AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.5.1.2

Reaction profiles

Past-paper questions

Tier	**Higher**
Question groups	**5**
Available paper years	**2018–2024**

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.

5.5.1.2 Reaction profiles

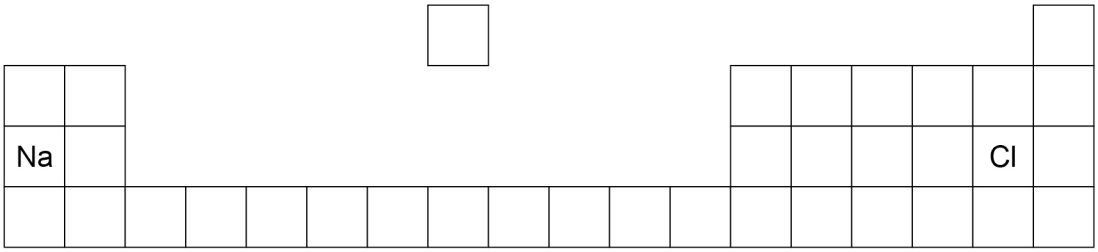
Question 01

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

0 2 This question is about sodium and chlorine.

Figure 2 shows the positions of sodium and chlorine in the periodic table.

Figure 2



0 2 . 1 State **one** difference and **one** similarity in the electronic structure of sodium and of chlorine.

[2 marks]

Difference _____

_____

Similarity _____

_____

0 2 . 2 Sodium atoms react with chlorine atoms to produce sodium chloride (NaCl).

Describe what happens when a sodium atom reacts with a chlorine atom.

Write about electron transfer in your answer.

[4 marks]

_____

_____

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5.5.1.2 Reaction profiles

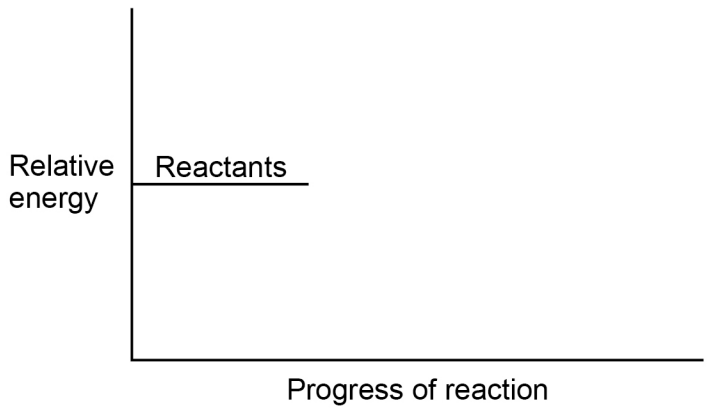
Question 01 · continued

0 2 . 3 The reaction between sodium and chlorine is an exothermic reaction.

Complete the reaction profile for the reaction between sodium and chlorine.

[2 marks]

Figure 3



8

5.5.1.2 Reaction profiles

Question 02

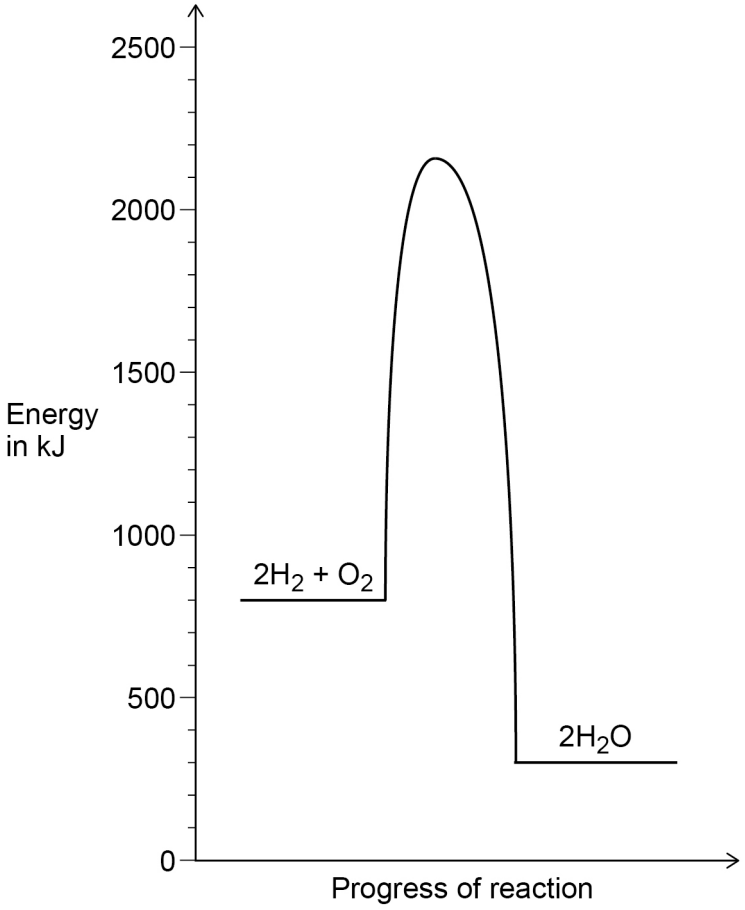
0 3 This question is about oxygen.

0 3 . 1 Hydrogen reacts with oxygen.

$$2\,H_2\,(g) + O_2\,(g) \rightarrow 2\,H_2O\,(g)$$

Figure 2 shows the relative energies of the reactants and products at a certain temperature.

Figure 2



Label the activation energy on **Figure 2**.

[1 mark]

5.5.1.2 Reaction profiles

Question 02 · continued

0 3 . 2 Determine the overall energy change for the reaction between hydrogen and oxygen shown in Question **03.1**

Use **Figure 2**.

[2 marks]

Energy change = _____ kJ

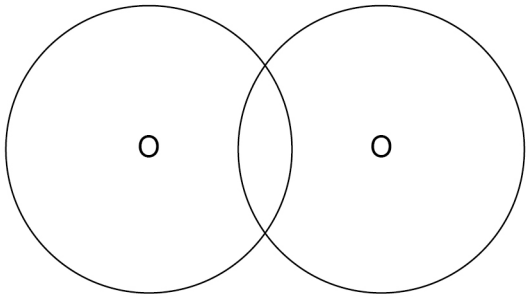
0 3 . 3 Oxygen is in Group 6 of the periodic table.

Figure 3 shows the outer energy levels in one molecule of oxygen (O_2).

Draw the electrons in the outer energy levels in **Figure 3**.

[2 marks]

Figure 3



Question 3 continues on the next page

5.5.1.2 Reaction profiles

Question 02 · continued

0 3 . 4 The equation shows the decomposition of hydrogen peroxide.

$$2\ H{-}O{-}O{-}H \rightarrow 2\ H{-}O{-}H\ +\ O{=}O$$

Table 1 shows the bond energies.

Table 1

Bond	**O–O**	**O=O**	**O–H**
Bond dissociation energy in kJ per mole	138	496	463

Calculate the overall energy change for the reaction.

[3 marks]

Energy change = _____ kJ

8

5.5.1.2 Reaction profiles

Question 03

June 2019 | 8464/C/2H | Original Q4

0 4 This question is about copper and fuels.

0 4 . 1 Copper is extracted from low-grade ores by phytomining.

Describe how copper metal is produced by phytomining.

[4 marks]

0 4 . 2 Another method of extracting copper from low-grade ores is bioleaching.

A solution of copper sulfate ($CuSO_4$) produced by bioleaching has a concentration of 0.319 g/dm^3

Relative atomic masses (A_r): Cu = 63.5 O = 16 S = 32

Calculate the number of moles of copper that can be produced from 1 dm^3 of this solution.

[3 marks]

Number of moles of copper = _____ mol

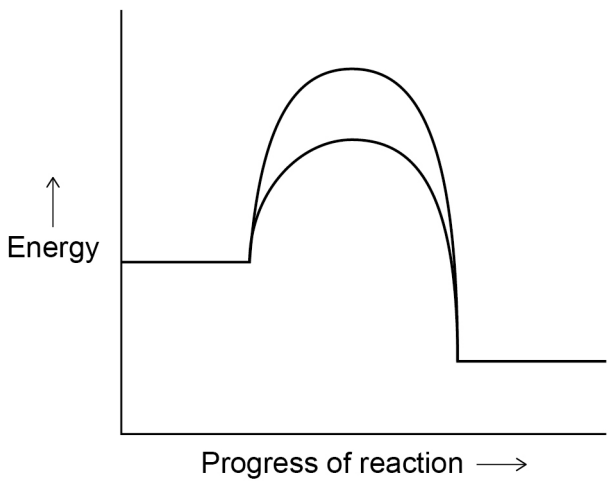
5.5.1.2 Reaction profiles

Question 03 · continued

Copper is used as a catalyst.

Figure 1 shows reaction profiles for a reaction with and without a catalyst.

Figure 1



0 4 . 3 How do the reaction profiles show that using a catalyst does **not** affect the overall energy change for the reaction?

[1 mark]

Tick (✓) **one** box.

Both reaction profiles show exothermic reactions. ☐

Both reaction profiles start at the same energy level and end at the same energy level. ☐

Both reaction profiles show the activation energy. ☐

The activation energy for the uncatalysed reaction is much lower than for the catalysed reaction. ☐

5.5.1.2 Reaction profiles

Question 03 · continued

0 4 . 4 Copper is a catalyst in a reaction to produce ethanol from carbon dioxide.

Ethanol (C_2H_5OH) is used as a fuel.

Suggest why producing ethanol from carbon dioxide is sustainable.

[2 marks]

0 4 . 5 Chemistry plays an important role in sustainable development.

What is sustainable development?

[2 marks]

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5.5.1.2 Reaction profiles

Question 04

November 2021 | 8464/C/1H | Original Q3

0 3 This question is about energy change.

A student investigated the temperature change when 10 g of ammonium nitrate was added to 100 cm^3 of water.

This is the method used.

1. Measure the temperature of 100 cm^3 of water.

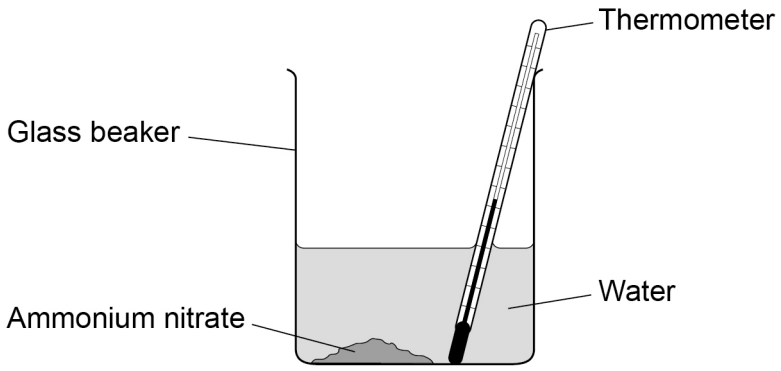
2. Add 10 g of ammonium nitrate.

3. Stir once.

4. Measure the temperature of the solution every minute for 7 minutes.

Figure 3 shows the apparatus.

Figure 3



0 3 . 1 What is the dependent variable in this investigation?

[1 mark]

0 3 . 2 Give **three** improvements to the investigation to make the results more accurate.

[3 marks]

1

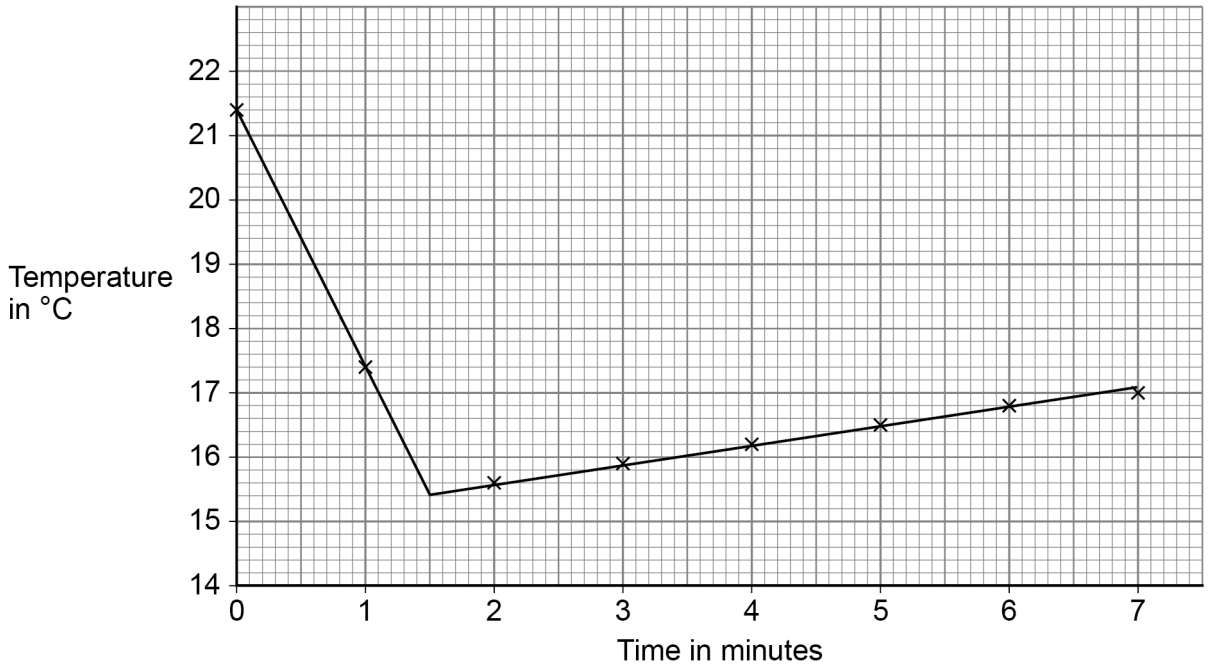
2

3

5.5.1.2 Reaction profiles

0 3 . 3 **Figure 4** shows the results.

Figure 4



Explain the results.

[4 marks]

Question 3 continues on the next page

5.5.1.2 Reaction profiles

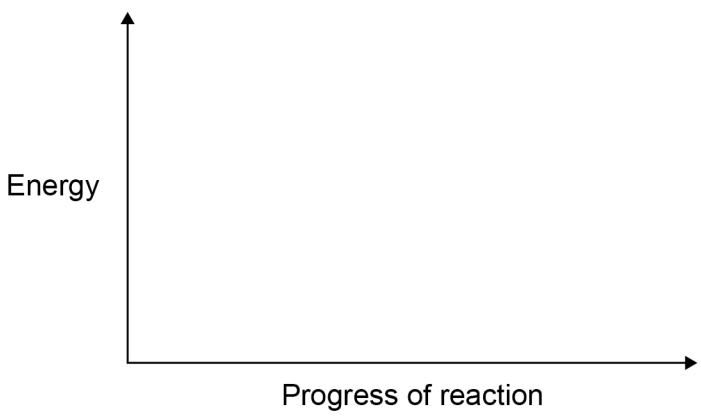
Question 04 · continued

0 3 . 4 Draw a reaction profile for an exothermic reaction.

You should label:

- the energy level of the reactants and of the products
- the activation energy
- the overall energy change.

[4 marks]



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5.5.1.2 Reaction profiles

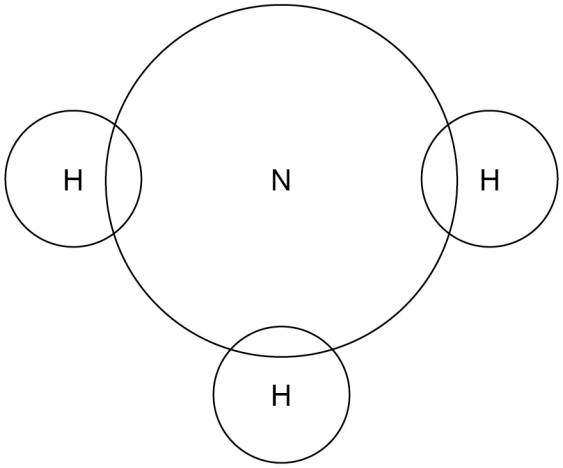
Question 05

June 2024 | 8464/C/1H | Original Q5

0 5 Nitrogen reacts with hydrogen to produce ammonia (NH_3).

0 5 . 1 Complete the dot and cross diagram for an ammonia molecule.

[2 marks]



5.5.1.2 Reaction profiles

Question 05 · continued

0 5 . 2 The equation for the reaction between nitrogen and hydrogen to produce ammonia is:

$$N_2 + 3H_2 \rightarrow 2NH_3$$

Calculate the mass of hydrogen that is needed to produce 25 g of ammonia.

Relative atomic masses (A_r): H = 1 N = 14

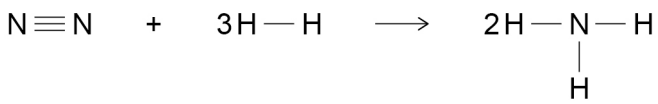
[4 marks]

Mass of hydrogen = _____ g

Question 5 continues on the next page

Figure 7 shows the displayed formulae equation for the reaction of nitrogen with hydrogen.

Figure 7



In the reaction the energy released forming new bonds is 93 kJ/mol greater than the energy needed to break existing bonds.

Table 3 shows bond energies.

Table 3

Bond	N≡N	H—H	N—H
Bond energy in kJ/mol	945	**X**	391

0 5 . 3 Calculate the bond energy **X** for the H—H bond.

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

[5 marks]

X = _____ kJ/mol

5.5.1.2 Reaction profiles

Question 05 · continued

0 5 . 4 Energy is released from the reaction to produce ammonia.

Figure 8 shows part of the reaction profile for the reaction between nitrogen and hydrogen to produce ammonia.

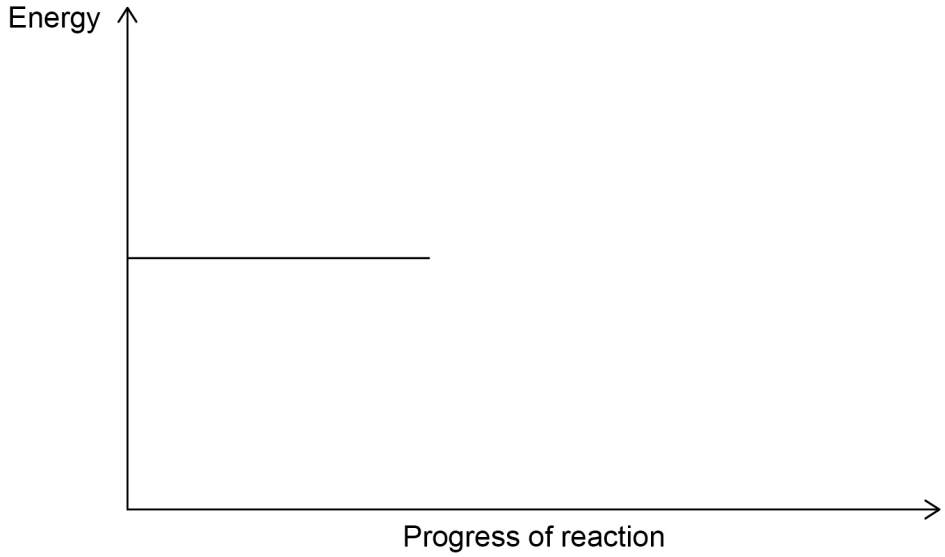
Complete **Figure 8**.

You should:

- complete the profile line
- label the energy level of the reactants and the product
- label the **overall** energy change.

[3 marks]

Figure 8



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