AQA

Please write clearly in block capitals.

Centre number ☐☐☐☐☐   Candidate number ☐☐☐☐

Surname _____

Forename(s) _____

Candidate signature _____
I declare this is my own work.

GCSE
CHEMISTRY

H

Higher Tier   Paper 2

Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:
- a ruler
- a scientific calculator
- the periodic table (enclosed).

Instructions

- Use black ink or black ball-point pen.
- Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

Information

- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
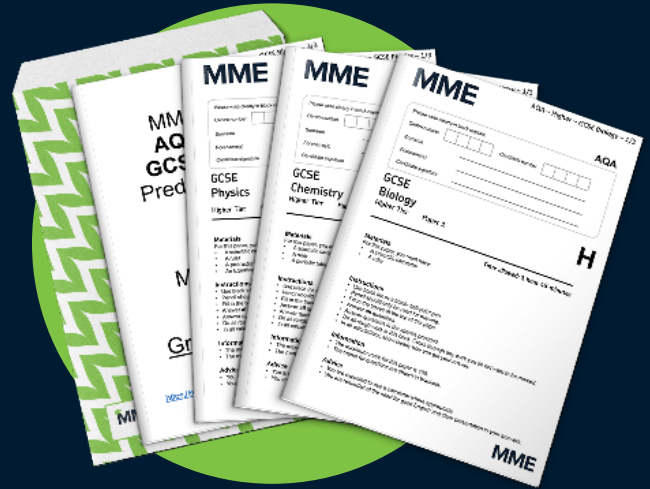- You are reminded of the need for good English and clear presentation in your answers.

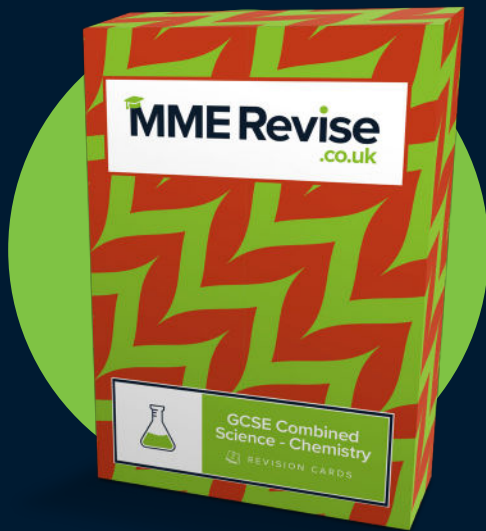| For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	

MME.

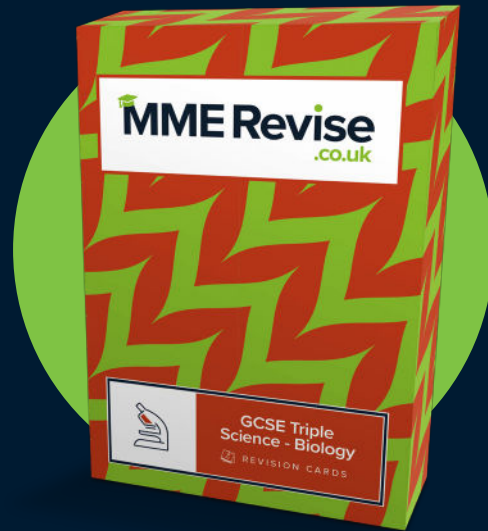# Revision Products - GCSE Science
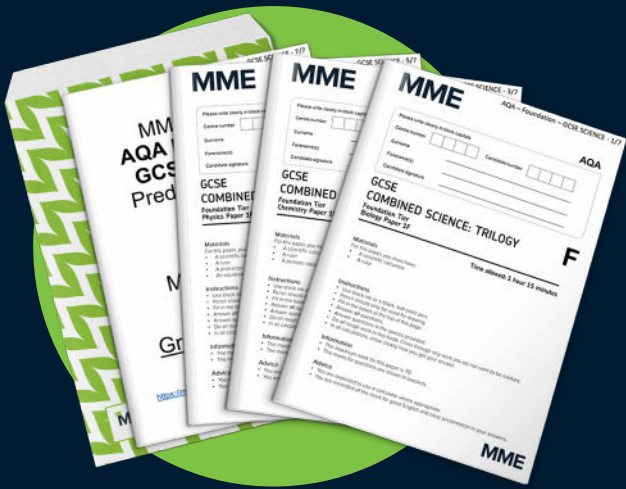
**GCSE Combined Science
Predicted Papers 2024**

**AQA GCSE Triple Science
Predicted Papers 2024**

**GCSE Combined
Science Revision Cards**

**GCSE Triple Science
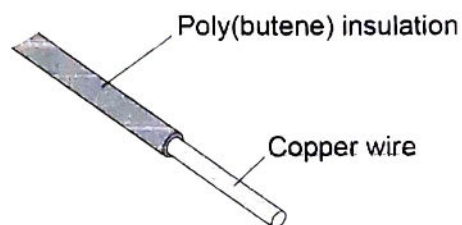Revision Cards**

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0 1 This question is about copper wire and copper compounds.

Copper is used to make electrical wires.

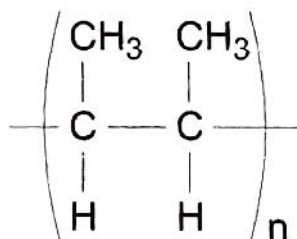**Figure 1** shows how copper electrical wire is insulated using an addition polymer called poly(butene).

Figure 1

Poly(butene) insulation

Copper wire

0 1 . 1 The addition polymer poly(butene) has the displayed structural formula:
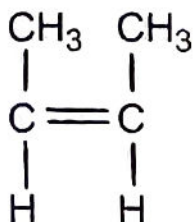

Poly(butene) is produced from the monomer butene.

Complete **Figure 2** to show the displayed structural formula of butene.

[2 marks]

Figure 2

Copper can be obtained by recycling scrap copper wire.

0 1 . 2 Suggest why poly(butene) insulation must be removed from scrap copper wire before the copper is recycled.

[1 mark]

Otherwise the copper produced would be impure

0 1 . 3 Describe how scrap copper wire can be recycled to make new copper water pipes.

[2 marks]

The wire can be heated until the copper melts. This can then be reformed into pipes.

0 1 . 4 Suggest **two** reasons why recycling scrap copper is more sustainable than extracting copper from copper ores.

[2 marks]

1 It uses less energy.

2 It also conserves copper reserves

Question 1 continues on the next page

Turn over ▶

Copper sulfate is a compound of copper.

Copper sulfate solution contains copper(II) ions and sulfate ions.

0 1 . 5 A solution can be added to copper sulfate solution to show the presence of copper(II) ions.

Name the solution added.

Give the result of the test.

[2 marks]

Name of solution added ___Sodium Hydroxide___

Result ___Blue precipitate___

0 1 . 6 Describe **one** test to show the presence of sulfate ions in copper sulfate solution.

Give the result of the test.

[2 marks]

Test ___Add acidified barium chloride.___

Result ___White preciptate___

11

Turn over for the next question

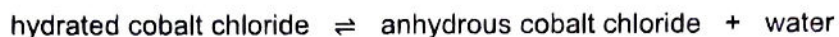**DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED**

Turn over ▶

0 2 A student investigated the change in mass when hydrated cobalt chloride was heated.

The word equation for the reaction is:

hydrated cobalt chloride ⇌ anhydrous cobalt chloride + water

This is the method used.

1. Add 2.0 g of hydrated cobalt chloride to an empty test tube.

2. Measure the mass of the test tube and contents.

3. Heat the test tube and contents gently for 30 seconds.

4. Allow the test tube and contents to cool.

5. Measure the mass of the test tube and contents.

6. Repeat steps 3 to 5 until the mass of the test tube and contents does not change.

Table 1 shows the results.

Table 1

Total heating time in seconds	Mass of test tube and contents in grams
0	26.5
30	26.2
60	25.9
90	25.6
120	25.6

0 2 . 1 Determine the mass of the empty test tube.

[1 mark]

$$26.5 - 2.0 = 24.5 \text{ g}$$

Mass of empty test tube = __24.5__ g

0 2 . 2 Explain why the mass of the test tube and contents decreased.

[2 marks]

Water vapour was produced.
This water vapour escaped
from the tube.

0 2 . 3 Suggest why the test tube and contents were heated until the mass did not change.

[1 mark]

This was when the reaction
was complete,

Question 2 continues on the next page

Energy is taken in from the surroundings when hydrated cobalt chloride is heated.

| 0 | 2 |.| 4 |

When 238 g of hydrated cobalt chloride is heated until the mass does not change, 88.1 kJ of energy is taken in.

The student heated 2.00 g of hydrated cobalt chloride until the mass did not change.

Calculate the energy taken in during this reaction.

Give your answer to 3 significant figures.

[3 marks]

$$\frac{2.00}{238} \times 88.1 \ kJ = 0.740336\ldots$$

$$Energy = 0.740 \ kJ$$

Energy taken in (3 significant figures) = __0.740__ kJ

| 0 | 2 |.| 5 |

What type of reaction takes place when hydrated cobalt chloride is heated?

[1 mark]

Endothermic reaction.

8

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

Turn over ▶

| 0 | 3 | This question is about life cycle assessments (LCAs).

| 0 | 3 |.| 1 | Milk bottles can be made from glass or from a polymer.

Table 2 shows information about milk bottles of equal volume.

Table 2

	Glass	Polymer
Raw materials	Limestone Sand Sodium carbonate	Crude oil
Energy needed to process raw materials in kilojoules	6750	1710
Energy needed to manufacture bottle in kilojoules	750	90
Mass of bottle in grams	200	20
Mean number of times used during lifetime of bottle	25	1
One disposal method at end of useful life	Recycled to make different glass products	Recycled to make different polymer products

Evaluate the use of glass for milk bottles compared with the use of a polymer for milk bottles.

Use features of life cycle assessments (LCAs) in your answer.

Use **Table 2**.

[6 marks]

Glass bottles use more energy to produce and transport due to their weight. Although they're reusable and conserve natural resources, their washing consumes energy and water. Both glass and polymer bottles are recyclable, but

recycling polymer ~~Consuming~~ Consumes less energy and conserves finite resources. Considering the total energy expended, including production, reuse and recycling, polymer bottles have lower overall impact. Hence, polymer bottles appear more sustainable due to their lower energy consumption and resource conservation during their life cycle.

| 0 | 3 | . | 2 | Milk is also sold in cardboard cartons.

A carton is made using 40 cm³ of cardboard.

The density of the cardboard is 0.40 g/cm³.

Calculate the mass of the carton.

Use the equation:

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

[3 marks]

$\text{density} = \dfrac{\text{mass}}{\text{Volumes}}$ so $\text{mass} = \text{density} \times \text{volume}$

$\text{mass} = 0.40 \times 40 = 16 \text{ g}$

Mass = _____16_____ g

9

| 0 | 4 |

This question is about the fractions obtained from crude oil.

| 0 | 4 |.| 1 |

Crude oil is separated into fractions by fractional distillation.

The fractions obtained from crude oil include:

- lubricating oil
- naphtha
- petroleum gases.

Table 3 shows the boiling point range of these fractions.

Table 3

Fraction	Boiling point range in °C
Lubricating oil	300–350
Naphtha	90–200
Petroleum gases	< 25

Explain how these fractions are obtained from crude oil by fractional distillation.

[4 marks]

Crude oil is heated to vaporise the hydrocarbons. In the fractionating column, there is a temperature gradient. This means that the further up the column, the cooler it is. The gases will therefore condense at different levels because of their different boiling points.

0 4 . 2 Fractions from crude oil can be processed to produce feedstock for the petrochemical industry.

Which **two** are useful materials produced from this feedstock?

[2 marks]

Tick (✓) **two** boxes.

Alloys ☐

Ceramics ☐

Detergents ☑

Fertilisers ☐

Solvents ☑

Another fraction obtained from crude oil is petrol.

0 4 . 3 Petrol contains a hydrocarbon with the formula C_9H_{20}

Complete the equation for the complete combustion of C_9H_{20}

You should balance the equation.

[2 marks]

$$C_9H_{20} + \underline{14 O_2} \rightarrow \underline{9 CO_2} + \underline{10 H_2O}$$

0 4 . 4 Petrol obtained from crude oil contains sulfur impurities.

Explain why sulfur impurities are removed before petrol is burned in car engines.

[2 marks]

When Sulfur impurities are burnt, they produce Sulfur dioxide. This causes acid rain.

0 4 . 5 **Table 4** shows information about two more fractions obtained from crude oil.

Table 4

Fraction	Range of number of carbon atoms in each molecule
Kerosene	11–15
Heavy fuel oil	20–40

A student predicted that heavy fuel oil is more viscous than kerosene.

The student's prediction was correct.

Justify the student's prediction.

[2 marks]

When molecular size increases, viscosity increases. Heavy oil has larger molecules, so it is more viscous.

The heavy fuel oil fraction can be processed to produce smaller hydrocarbon molecules.

0 4 . 6 Name the process which produces smaller hydrocarbon molecules from heavy fuel oil.

Give the conditions used in this process.

[3 marks]

Name of process ___Cracking___

Conditions ___High temperature and the use___

___of a catalyst.___

0 4 . 7 Hydrocarbon molecules containing seven and eight carbon atoms can be produced when heavy fuel oil is processed.

Which pair of hydrocarbon molecules would **both** turn bromine water colourless?

[1 mark]

Tick (✓) **one** box.

C_7H_{14} and C_8H_{16} ✓

C_7H_{14} and C_8H_{18} ☐

C_7H_{16} and C_8H_{16} ☐

C_7H_{16} and C_8H_{18} ☐

16

Turn over ▶

There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

| 0 | 5 | This question is about water.

| 0 | 5 | . | 1 | Sewage is waste water.

Sewage contains organic matter.

Describe how sewage is treated to remove organic matter.

[4 marks]

Firstly, the grit is removed in a process called screening. Then, the sewage is put through sedimentation ~~sedimentation~~ to produce sewage sludge and effluent. Then the solid sewage sludge is aneorobically digested. There is aerobic biological treatment of the liquid effluent

Question 5 continues on the next page

Sea water and ground water are treated to make them potable.

Table 5 shows information about the composition and treatment of sea water and of ground water.

Table 5

	Sea water	Ground water
Concentration of sodium ions and chloride ions before **Process 1**	Na^+ : 0.5 mol/dm³ Cl^- : 0.5 mol/dm³	Na^+ : 0.001 mol/dm³ Cl^- : 0.001 mol/dm³
Process 1	Reverse osmosis	Filtration
Concentration of sodium ions and chloride ions after **Process 1**	X	Na^+ : 0.001 mol/dm³ Cl^- : 0.001 mol/dm³
Process 2	Add ozone	Expose to ultraviolet light

| 0 | 5 |.| 2 | Sea water is desalinated during **Process 1**.

Which pair of concentrations could represent **X** in **Table 5**?

[1 mark]

Tick (✓) **one** box.

Na^+ : 0.003 mol/dm³ Cl^- : 0.003 mol/dm³   ☑

Na^+ : 0.003 mol/dm³ Cl^- : 0.5 mol/dm³   ☐

Na^+ : 0.5 mol/dm³ Cl^- : 0.003 mol/dm³   ☐

Na^+ : 0.5 mol/dm³ Cl^- : 0.5 mol/dm³   ☐

| 0 | 5 |.| 3 | Explain why the concentrations of sodium ions and of chloride ions in the ground water in **Table 5** are unchanged by **Process 1**.

[2 marks]

The ions pass through the filter in process 1. This is because the ions are in solution.

0 5 . 4 Explain why the ground water in **Table 5** requires **Process 2** before the water is safe to drink.

[2 marks]

The ground water contains microbes which are harmful. Therefore, the water is sterilised.

0 5 . 5 After treatment the ground water in **Table 5** is sold by a company as pure water.

The ground water in **Table 5** is not chemically pure because the water contains sodium ions and chloride ions.

Suggest what the company means by 'pure'.

[1 mark]

Nothing is added to the water.

0 5 . 6 Chlorine is also used to treat some ground water.

Describe the test for chlorine gas.

Give the result of the test.

[2 marks]

Test _____ Use damp litmus paper.

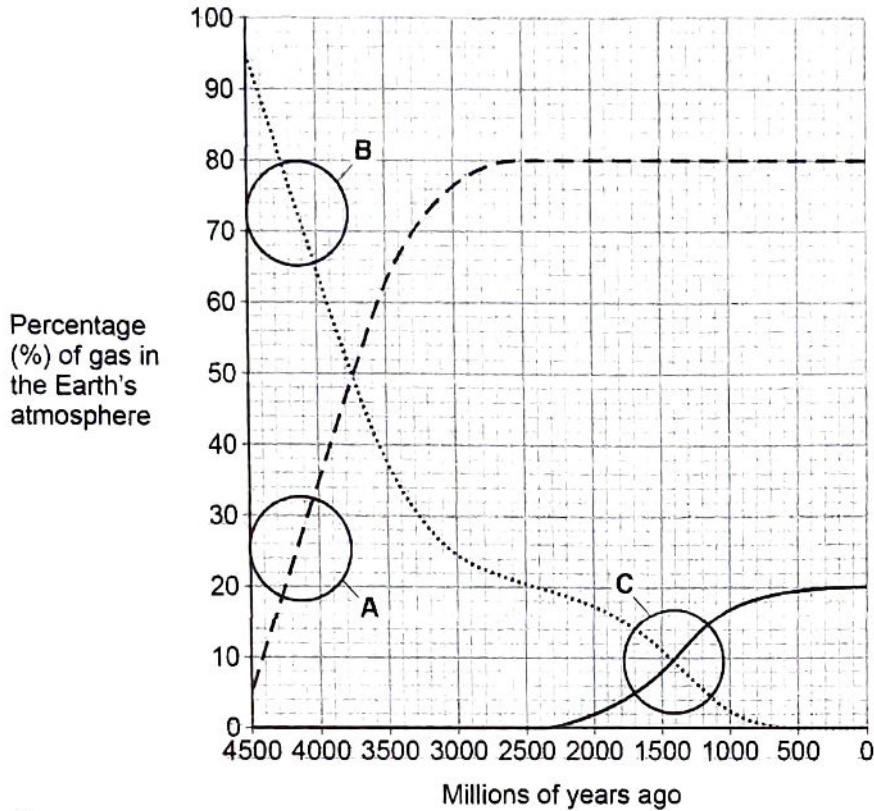Result _____ The paper turns white

12

Turn over ▶

| 0 | 6 |

This question is about the chemistry of the Earth's atmosphere.

Figure 3 shows how the percentages of gases in the Earth's atmosphere may have changed since the atmosphere was formed.
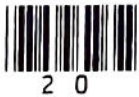
Figure 3

Key

.... Carbon dioxide

– – – Nitrogen

——— Oxygen

| 0 | 6 |.| 1 |

Explain the change in the percentage of gas in the region labelled **A** on **Figure 3**.

[2 marks]

The percentage of nitrogen increased, because of intense volcanic activity.

0 6 . 2 Explain the change in the percentage of gas in the region labelled **B** on **Figure 3**.

[2 marks]

The percentage of carbon dioxide decreased because the carbon dioxide dissolved in oceans.

0 6 . 3 Compare the changes in the percentages of gases in the region labelled **C** on **Figure 3**.

[2 marks]

The percentage of carbon dioxide decreased and the percentage of oxygen increased. These occur at the same rate.

0 6 . 4 What process caused the changes in the percentages of gases in the region labelled **C** on **Figure 3**?

[1 mark]

Photosynthesis

0 6 . 5 Natural gas is a fossil fuel.

Describe how deposits of natural gas were formed.

[3 marks]

The plankton died, and they were covered by sediments. They were subjected to high temperatures and pressures over millions of years.
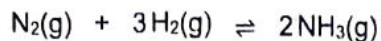
10

Turn over ▶

0 7   Ammonia is produced in the Haber process.

The raw materials for the Haber process are nitrogen and hydrogen.

The equation for the reaction is:

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

0 7 . 1   Give the sources of the nitrogen and of the hydrogen used in the Haber process.

[2 marks]

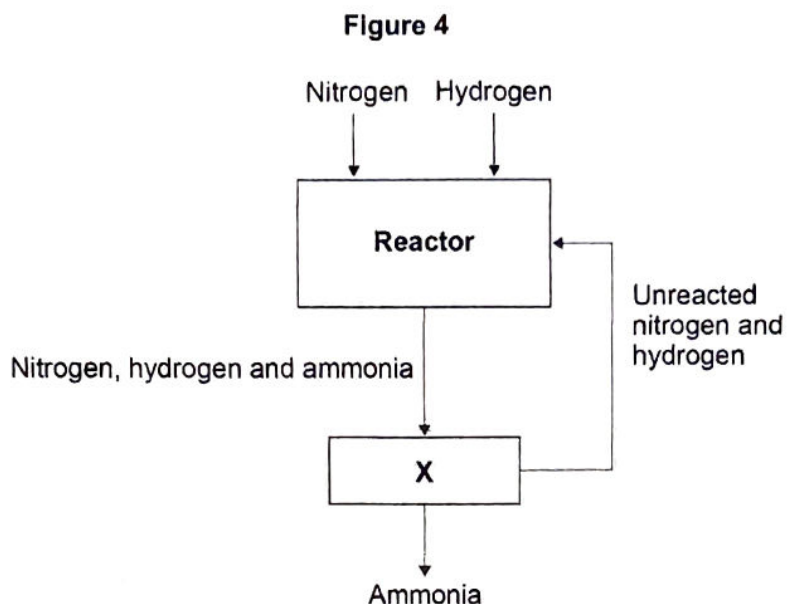Nitrogen _____ Air _____

Hydrogen _____ Natural gas _____

0 7 . 2   How does the equation for the reaction show that the atom economy of the forward reaction is 100%?

[1 mark]

There is only one product.

| 0 | 7 | . | 3 |

Figure 4 represents the Haber process.

Figure 4

Nitrogen   Hydrogen

Reactor

Unreacted nitrogen and hydrogen

Nitrogen, hydrogen and ammonia

X

Ammonia

Explain how the ammonia produced is separated from the unreacted nitrogen and hydrogen in **X**.

[2 marks]

The mixture is cooled so that only the ammonia liquefies, therefore it can be easily removed.

Question 7 continues on the next page

Turn over ▶

The Haber process uses a temperature of 450 °C and a pressure of 200 atmospheres.

Table 6 shows the percentage yield of ammonia produced at 450 °C using different pressures.

Table 6

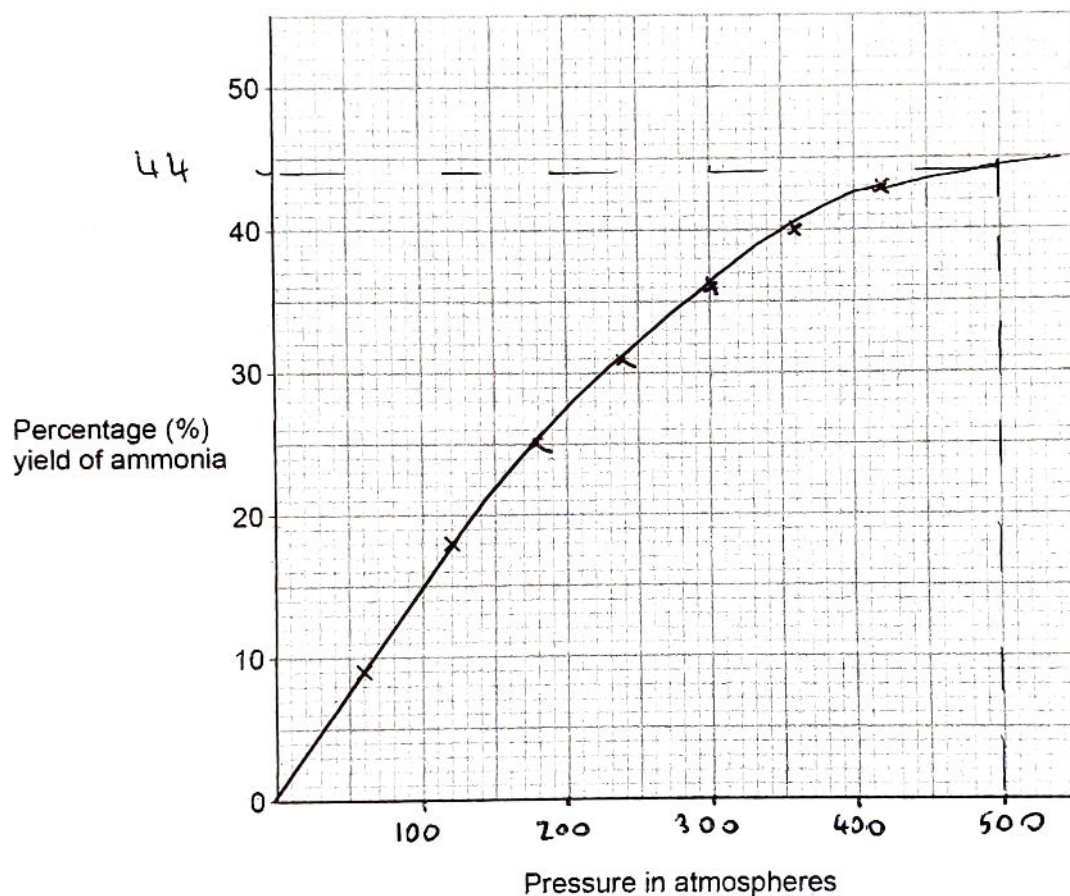| Pressure in atmospheres	Percentage (%) yield of ammonia
60	9
120	18
180	25
240	31
300	36
360	40
420	43

0 7 . 4 Complete **Figure 5**.

The first two points have been plotted.

You should:

- use a suitable scale for the *x*-axis
- plot the remaining data from **Table 6**
- draw a line of best fit.

[4 marks]

Figure 5

Pressure in atmospheres

0 7 . 5 Determine the percentage yield of ammonia at 450 °C and 500 atmospheres.

Show your working on **Figure 5**.

[2 marks]

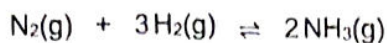Percentage yield = ___44___ %

Turn over ▶

0 7 . 6 The equation for the production of ammonia in the Haber process is:

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

The forward reaction is exothermic.

The conditions used are:

- a temperature of 450 °C
- a pressure of 200 atmospheres
- the presence of an iron catalyst.

Explain why these conditions are chosen for economical production of ammonia in the Haber process.

You should include references to the rate of reaction and the position of equilibrium.

[6 marks]

The conditions chosen for this reaction are a result of multiple considerations. Firstly, a higher temperature is selected as it leads to a higher rate due to increased collision frequency and more particles possessing the activation energy. A higher pressure increases collision frequency, also increasing the rate. A catalyst is used to lower the activation energy, increasing the rate of reaction. These choices may add to the cost, because temperatures above 450°C and pressures above 200 atm require higher energies and strong containers. The selected temperature and pressure represent a compromise between reaction rate, equilibrium position and cost. This ensures optimum balance for yield and reaction rate.

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

Turn over ▶

0 8 This question is about the reaction between sodium thiosulfate solution and hydrochloric acid.

When hydrochloric acid is added to sodium thiosulfate solution, the mixture gradually becomes cloudy.

The equation for the reaction is:

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

0 8 . 1 Sulfur is produced in the reaction.

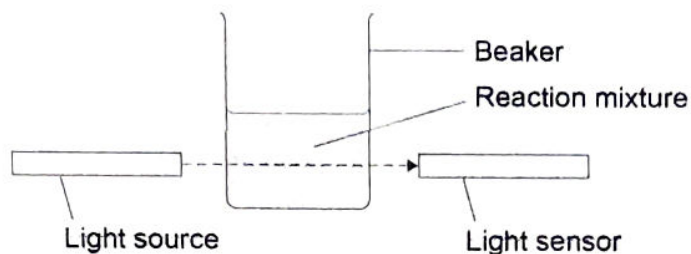Why does the mixture become cloudy?

[1 mark]

Sulfur is a solid

A student investigated the effect of changing the concentration of sodium thiosulfate solution on the rate of the reaction.

Figure 6 shows the apparatus used.

Figure 6

A smaller percentage of light from the light source reaches the light sensor as the mixture becomes more cloudy.

This is the method used.

1. Measure 50 cm³ of 0.10 mol/dm³ sodium thiosulfate solution into the beaker.

2. Add 10 cm³ of hydrochloric acid to the sodium thiosulfate solution.

3. Immediately start a timer.

4. Record the percentage of light from the light source that reaches the light sensor every 20 seconds for 120 seconds.

5. Repeat steps 1 to 4 using 0.20 mol/dm³ sodium thiosulfate solution.

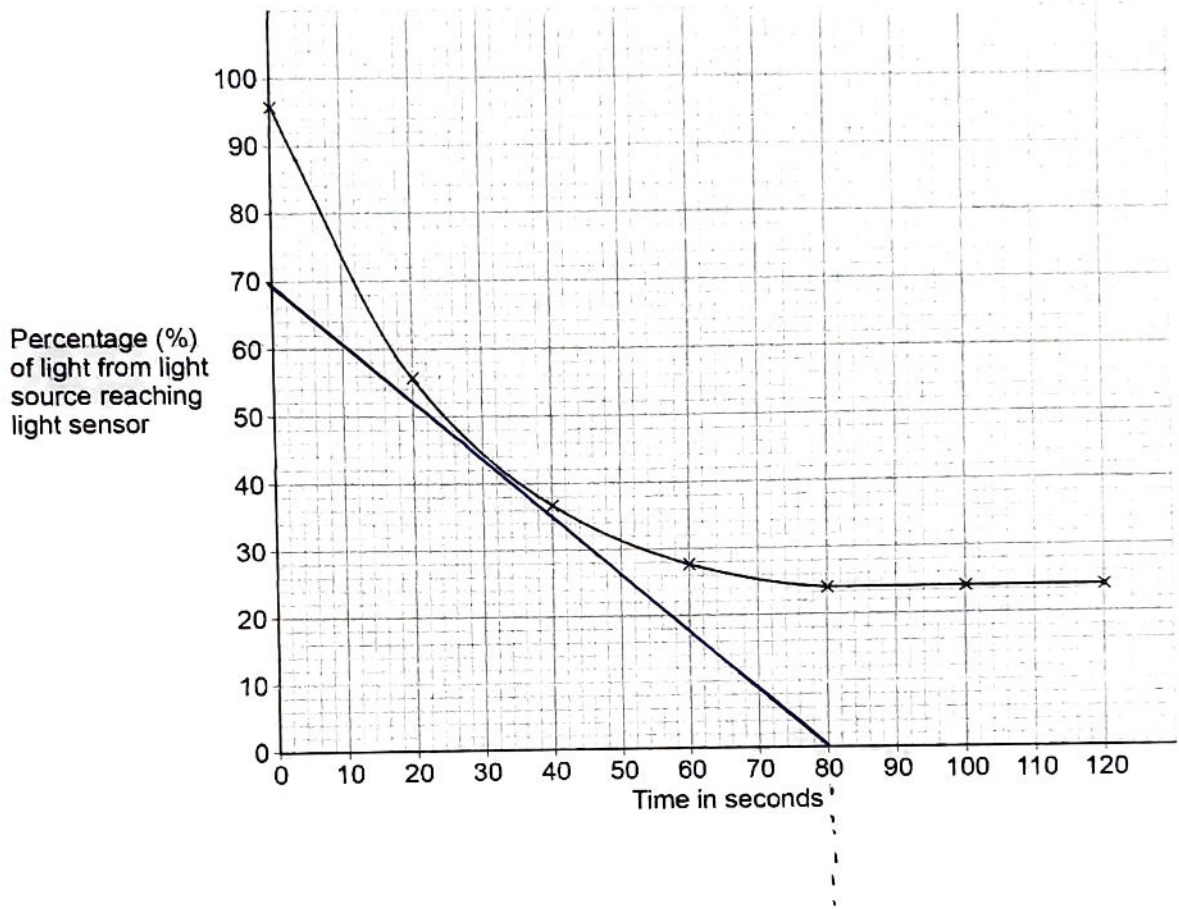**Question 8 continues on the next page**

Turn over ▶

Figure 7 shows the results for 0.10 mol/dm³ sodium thiosulfate solution.

Figure 7

0 8 . 2 The percentage of light reaching the light sensor decreases by 1% when 7.1×10^{-5} moles of sulfur is produced.

Determine the rate of reaction in mol/s for the production of sulfur at 30 seconds.

You should draw a tangent on **Figure 7**.

[5 marks]

Using my tangent on Figure 7:

Change in the y axis: 70 - 0 = 70%
Change in the x axis: 80 - 0 = 80 seconds

70/80 = - 0.875 % per seconds

- 0.875 × 7.1 × 10⁻⁵ = - 0.62125 ×10⁻⁵

Rate = -0.621×10^{-5} mol/s

0 8 . 3 Explain why the rate of reaction changes between 0 and 60 seconds.

Answer in terms of concentration.

Use **Figure 7**.

[2 marks]

The rate decreases because the concentration of reactants decreases.

Figure 8 is a repeat of Figure 7.

Figure 8
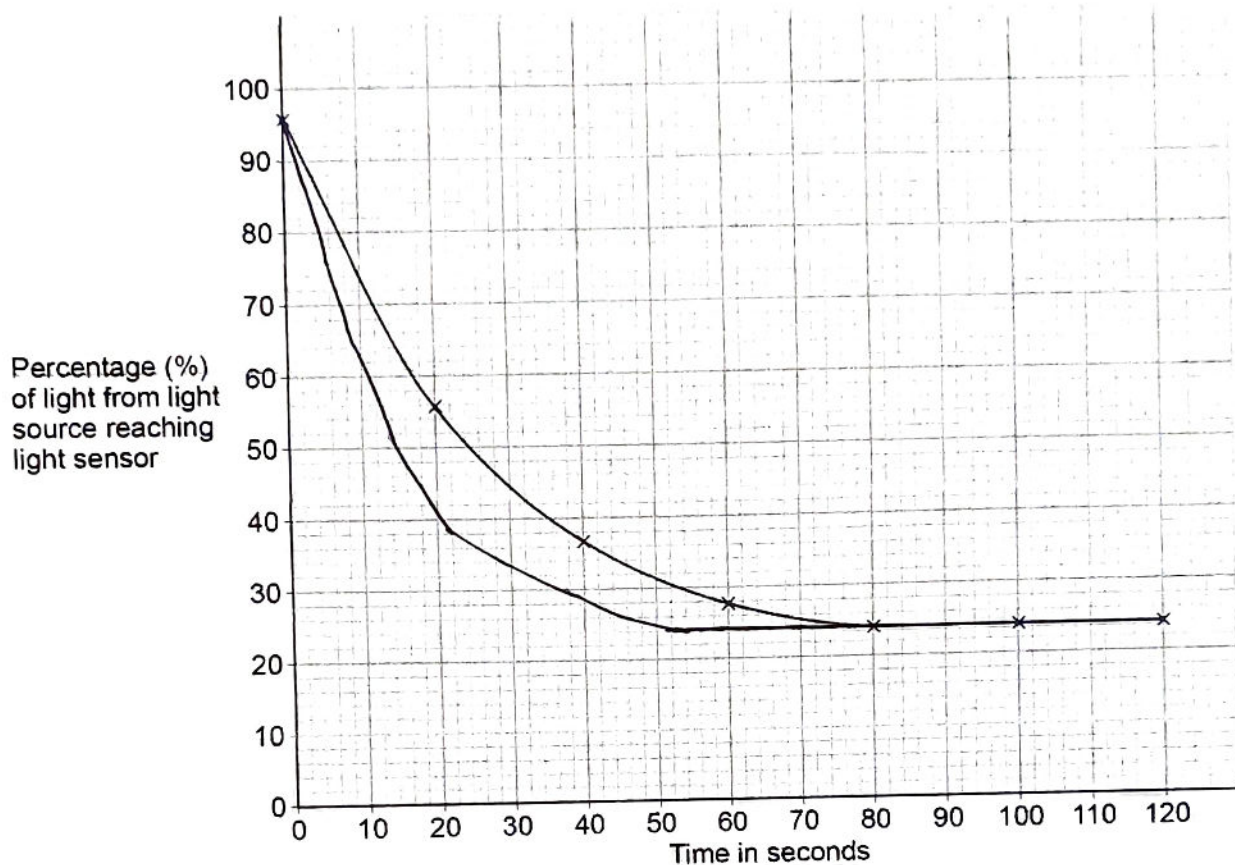

Figure 8 shows the results for 0.10 mol/dm³ sodium thiosulfate solution.

Sodium thiosulfate solution was in excess in the investigation.

0 8 . 4   The line of best fit on **Figure 8** is horizontal between 80 and 120 seconds because the reaction stopped.

Why did the reaction stop?

[1 mark]

All the hydrochloric acid is used up

0 8 . 5   Sketch a line on **Figure 8** to show the results you would predict for 0.20 mol/dm³ sodium thiosulfate solution.

[2 marks]

The same student did the investigation again the next day.

The student found that the same method produced different results for the percentage of light reaching the light sensor.

0 8 . 6 How could the student improve the method so that the same percentages of light reached the light sensor?

[1 mark]

Tick (✓) **one** box.

Record the percentage of light every 10 seconds. ☐

Stop light from other sources reaching the light sensor. ✓

Use a larger volume of sodium thiosulfate solution. ☐

Use a more sensitive light sensor. ☐

0 8 . 7 The student improved the method so that similar results were obtained on different days.

What name is given to similar results obtained on different days under the same conditions by the same student?

[1 mark]

Tick (✓) **one** box.
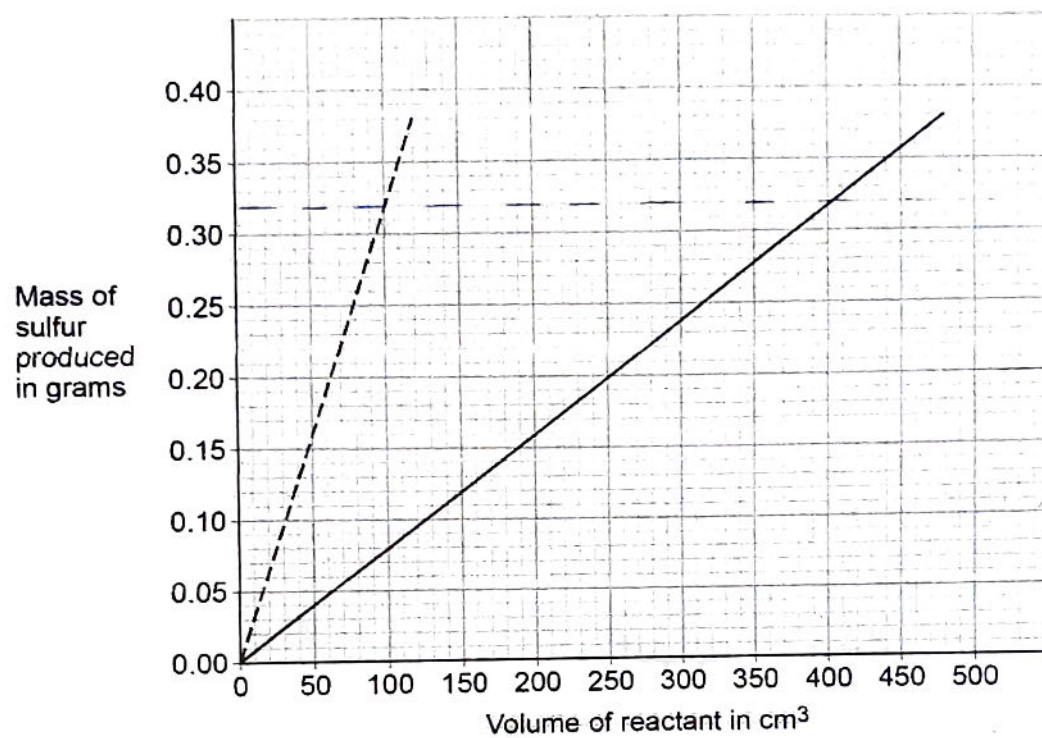
Anomalous ☐

Precise ☐

Repeatable ✓

Reproducible ☐

Turn over ▶

Figure 9 shows the volumes of:

- sodium thiosulfate solution of concentration 0.10 mol/dm³
- hydrochloric acid of concentration 0.05 mol/dm³

which completely react to produce different masses of sulfur.

Figure 9

Key

- - - 0.10 mol/dm³ sodium thiosulfate solution
—— 0.05 mol/dm³ hydrochloric acid

0 8 . 8   Which expression represents the relationship between the volume (V) of sodium thiosulfate solution used and the mass (m) of sulfur produced?

Use **Figure 9**.

[1 mark]

Tick (✓) **one** box.

V ∝ m ☑

V ~ m ☐

V << m ☐

V = m ☐

0 8 . 9   Determine the simplest whole number ratio of the volumes of

sodium thiosulfate solution : hydrochloric acid

which completely react with each other.

Use **Figure 9**.   (using Figure 9)

[3 marks]

Volume of sodium thiosulfate = 100
Volume of hydrochloric acid = 400

Sodium thiosulfate solution : hydrochloric acid

(÷100)   100 : 400 (÷100)

1 : 4

Simplest whole number ratio = ___1___ : ___4___

17

END OF QUESTIONS