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

Friday 13 June 2025 Morning 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.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
TOTAL	

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.
- In all calculations, show clearly how you work out your answer.
- You are reminded of the need for good English and clear presentation in your answers.

Do not write outside the box

0 1 A student investigated the mass of dissolved solids in sea water.

This is the method used.

1. Weigh an empty evaporating basin.
2. Measure 10.0 cm^3 of sea water sample **A** into the evaporating basin using a burette.
3. Heat the evaporating basin until all the water seems to have evaporated.
4. Weigh the evaporating basin and contents.
5. Calculate the mass of dissolved solids in the sample.
6. Repeat steps 1 to 5 with sea water samples **B**, **C** and **D**.

0 1 . 1 Why did the student use a burette rather than a measuring cylinder to measure 10.0 cm^3 of each sample?

[1 mark]

0 1 . 2 What was the dependent variable in this investigation?

[1 mark]

0 1 . 3 Describe how the student could make sure **all** of the water had evaporated in **step 3**.

[2 marks]

0 1 . 4 How did the student calculate the mass of dissolved solids in each sea water sample?

[1 mark]

Do not write outside the box

Table 1 shows the results.

Table 1

Sea water sample	**A**	**B**	**C**	**D**
Mass of dissolved solids in grams	0.35	0.37	0.33	0.34

0 1 . 5 Calculate the mean concentration of dissolved solids in 10.0 cm^3 samples of sea water **A**, **B**, **C** and **D**.

Use **Table 1** and the equation:

$$\text{mean concentration of dissolved solids } (g/dm^3) = \frac{\text{mean mass of dissolved solids (g)}}{\text{volume of sample } (dm^3)}$$

Give your answer in g/dm^3.

[5 marks]

Mean concentration = _____ g/dm^3

0 1 . 6 Suggest why sea water samples **A**, **B**, **C** and **D** contain different masses of dissolved solids.

[1 mark]

11

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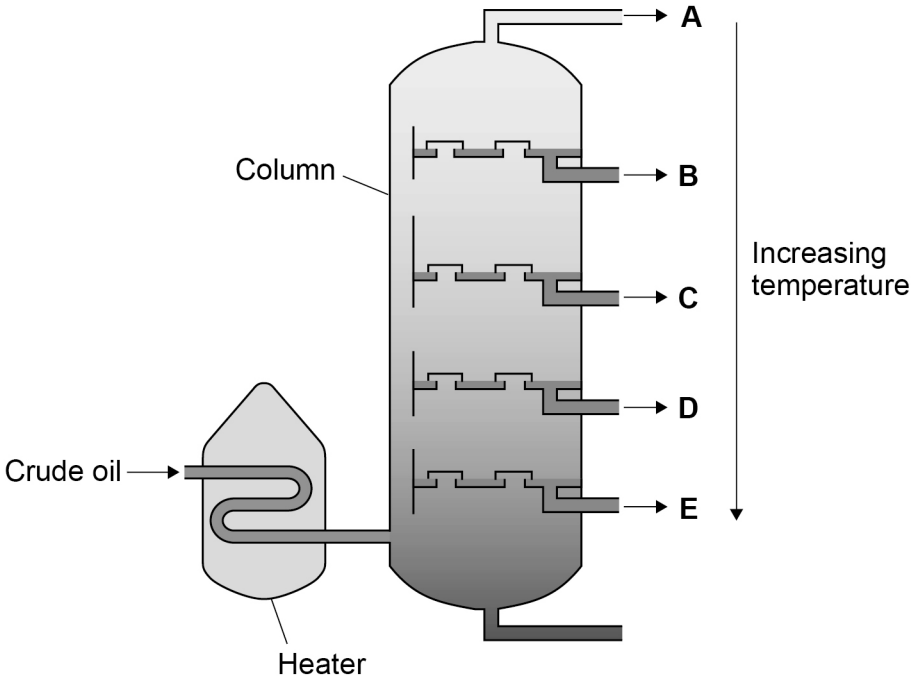
0 2 This question is about hydrocarbon fuels.

Figure 1 represents the process used to separate hydrocarbon fuels from crude oil.

Figure 1



0 2 . 1 Name the process represented by **Figure 1**.

[1 mark]

0 2 . 2 Changes of state take place during the process in **Figure 1**.

Name the change of state taking place in:

- the heater
- the column.

[2 marks]

Heater _____

Column _____

Do not write outside the box

Different fuels are obtained from crude oil at the points on **Figure 1** labelled **A** to **E**.

Table 2 shows the boiling point ranges of different fuels obtained from the process in **Figure 1**.

Table 2

Fuel	**Boiling point range in °C**
Diesel oil	260 – 320
Heavy fuel oil	320 – 400
Kerosene	180 – 260
Petrol	40 – 110
Petroleum gases	Below 30

0 2 . 3 Which fuel is obtained at **B** in the column?

Use **Figure 1** and **Table 2**.

[1 mark]

0 2 . 4 Fuels with higher boiling point ranges contain larger molecules.

What is the order of increasing flammability of the fuels?

Use **Table 2**.

[1 mark]

Tick (✓) **one** box.

Heavy fuel oil ⟶ diesel oil ⟶ kerosene ☐

Heavy fuel oil ⟶ kerosene ⟶ diesel oil ☐

Kerosene ⟶ diesel oil ⟶ heavy fuel oil ☐

Kerosene ⟶ heavy fuel oil ⟶ diesel oil ☐

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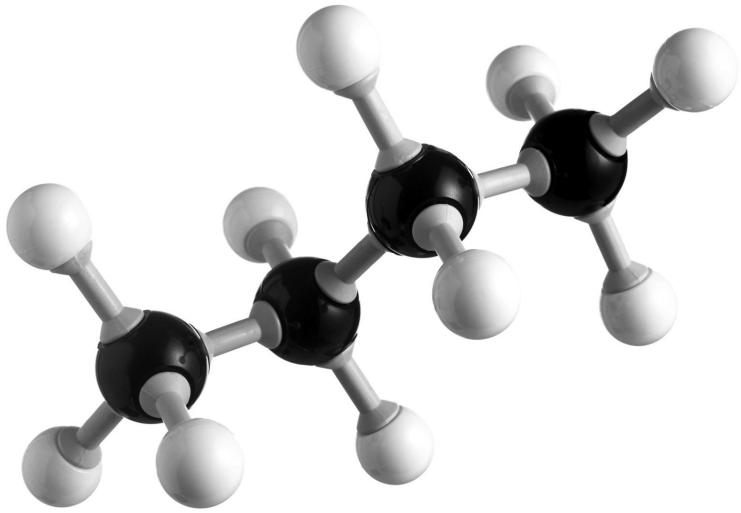
Liquified petroleum gases are a mixture of several different hydrocarbons.

Figure 2 shows a model of one of these hydrocarbons.

Figure 2



0 2 . 5 Write the molecular formula of the hydrocarbon represented by the model in **Figure 2**.

[1 mark]

0 2 . 6 Name the hydrocarbon represented by the model in **Figure 2**.

[1 mark]

0 2 . 7 Petroleum gases also contain a hydrocarbon with the formula C_3H_8

Balance the equation for the complete combustion of C_3H_8

[2 marks]

$$C_3H_8 \quad + \quad 5\ O_2 \quad \longrightarrow \quad \_\_\_\_\ CO_2 \quad + \quad \_\_\_\_\ H_2O$$

9

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 3 Doors can be made from aluminium or wood.

0 3 . 1 **Table 3** gives information about aluminium and wood.

Table 3

	Aluminium	**Wood**
Raw material	Metal ore from rock	Trees
Relative cost of 1 kilogram of material	87	1
Relative strength	1.3	1.0
Protection	No protection needed to prevent corrosion	Painted to prevent rotting
Disposal	Melted to form new products	Shredded into wood chips for fuel

Evaluate the use of aluminium and of wood for making doors.

[6 marks]

Extra space

Do not write outside the box

0 3 . 2 Aluminium has an oxide coating that protects the metal from corrosion.

Explain how the oxide coating protects aluminium from corrosion.

[2 marks]

0 3 . 3 Doors made from wood need painting to prevent rotting.

Paints are **formulations** made by mixing a solid pigment and a liquid.

Which statement describes the composition of a paint?

[1 mark]

Tick (✓) **one** box.

A fixed mass of pigment and a fixed mass of liquid ☐

A fixed mass of pigment and a variable mass of liquid ☐

A variable mass of pigment and a fixed mass of liquid ☐

A variable mass of pigment and a variable mass of liquid ☐

9

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0 4 The Earth's atmosphere has changed over time.

0 4 . 1 Explain how the percentage of nitrogen changed in the Earth's early atmosphere.

[2 marks]

0 4 . 2 **Table 4** shows the percentage (%) of carbon dioxide present in the Earth's early atmosphere.

Table 4

Time in billions of years ago	Percentage (%) of carbon dioxide in the Earth's early atmosphere
4.5	98
4.0	54
3.5	30
3.0	21

The percentage of carbon dioxide in the Earth's **early** atmosphere changed between 4.5 billion and 3.0 billion years ago.

Give **two** reasons why.

[2 marks]

1

2

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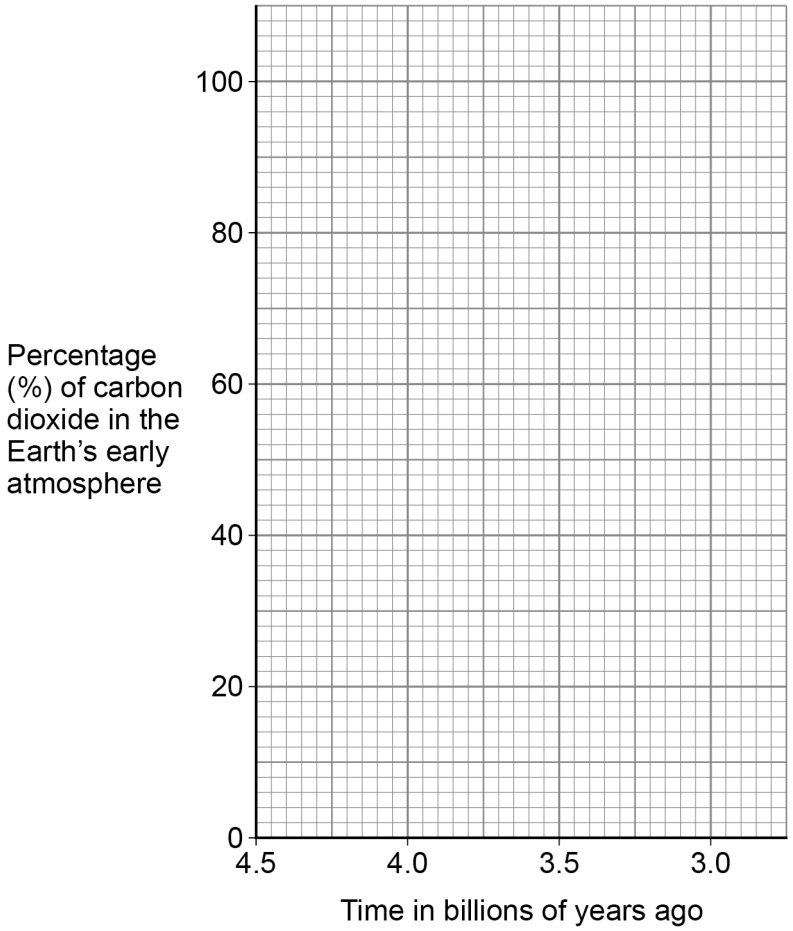
0 4 . 3 Complete **Figure 3**.

You should:

- plot the data in **Table 4**
- draw a line of best fit.

[2 marks]

Figure 3



Question 4 continues on the next page

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0 4 . 4 **Table 5** shows information about the percentage (%) of carbon dioxide and of oxygen present in the Earth's atmosphere over time.

Table 5

Time in billions of years ago	Percentage (%) of gas in the Earth's atmosphere	
	Carbon dioxide	Oxygen
2.5	18	1
2.0	15	2
1.5	10	8
1.0	3	17
0.5	1	19

The percentages of carbon dioxide and of oxygen in the Earth's atmosphere changed between 2.5 billion and 0.5 billion years ago.

Explain how.

[3 marks]

9

Do not write outside the box

0 5 This question is about unsaturated hydrocarbons.

0 5 . 1 **Table 6** shows the boiling points of some unsaturated hydrocarbons.

Table 6

Formula of unsaturated hydrocarbon	Boiling point in °C
C_2H_4	– 104
C_3H_6	– 47
C_4H_8	**X**
C_5H_{10}	30
C_6H_{12}	63

Estimate the boiling point **X** in **Table 6**.

[1 mark]

_____ °C

0 5 . 2 C_2H_4 reacts with water vapour (steam).

Name the compound produced when C_2H_4 reacts with water vapour.

[1 mark]

_____

Question 5 continues on the next page

Do not write outside the box

C_4H_8 reacts with chlorine (Cl_2).

0 5 . 3 Describe the test for chlorine.

Give the result of the test.

[2 marks]

Test _____

_____

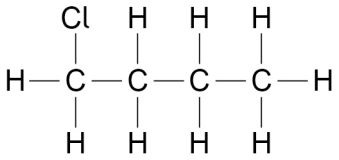
Result _____

_____

0 5 . 4 Which is the displayed formula of the organic compound produced when C_4H_8 reacts with chlorine?

[1 mark]

Tick (✓) **one** box.



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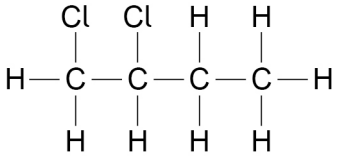

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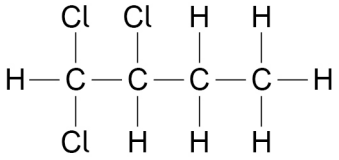

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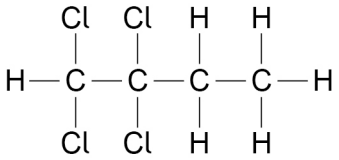

☐

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0 5 . 5 Name the unsaturated hydrocarbon with the formula C_3H_6

[1 mark]

_____

0 5 . 6 Why does C_3H_6 tend to burn in air with a smoky flame?

[1 mark]

_____

_____

0 5 . 7 C_3H_6 is a gas at room temperature and pressure.

Calculate the volume of 2.1 g of C_3H_6 at room temperature and pressure.

Give your answer in cm^3.

The volume of one mole of any gas at room temperature and pressure is 24 dm^3.

Relative atomic masses (A_r): H = 1 C = 12

[5 marks]

_____

_____

_____

_____

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_____

_____

_____

_____

Volume = _____ cm^3

12

Do not write outside the box

0 6 A student analysed three solutions, **A**, **B** and **C**.

Each solution contained one ionic compound.

The student added a few drops of sodium hydroxide solution to solution **A**.

Solution **A** produced a white precipitate.

Aluminium ions produce a white precipitate with a few drops of sodium hydroxide solution.

0 6 . 1 Name **one other** metal ion which produces a white precipitate with a few drops of sodium hydroxide solution.

[1 mark]

_____

0 6 . 2 Describe how the student could confirm the presence of aluminium ions in solution **A**.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

_____

Do not write outside the box

The student tested solution **B** to identify the ions present.

0 6 . 3 The student did a flame test on solution **B**.

An orange-red flame was produced.

Write the symbol for the metal ion in solution **B**.

[1 mark]

_____

0 6 . 4 The student added dilute nitric acid followed by silver nitrate solution to solution **B**.

A white precipitate was produced.

Write the symbol for the non-metal ion in solution **B**.

[1 mark]

_____

Question 6 continues on the next page

Do not write outside the box

The student added 1.0 mol/dm^3 nitric acid to solution **C**.

Bubbles of gas were produced.

0 6 . 5 Describe a test on the bubbles of gas that confirms that solution **C** contained carbonate ions.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

_____

0 6 . 6 The student repeated the test on solution **C** using 1.0 mol/dm^3 ethanoic acid instead of 1.0 mol/dm^3 nitric acid.

Bubbles of gas were produced more slowly using ethanoic acid.

Explain why.

[4 marks]

_____

_____

_____

_____

_____

_____

_____

_____

11

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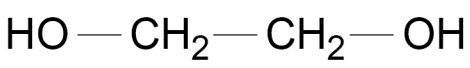
0 7 This question is about polymers.

A condensation polymer is produced from two different compounds, **A** and **B**.

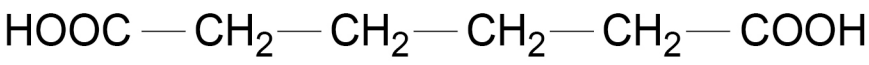
Figure 4 represents a molecule of **A** and a molecule of **B**.

Figure 4

A



B



0 7 . 1 Name compound **A** and compound **B**.

[2 marks]

A _____

B _____

0 7 . 2 Compound **A** and compound **B** react to produce a condensation polymer.

Name the type of condensation polymer produced from compound **A** and compound **B**.

[1 mark]

_____

0 7 . 3 Name the small molecule lost when molecules of compound **A** and of compound **B** react.

[1 mark]

_____

Do not write outside the box

Glycine is an amino acid.

Glycine can produce condensation polymers.

0 7 . 4 Name the type of condensation polymer produced when glycine polymerises.

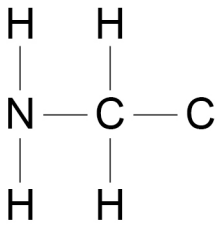
[1 mark]

_____

0 7 . 5 Complete **Figure 5** to show the displayed structural formula of glycine.

[1 mark]

Figure 5



0 7 . 6 Which polymer is produced when different amino acids are combined in the same chain?

[1 mark]

Tick (✓) **one** box.

Cellulose ☐

DNA ☐

Protein ☐

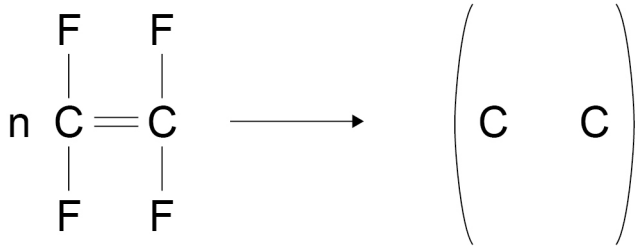
Starch ☐

Do not write outside the box

The polymer poly(tetrafluoroethene) is produced from the monomer tetrafluoroethene (C_2F_4).

0 7 . 7 Complete the equation for the production of poly(tetrafluoroethene) from tetrafluoroethene.

[3 marks]



0 7 . 8 Poly(tetrafluoroethene) is a thermosoftening polymer.

Some other polymers are thermosetting polymers.

Describe the structure of a thermosetting polymer.

[2 marks]

12

Turn over for the next question

Do not write outside the box

0 8 Hydrogen peroxide decomposes into water and oxygen.

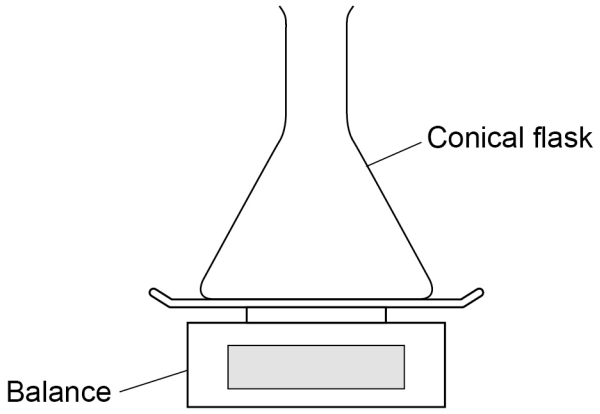
The equation for the reaction is:

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

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.

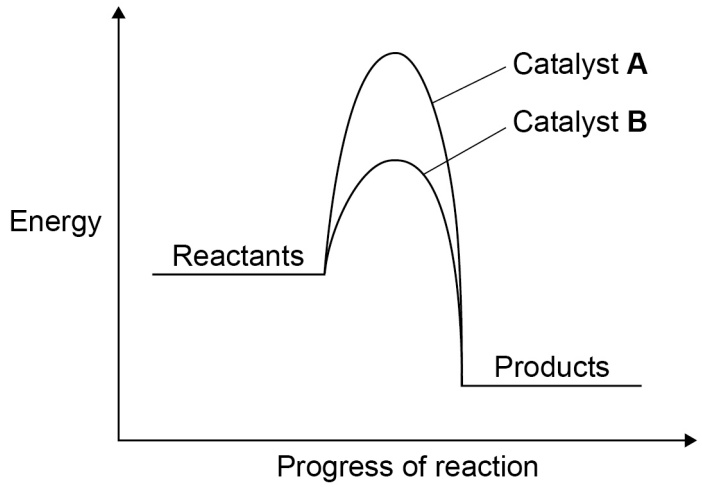
[2 marks]

Do not write outside the box

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

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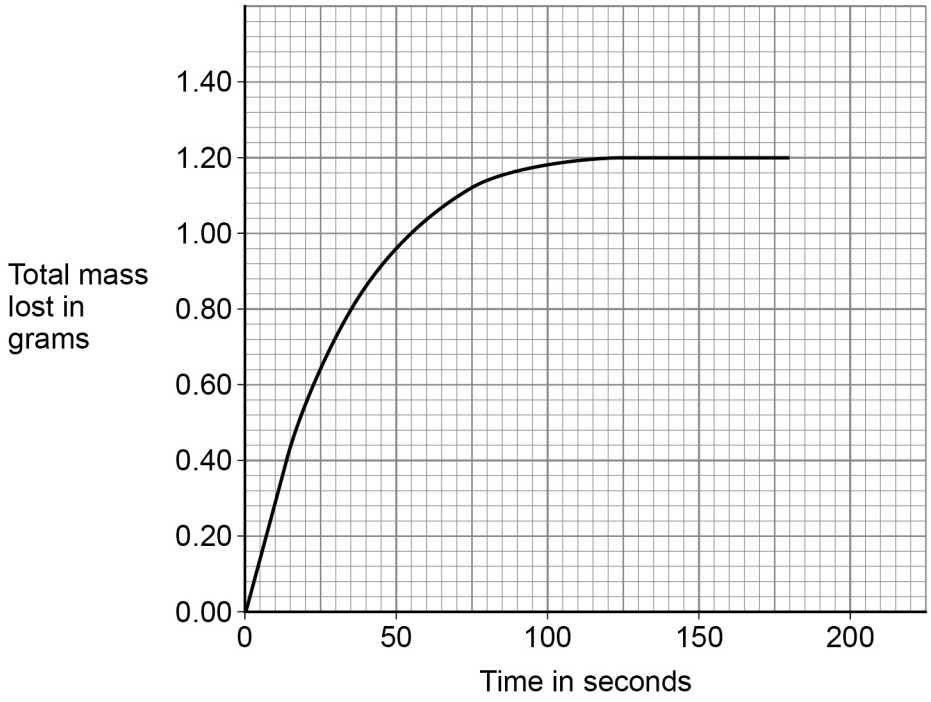
0 8 . 3 **Figure 8** shows the results for catalyst **A**.

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

Do not write outside the box

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

Do not write outside the box

0 9 This question is about ammonia.

Ammonia is produced from nitrogen and hydrogen in the Haber process.

Hydrogen is produced from methane and steam.

The equation for one of the reactions in the production of hydrogen is:

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3\,H_2(g)$$

The forward reaction absorbs energy from the surroundings.

0 9 . 1 Explain why a high temperature is used in this reaction.

[3 marks]

0 9 . 2 Explain why as low a pressure as possible is used in this reaction.

[2 marks]

Do not write outside the box

0 9 . 3 A nickel catalyst is used in this reaction.

What is the effect of the nickel catalyst on the position of equilibrium?

[1 mark]

Tick (✓) **one** box.

Equilibrium position shifts to the left. ☐

No effect on equilibrium position. ☐

Equilibrium position shifts to the right. ☐

0 9 . 4 The nitrogen needed in the Haber process is obtained from air.

Calculate the approximate volume of air required to obtain 50 dm^3 of nitrogen.

[2 marks]

Volume ~ _____ dm^3

Question 9 continues on the next page

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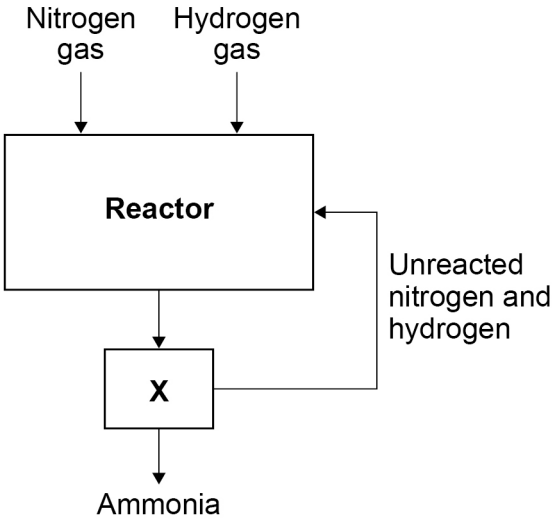
0 9 . 5 **Figure 9** shows how ammonia is produced from nitrogen and hydrogen.

Figure 9



Explain how the mixture of ammonia, nitrogen and hydrogen is separated at **X**.

[3 marks]

Do not write outside the box

0 9 . 6 Ammonia is used to produce fertilisers.

Nitrogen is released into the air when bacteria break down fertilisers and dead plant matter.

One of the reactions during the production of hydrogen from methane (natural gas) releases carbon dioxide into the air.

The use of nitrogen to produce ammonia is more sustainable than the use of hydrogen to produce ammonia.

Give **three** reasons why.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

14

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

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