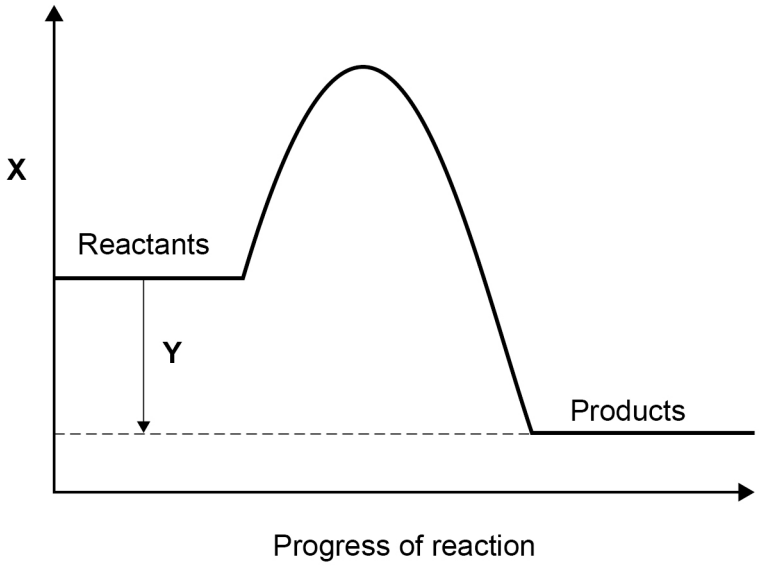
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4.5.1.2 Reaction profiles

Question 16 · continued

Figure 4 shows a reaction profile for the reaction of sodium carbonate with hydrochloric acid.

Figure 4



0 2 . 5 What do labels **X** and **Y** represent on **Figure 4**?

[2 marks]

X _____

Y _____

0 2 . 6 How does the reaction profile show that the reaction is exothermic?

Use **Figure 4**.

[1 mark]

_____

_____

17

4.5.1.2 Reaction profiles

Question 17

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

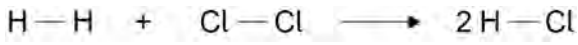


Table 4 shows the bond energies.

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 17 · 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.

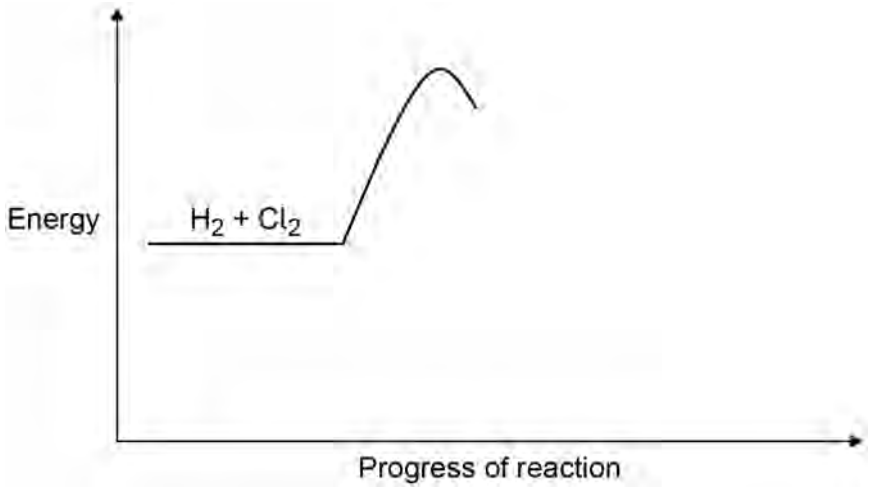
Complete the reaction profile in **Figure 4**.

You should:

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

[3 marks]

Figure 4



Question 4 continues on the next page

4.5.1.2 Reaction profiles

Question 17 · 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]

4.5.1.2 Reaction profiles

Question 17 · 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

4.5.1.2 Reaction profiles

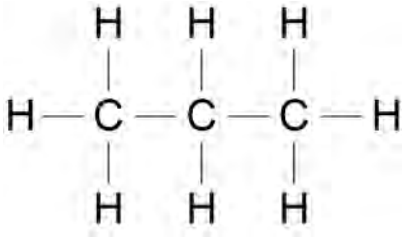
Question 18

June 2024 | 8462/1H | Original Q8

0 8 This question is about propane (C_3H_8).

Figure 7 shows the displayed structural formula of propane.

Figure 7



0 8 . 1 Explain why propane has a low boiling point.

[3 marks]

4.5.1.2 Reaction profiles

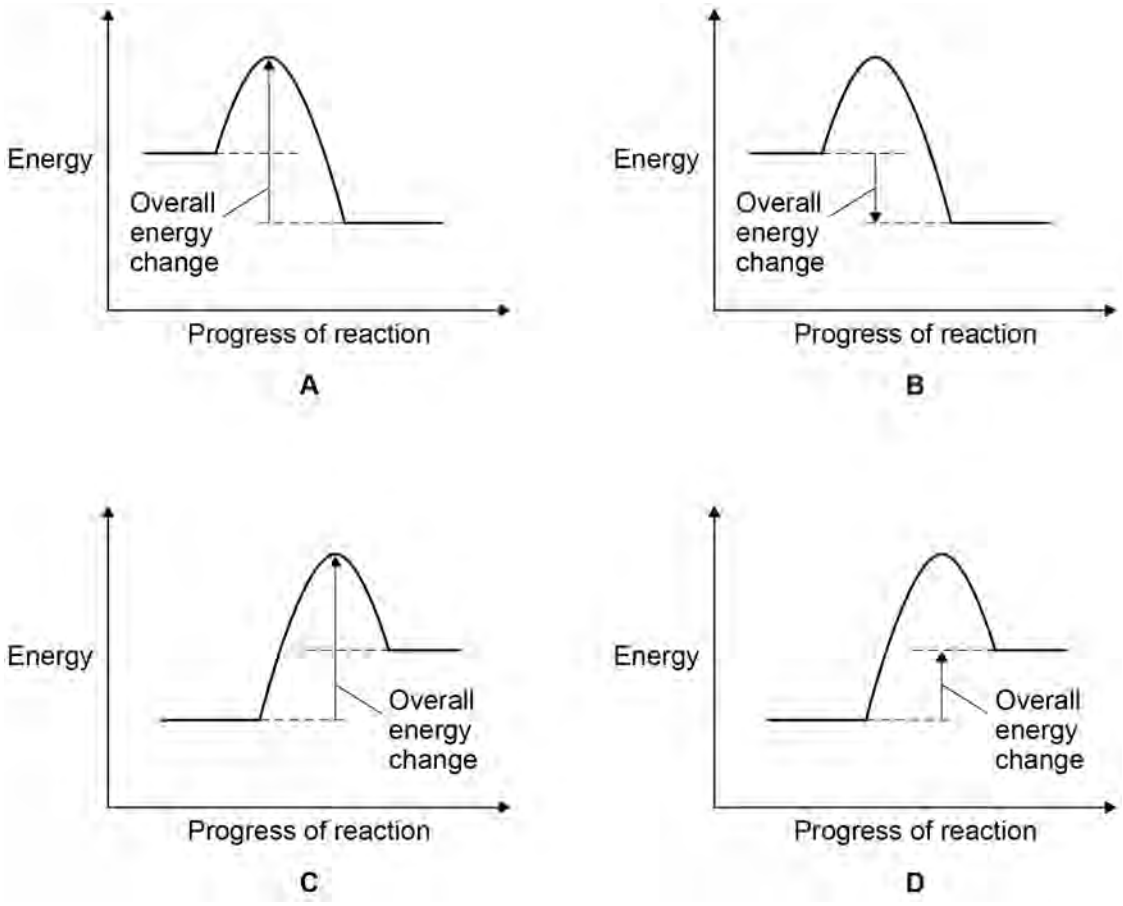
Question 18 · continued

Propane reacts with oxygen to produce carbon dioxide and water.

The reaction is exothermic.

0 8 . 2 **Figure 8** shows four reaction profiles.

Figure 8



Which is the correct reaction profile and labels for the reaction between propane and oxygen?

Tick (✓) **one** box.

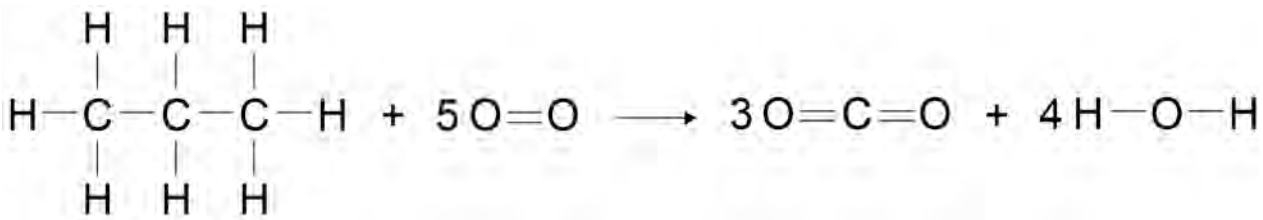
[1 mark]

A ☐ B ☐ C ☐ D ☐

Question 8 continues on the next page

0 8 . 3 **Figure 9** shows the displayed formula equation for the reaction between propane and oxygen.

Figure 9



The overall energy change of this exothermic reaction is 2219 kJ/mol.

Table 4 shows the bond energies of the bonds in the reaction.

Table 4

	C — C	C — H	O = O	C = O	O — H
Energy in kJ/mol	347	**X**	498	805	464

Calculate the bond energy of the C — H bond (**X**).

[5 marks]

Bond energy of the C — H bond (**X**) = _____ kJ/mol

9

4.5.1.2 Reaction profiles

Question 19

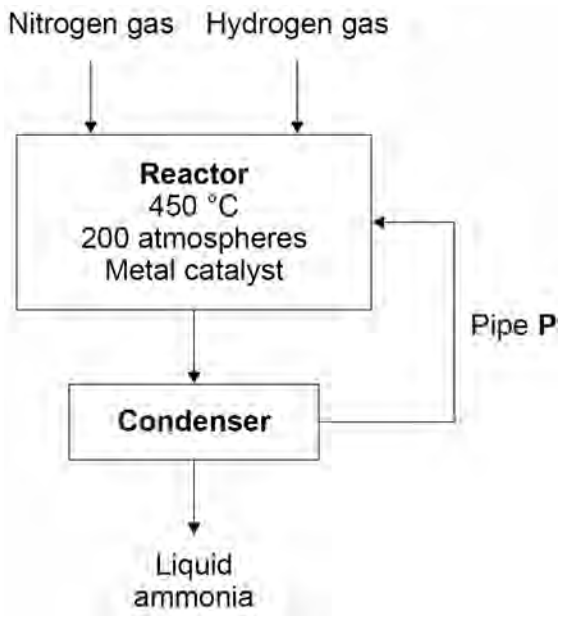
June 2024 | 8462/2H | Original Q2

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]

4.5.1.2 Reaction profiles

Question 19 · 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 _____

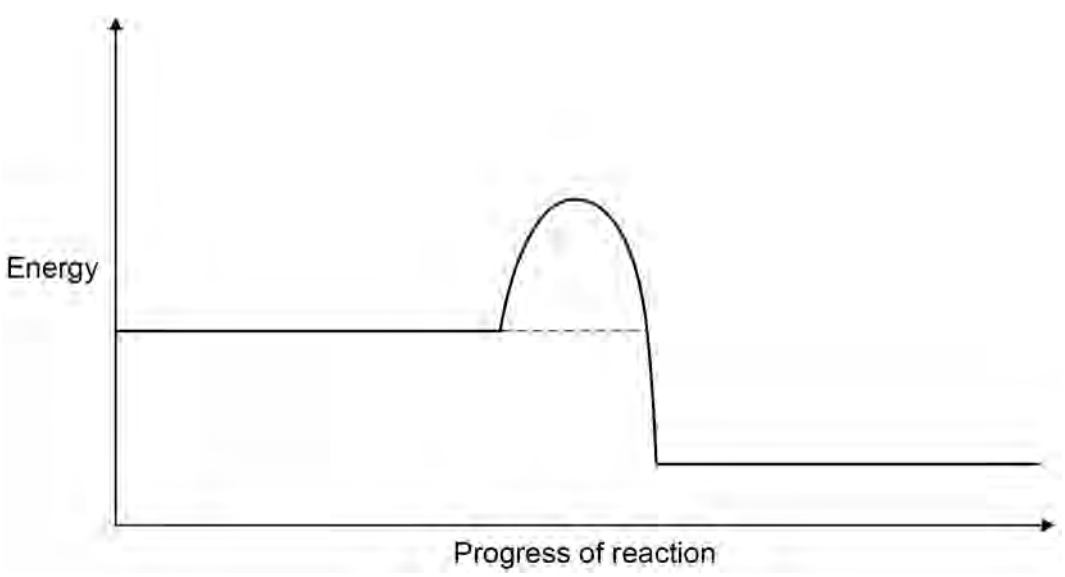
_____

Result _____

_____

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

Figure 2



4.5.1.2 Reaction profiles

Question 19 · 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

4.5.1.2 Reaction profiles

Question 20

June 2025 | 8462/2H | Original Q8

0 8 Hydrogen peroxide decomposes into water and oxygen.

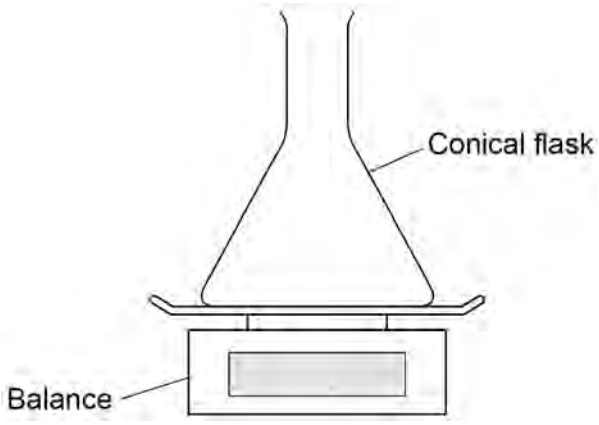
The equation for the reaction is:

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

A student investigated the effect of catalyst **A** and of catalyst **B** on the rate of this reaction.

Figure 6 shows the apparatus.

Figure 6



This is the method used.

1. Put the conical flask on the balance.
2. Add 50 cm^3 of 1.5 mol/dm^3 hydrogen peroxide solution to the conical flask.
3. Add 1.00 g of catalyst **A** to the conical flask.
4. Start a timer.
5. Record the loss in mass of the conical flask and contents every 30 seconds for 3 minutes.
6. Repeat steps 1 to 5 using catalyst **B**.

0 8 . 1 Explain why the conical flask and contents lost mass.

[2 marks]

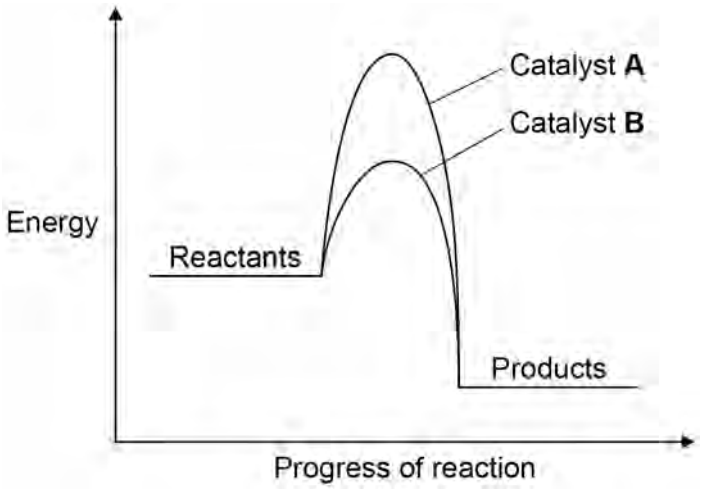
4.5.1.2 Reaction profiles

Question 20 · continued

0 8 . 2 **Figure 7** shows the reaction profile for the decomposition of hydrogen peroxide using:

- catalyst **A**
- catalyst **B**.

Figure 7



Explain why catalyst **A** and catalyst **B** give different rates of reaction for the decomposition of hydrogen peroxide.

[3 marks]

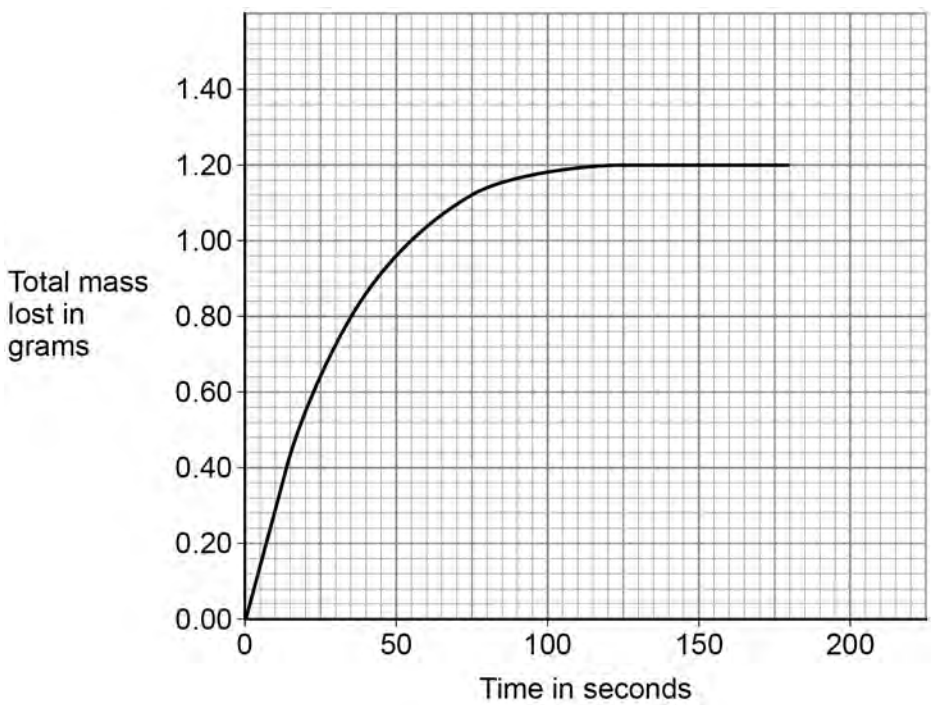
Question 8 continues on the next page

4.5.1.2 Reaction profiles

Question 20 · continued

0 8 . 3 **Figure 8** shows the results for catalyst **A**.

Figure 8



Determine the rate of the reaction when the time was 60 seconds.

Give your answer in standard form.

[5 marks]

Rate (standard form) = _____ g/s

4.5.1.2 Reaction profiles

Question 20 · continued

0 8 . 4 Explain how the rate of decomposition of hydrogen peroxide depends on the temperature of the solution.

[3 marks]

13

Turn over for the next question