Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE CHEMISTRY

F

Foundation Tier Paper 2

Tuesday 11 June 2024 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.

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.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

Do not write outside the box

0 1 This question is about hydrocarbons.

A hydrocarbon has the formula C_6H_{14}

0 1 . 1 Name the **two** elements in a hydrocarbon.

[2 marks]

1 _____

2 _____

0 1 . 2 How many atoms are there in one molecule of C_6H_{14}?

[1 mark]

Tick (✓) **one** box.

2 ☐

6 ☐

14 ☐

20 ☐

C_6H_{14} is a member of a homologous series.

0 1 . 3 What is the general formula for the homologous series that contains C_6H_{14}?

[1 mark]

Tick (✓) **one** box.

C_nH_{2n-2} ☐

C_nH_{2n} ☐

C_nH_{2n+2} ☐

Do not write outside the box

0 1 . 4 Which homologous series has C_6H_{14} as a member?

[1 mark]

Tick (✓) **one** box.

Alcohols ☐

Alkanes ☐

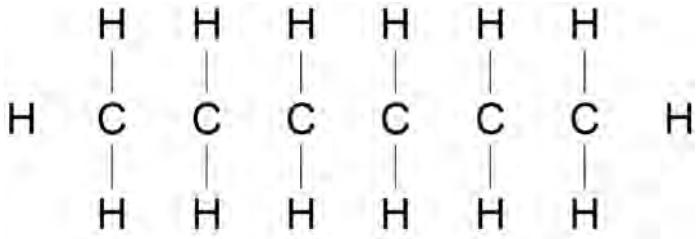
Alkenes ☐

Carboxylic acids ☐

0 1 . 5 Complete **Figure 1** to show the displayed structural formula of C_6H_{14}

[1 mark]

Figure 1



0 1 . 6 Petrol contains C_6H_{14}

Petrol is burned in car engines.

What general name is used to describe petrol when petrol is burned to release energy?

[1 mark]

_____

Question 1 continues on the next page

Do not write outside the box

0 1 . 7 Atmospheric pollutants are formed when C_6H_{14} undergoes incomplete combustion.

Complete the sentences.

Choose answers from the box.

[2 marks]

ammonia	**carbon monoxide**	**coal**
soot	**sulfur**	**sulfur dioxide**

The solid atmospheric pollutant formed during incomplete combustion of C_6H_{14} is

_____ .

The gaseous atmospheric pollutant formed during incomplete combustion of C_6H_{14} is

_____ .

0 1 . 8 A different organic compound ($C_{12}H_{26}$) can be broken down to produce C_6H_{14} and one other compound.

Complete the equation for the reaction.

[1 mark]

$$C_{12}H_{26} \rightarrow C_6H_{14} + C\_\_ H\_\_$$

Do not write outside the box

0 1 . 9 The percentage by mass of each element in C_6H_{14} is:

- 84% C
- 16% H

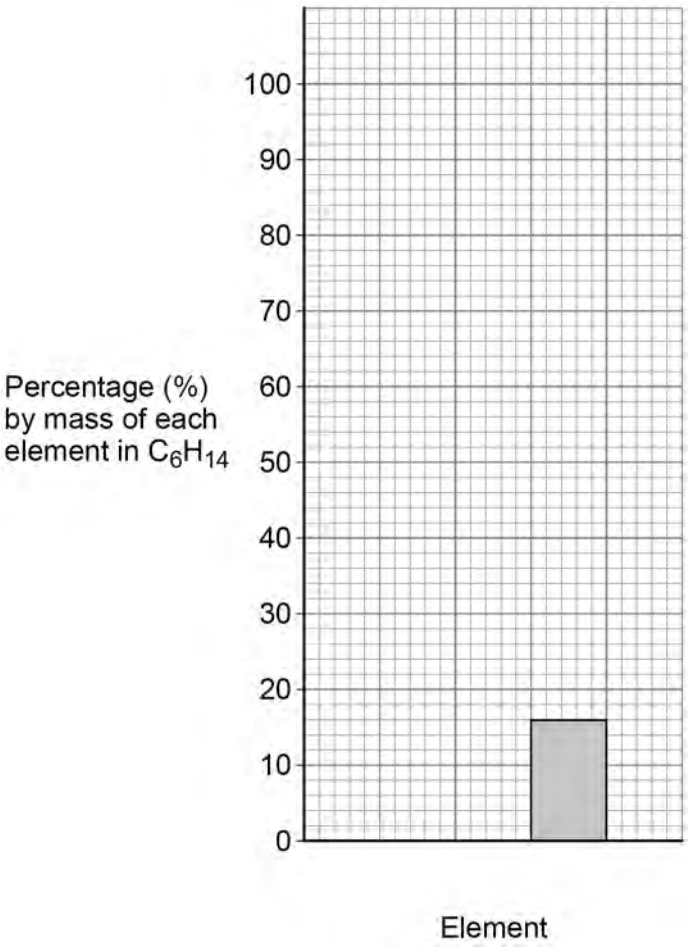
Complete **Figure 2**.

You should:

- label each element on the x-axis
- plot the percentage by mass of C in C_6H_{14}

[2 marks]

Figure 2



12

Do not write outside the box

0 2 This question is about burning coal.

A power station has four coal-burning furnaces.

Each furnace burns 3000 kg of coal per minute.

Table 1 shows some information about this coal burning power station

Table 1

Number of furnaces in use	Mass of coal burned per minute in kilograms	Mass of sulfur dioxide produced per minute in kilograms	Mass of carbon dioxide produced per minute in kilograms
0	0	0	0
1	3000	100	7000
2	6000	200	14 000
3	9000	300	21 000
4	12 000	400	28 000

0 2 . 1 Carbon dioxide is a greenhouse gas.

What is the effect on the rate of global climate change of using more furnaces in this power station?

Complete the sentence.

Choose the answer from the box.

[1 mark]

decreases	**stays the same**	**increases**

Use **Table 1**.

The rate of global climate change _____.

Do not write outside the box

0 2 . 2 7000 kg of carbon dioxide are produced when 3000 kg of coal are burned.

Calculate the mass of carbon dioxide produced when 1 kilogram of coal is burned.

[2 marks]

Mass of carbon dioxide = _____ kg

0 2 . 3 Complete the sentence.

[1 mark]

Sulfur dioxide causes an environmental effect called acid _____ .

Question 2 continues on the next page

Do not write outside the box

Table 1 is repeated below.

Table 1

Number of furnaces in use	Mass of coal burned per minute in kilograms	Mass of sulfur dioxide produced per minute in kilograms	Mass of carbon dioxide produced per minute in kilograms
0	0	0	0
1	3000	100	7000
2	6000	200	14 000
3	9000	300	21 000
4	12 000	400	28 000

0 2 . 4 **Figure 3** shows how the mass of sulfur dioxide produced per minute varies with the mass of coal burned per minute.

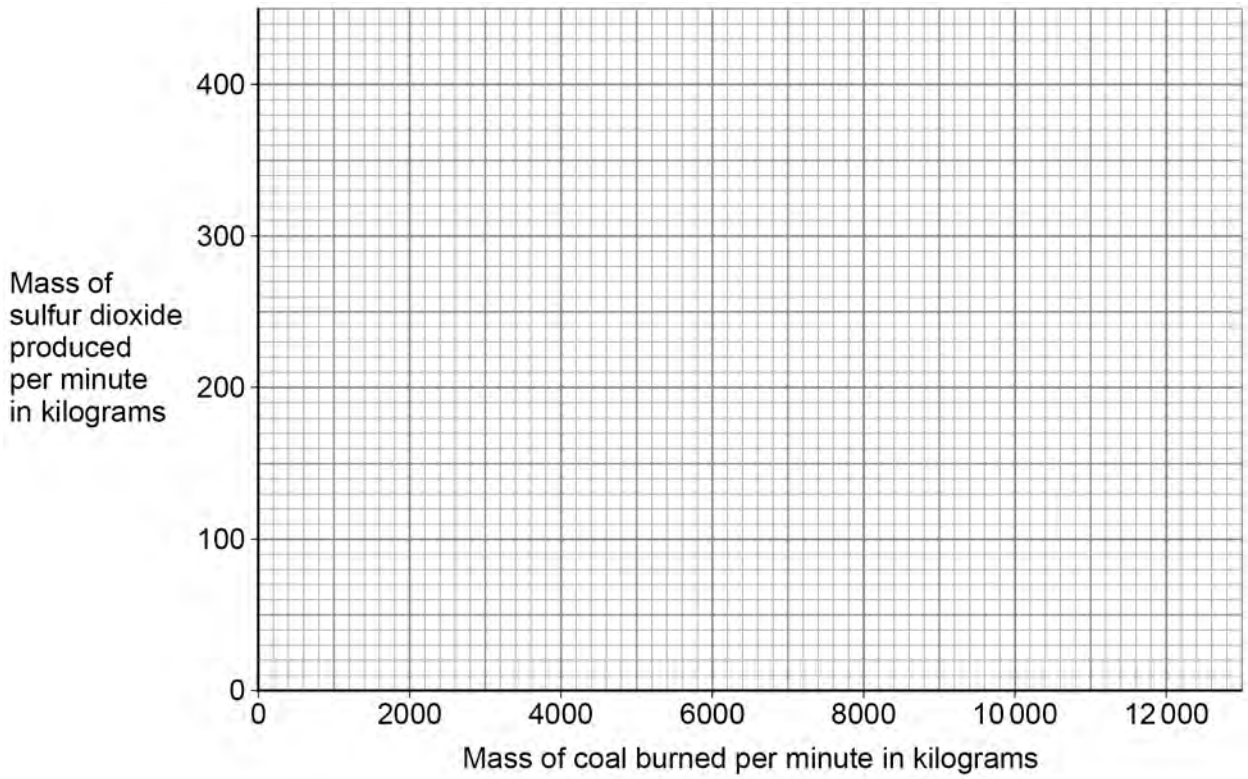
Complete **Figure 3**.

You should:

- plot data from **Table 1** on **Figure 3**
- draw a line of best fit.

[3 marks]

Figure 3



Do not write outside the box

0 2 . 5 Complete the sentence.

Use **Table 1** and **Figure 3**.

[1 mark]

As the mass of coal burned per minute increases, the mass of sulfur dioxide produced per minute _____ .

0 2 . 6 This power station also releases particulates into the air.

Complete the sentence.

[1 mark]

The release of particulates into the air causes global _____ .

9

Turn over for the next question

Do not write outside the box

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 3 This question is about paper chromatography.

A student investigated substance **Y** using paper chromatography.

This is the method used.

1. Draw a start line in ink on a piece of chromatography paper.
2. Put spots of four different dyes, **A**, **B**, **C** and **D**, and a spot of substance **Y** on the start line.
3. Dip the paper into water so that the water level is below the start line.
4. Wait until the water has risen to near the top of the paper.

0 3 . 1 The student's method contains a mistake in **Step 1**.

What is the mistake in **Step 1**?

Give **one** reason for your answer.

[2 marks]

Mistake _____

_____

Reason _____

_____

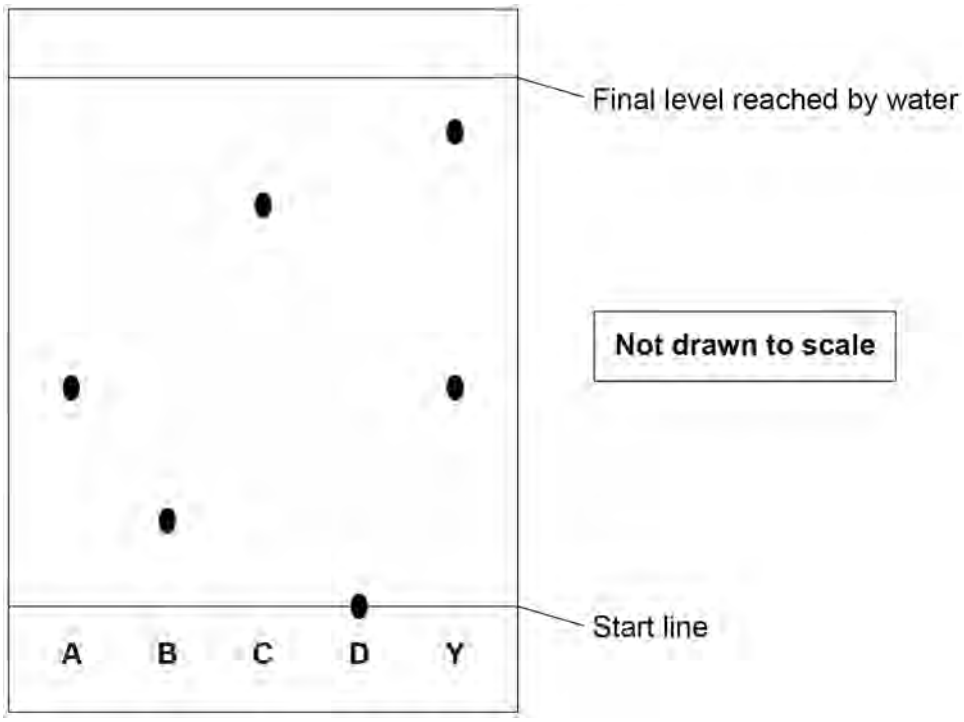
Question 3 continues on the next page

Do not write outside the box

A different student used a method which gave valid results.

Figure 4 shows the results.

Figure 4



0 3 . 2 How many different dyes are in substance **Y**?

Use **Figure 4**.

[1 mark]

_____

0 3 . 3 Which of the four dyes, **A**, **B**, **C** and **D**, could be in substance **Y**?

Give **one** reason for your answer.

Use **Figure 4**.

[2 marks]

Dye _____

Reason _____

_____

Do not write outside the box

0 3 . 4 Suggest why dye **D** remained on the start line at the end of the investigation.

Use **Figure 4**.

[1 mark]

0 3 . 5 The student determined that:

- the distance moved by the water was 6.0 cm
- the distance moved by dye **A** was 2.4 cm.

Calculate the R_f value of dye **A**.

Use the equation:

$$R_f = \frac{\text{distance moved by dye } \mathbf{A}}{\text{distance moved by water}}$$

[2 marks]

R_f = _____

0 3 . 6 Complete the sentence.

Choose the answer from the box.

[1 mark]

solute	**solution**	**solvent**

The water in **step 3** is used as a _____ .

9

Turn over ►

Do not write outside the box

There are no questions printed on this page

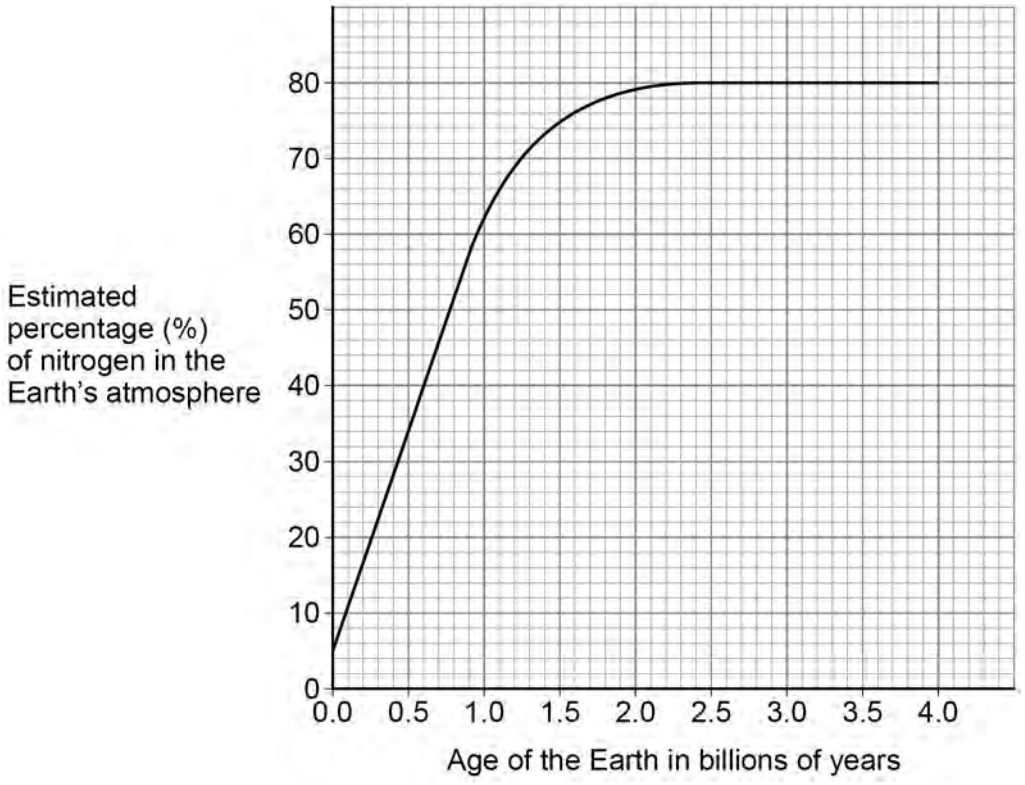
DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 4 This question is about the Earth's atmosphere and naturally occurring polymers.

0 4 . 1 **Figure 5** shows how the estimated percentage of nitrogen in the Earth's atmosphere has changed since the Earth was formed.

Figure 5



Describe the trends shown by the graph.

Use data from **Figure 5**.

[3 marks]

Question 4 continues on the next page

Do not write outside the box

The percentage of oxygen in the Earth's atmosphere has increased since the Earth was formed.

This is because of photosynthesis.

The word equation for the photosynthesis reaction is:

carbon dioxide + water → glucose + oxygen

0 4 . 2 What happened to the percentage of carbon dioxide in the atmosphere when photosynthesis began?

[1 mark]

Tick (✓) **one** box.

The percentage of carbon dioxide decreased. ☐

The percentage of carbon dioxide stayed the same. ☐

The percentage of carbon dioxide increased. ☐

0 4 . 3 The photosynthesis reaction takes in energy from the surroundings.

Complete the sentence.

Choose the answer from the box.

[1 mark]

carbon dioxide	**light**	**water**

The source of the energy used in photosynthesis is _____.

Do not write outside the box

0 4 . 4 Which **two** produce oxygen by photosynthesis?

[2 marks]

Tick (✓) **two** boxes.

- Algae ☐
- Animals ☐
- Plants ☐
- Viruses ☐
- Yeast ☐

0 4 . 5 The glucose produced during photosynthesis can form naturally occurring polymers.

Which **two** are naturally occurring polymers that can be produced from glucose?

[2 marks]

Tick (✓) **two** boxes.

- Cellulose ☐
- DNA ☐
- Poly(propene) ☐
- Protein ☐
- Starch ☐

Question 4 continues on the next page

Do not write outside the box

DNA molecules contain two polymer chains.

A DNA molecule has a relative formula mass (M_r) of approximately 140 000 000 000

0 4 . 6 What is the approximate relative formula mass (M_r) of the DNA molecule in standard form?

[1 mark]

Tick (✓) **one** box.

1.4×10^9 ☐

1.4×10^{10} ☐

1.4×10^{11} ☐

1.4×10^{12} ☐

0 4 . 7 What is the approximate relative formula mass (M_r) of each polymer chain in the DNA molecule?

[1 mark]

Tick (✓) **one** box.

70 000 000 000 ☐

140 000 000 000 ☐

280 000 000 000 ☐

560 000 000 000 ☐

0 4 . 8 Complete the sentence.

[1 mark]

The shape of a DNA molecule is a double _____ .

Do not write outside the box

0 4 . 9 How many different nucleotides are present in a molecule of DNA?

[1 mark]

Tick (✓) **one** box.

1 ☐

2 ☐

3 ☐

4 ☐

13

Turn over for the next question

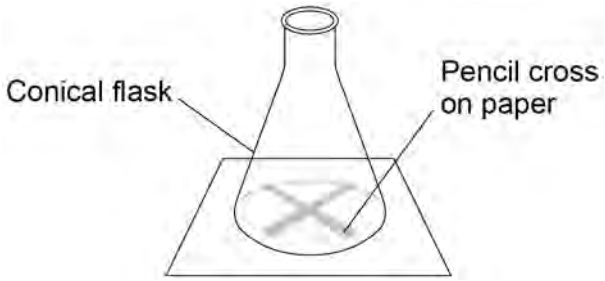
Do not write outside the box

0 5 A student investigated the rate of the reaction of sodium thiosulfate solution with hydrochloric acid.

When sodium thiosulfate solution reacts with hydrochloric acid, the mixture becomes cloudy.

Figure 6 shows the apparatus.

Figure 6



This is the method used.

1. Put 75 cm^3 of sodium thiosulfate solution in a conical flask.
2. Draw a pencil cross on paper.
3. Put the conical flask on the pencil cross.
4. Add 15 cm^3 of hydrochloric acid to the contents of the conical flask.
5. Swirl the conical flask to mix the contents and immediately start a timer.
6. Stop the timer when the pencil cross is no longer visible through the reaction mixture.
7. Repeat steps 1 to 6 using different concentrations of sodium thiosulfate solution.

0 5 . 1 Explain why a 50 cm^3 conical flask is unsuitable to use in this method.

[2 marks]

Do not write outside the box

0 5 . 2 Name a piece of equipment suitable for measuring the volume of sodium thiosulfate solution.

[1 mark]

0 5 . 3 The student measured the time taken for the pencil cross to be no longer visible for different concentrations of sodium thiosulfate solution.

Draw **one** line from each type of variable to the variable in this investigation.

[2 marks]

Type of variable	**Variable in this investigation**
	Concentration of sodium thiosulfate solution
	Size of conical flask
Dependent variable	
	Temperature of sodium thiosulfate solution
Independent variable	
	Time for pencil cross to become no longer visible
	Volume of hydrochloric acid

Question 5 continues on the next page

Do not write outside the box

0 5 . 4 What effect will using a darker pencil cross have on the time taken for the cross to be no longer visible?

[1 mark]

Tick (✓) **one** box.

The time taken will decrease. ☐

The time taken will be the same. ☐

The time taken will increase. ☐

0 5 . 5 **Table 2** shows the results.

Table 2

Concentration of sodium thiosulfate solution in g/dm^3	Time for cross to become no longer visible in seconds
8	120
16	60
24	40
32	30

Which concentration of sodium thiosulfate solution had the highest rate of reaction?

[1 mark]

Tick (✓) **one** box.

8 g/dm^3 ☐ 16 g/dm^3 ☐ 24 g/dm^3 ☐ 32 g/dm^3 ☐

Do not write outside the box

0 5 . 6 Increasing the concentration of sodium thiosulfate solution changes the rate of the reaction with hydrochloric acid.

Which **two** statements explain the effect of increasing the concentration?

[2 marks]

Tick (✓) **two** boxes.

The particles are closer together. ☐

The particles are further apart. ☐

The particles collide less frequently. ☐

The particles collide more frequently. ☐

The particles move faster. ☐

The particles move slower. ☐

0 5 . 7 The effect on the time taken for the cross to disappear can also be investigated by:

- changing the temperature of the hydrochloric acid
- changing the concentration of the hydrochloric acid.

Complete the sentences.

Choose the answers from the box.

[2 marks]

decreases	**stays the same**	**increases**

If the temperature of the hydrochloric acid is **increased**, the time taken for the cross to disappear _____.

If the concentration of the hydrochloric acid is **decreased**, the time taken for the cross to disappear _____.

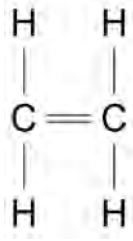
11

Do not write outside the box

0 6 This question is about addition reactions.

Figure 7 shows the displayed structural formula of ethene.

Figure 7



0 6 . 1 Complete the sentence.

[1 mark]

When bromine water is added to ethene, the bromine water changes from orange to

_____ .

Do not write outside the box

Chlorine reacts with ethene.

0 6 . 2 What is used to identify chlorine?

[1 mark]

Tick (✓) **one** box.

A lighted splint ☐

Damp litmus paper ☐

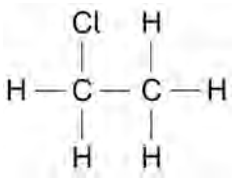
Limewater ☐

0 6 . 3 Which of the following shows the displayed structural formula of the compound produced when chlorine reacts with ethene?

Use **Figure 7**.

[1 mark]

Tick (✓) **one** box.



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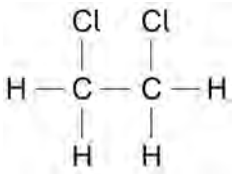

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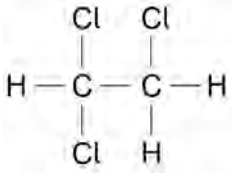


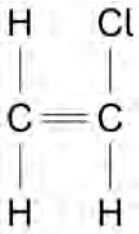
☐

Question 6 continues on the next page

Do not write outside the box

0 6 . 4 Chloroethene can be used to produce a polymer called poly(chloroethene).

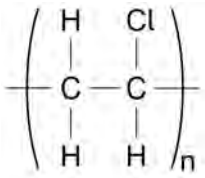
The displayed structural formula of chloroethene is

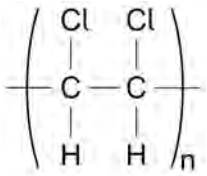


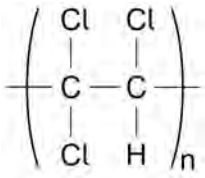
Which represents the structure of poly(chloroethene)?

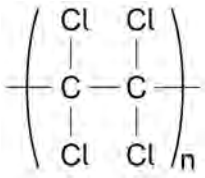
[1 mark]

Tick (✓) **one** box.

 ☐

 ☐

 ☐

 ☐

Do not write outside the box

Ethene can be used to produce another polymer called poly(ethene).

Table 3 shows information about poly(chloroethene) and poly(ethene).

Table 3

	Poly(chloroethene)	**Poly(ethene)**
Density in g/cm^3	1.5	0.9
Temperature at which polymer completely melts in °C	260	120

0 6 . 5 Determine the simplest whole number ratio of the density of poly(chloroethene) : density of poly(ethene).

[3 marks]

Simplest whole number ratio = _____ : _____

0 6 . 6 Poly(ethene) **and** poly(chloroethene) can both be used to make pipes.

Suggest why neither polymer is suitable for pipes carrying steam at a temperature of 300 °C.

Use **Table 3**.

[1 mark]

0 6 . 7 Poly(ethene) and paper can both be used to make shopping bags.

Poly(ethene) is produced from crude oil. Paper is produced from trees.

Suggest **one** reason why paper is more sustainable than poly(ethene) for making shopping bags.

[1 mark]

9

Do not write outside the box

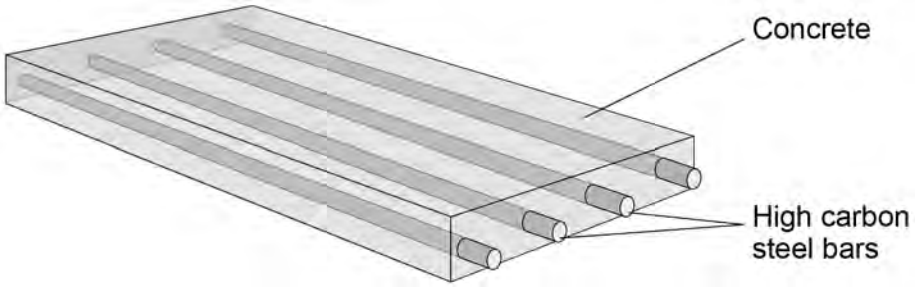
0 7 This question is about materials.

Pre-stressed concrete is a composite material.

The concrete is strengthened using high carbon steel bars.

Figure 8 shows the structure of a piece of pre-stressed concrete.

Figure 8



0 7 . 1 Which **two** words describe the high carbon steel bars?

[2 marks]

Tick (✓) **two** boxes.

- Alloy ☐
- Binder ☐
- Matrix ☐
- Ore ☐
- Reinforcement ☐

Do not write outside the box

Limestone is mainly calcium carbonate.

Limestone is a raw material used in the production of concrete.

0 7 . 2 In the first part of the production of concrete:

- air is heated by burning methane
- the hot air is used to heat limestone
- the limestone decomposes.

The equation for the decomposition of limestone is:

calcium carbonate → calcium oxide + carbon dioxide

Give **two** ways in which a greenhouse gas is released in this process.

[2 marks]

1 _____

_____

2 _____

_____

0 7 . 3 How could a sample of limestone be tested to show the presence of carbonate ions?

Complete the sentences.

Choose answers from the box.

[2 marks]

barium chloride	**hydrochloric acid**	**limewater**
sodium hydroxide		**universal indicator**

The substance added to the limestone is _____.

The gas produced is identified using _____.

Question 7 continues on the next page

Do not write outside the box

Table 4 gives some information about plain concrete and pre-stressed concrete.

Table 4

	Plain concrete	**Pre-stressed concrete**
Cost in £ per m^3	75	225
Density in kg per m^3	2300	2500
Strength in arbitrary units	600	3000

0 7 . 4 Explain why pre-stressed concrete rather than plain concrete is used to make bridges that carry heavy lorries.

Use **Table 4**.

[2 marks]

Do not write outside the box

0 7 . 5 **Figure 9** shows a garden path made of plain concrete slabs.

Figure 9

Suggest **two** reasons why plain concrete rather than pre-stressed concrete is used to make slabs for garden paths.

Use **Table 4**.

[2 marks]

1 _____

_____

2 _____

_____

10

Turn over for the next question

Do not write outside the box

0 8 A student investigated an aqueous solution of a salt.

The student identified that the salt solution contained only sodium ions and chloride ions.

0 8 . 1 Describe a test to identify sodium ions.

Give the result of the test.

[2 marks]

Test for sodium ions _____

_____

Result _____

_____

0 8 . 2 Describe a test to identify chloride ions.

Give the result of the test.

[2 marks]

Test for chloride ions _____

_____

Result _____

_____

Do not write outside the box

The student determined the concentration of sodium chloride in the salt solution.

This is the method used.

1. Weigh an empty evaporating dish.
2. Add 25.0 cm^3 of the salt solution into the evaporating dish.
3. Heat the evaporating dish and contents.
4. Weigh the evaporating dish and contents.
5. Repeat steps 3 to 4 until there is no further change in mass.
6. Repeat steps 1 to 5 three more times.

0 8 . 3 Why did the student heat the evaporating dish and contents until the mass did not change?

[1 mark]

0 8 . 4 How did the student calculate the mass of solid sodium chloride remaining after steps 1 to 5?

[1 mark]

Tick (✓) **one** box.

- Mass of 25 cm^3 of salt solution + mass of empty evaporating dish ☐
- Mass of 25 cm^3 of salt solution – mass of empty evaporating dish ☐
- Mass of evaporating dish and dry contents + mass of empty evaporating dish ☐
- Mass of evaporating dish and dry contents – mass of empty evaporating dish ☐

Question 8 continues on the next page

Do not write outside the box

0 8 . 5 The student calculated the concentration of sodium chloride in the salt solution.

Table 5 shows the results.

Table 5

Concentration of sodium chloride in g/dm^3			
Trial 1	**Trial 2**	**Trial 3**	**Trial 4**
35.2	34.6	36.4	33.8

The percentage by mass of sodium ions in sodium chloride is 39.3%.

Calculate the mean concentration of sodium ions in the salt solution.

[4 marks]

Mean concentration = _____ g/dm^3

10

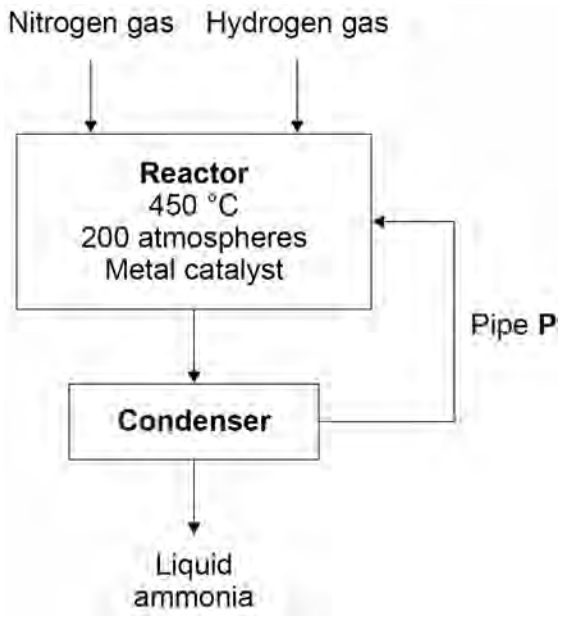
Do not write outside the box

0 9 This question is about ammonia and nitric acid.

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

Figure 10 represents the Haber process.

Figure 10



0 9 . 1 Pipe **P** links the condenser to the reactor.

Why is the condenser linked to the reactor?

Use **Figure 10**.

[1 mark]

0 9 . 2 Which metal is used as a catalyst in this reaction?

[1 mark]

Do not write outside the box

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 9 . 3 Describe the test for oxygen gas.

Give the result if oxygen gas is present.

[2 marks]

Test _____

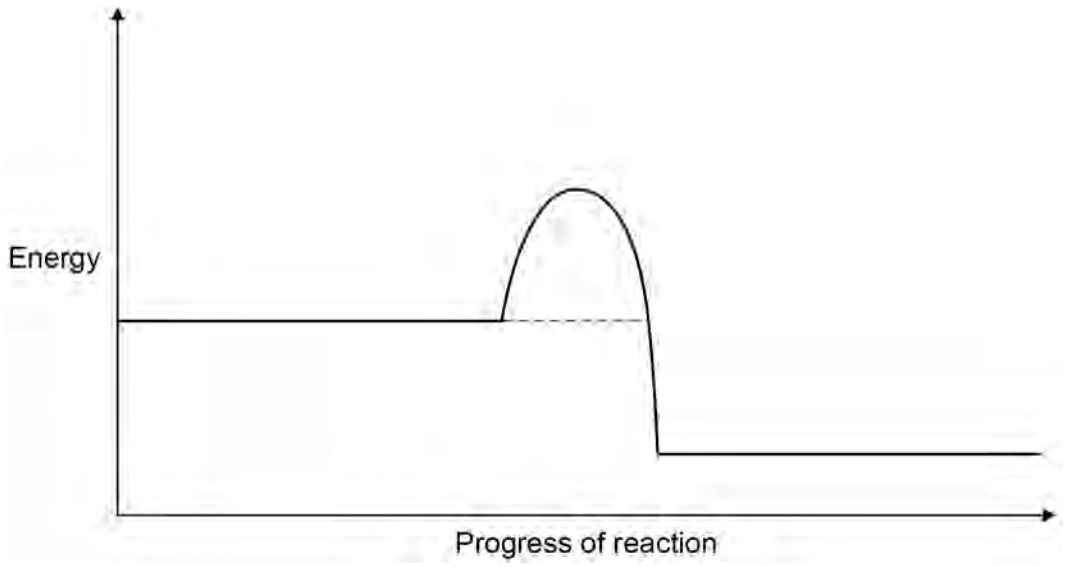
_____

Result _____

_____

Figure 11 represents the reaction profile of the catalysed reaction between ammonia and oxygen.

Figure 11



Do not write outside the box

0 9 . 4 Complete the reaction profile for the catalysed reaction in **Figure 11**.

You should:

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

[2 marks]

0 9 . 5 How would **Figure 11** 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 9 . 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

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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1 0 This question is about water.

1 0 . 1 Hydrogen gas reacts with oxygen gas to produce water.

Water is decomposed into hydrogen gas and oxygen gas using electricity.

Which **two** words describe the reaction between hydrogen gas and oxygen gas?

[2 marks]

Tick (✓) **two** boxes.

Alloying ☐

Combustion ☐

Corrosion ☐

Endothermic ☐

Reversible ☐

1 0 . 2 Water molecules break down into hydrogen ions and hydroxide ions.

The equation for the reaction is:

$$H_2O \rightleftharpoons H^+ + OH^-$$

Which sentence describes this reaction at equilibrium?

[1 mark]

Tick (✓) **one** box.

Water molecules break down at a higher rate than they reform. ☐

Water molecules break down and reform at the same rate. ☐

Water molecules break down at a lower rate than they reform. ☐

Question 10 continues on the next page

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1 0 . 3 Water collected from rivers is used in the home for drinking and flushing toilets.

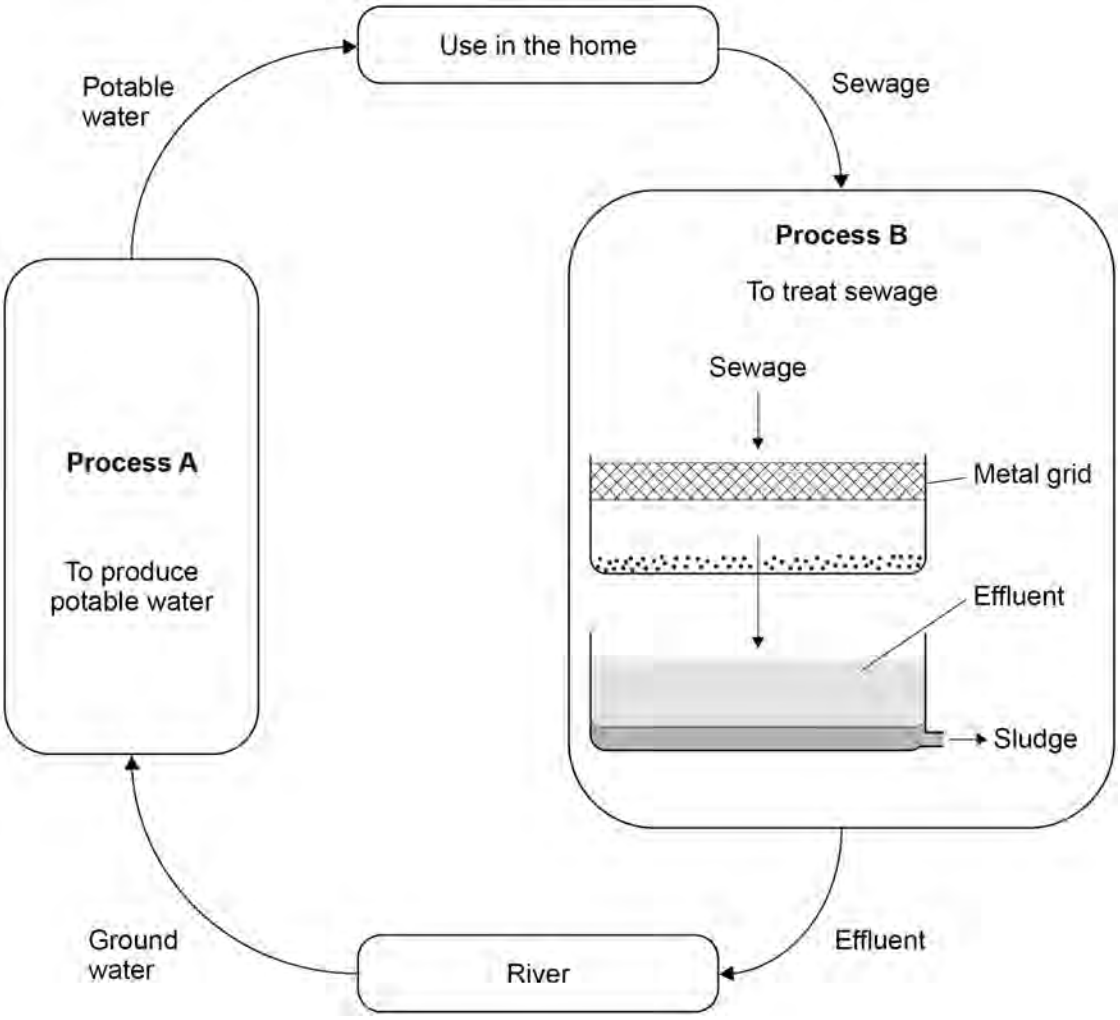
Water used in the home must be potable.

Potable water is safe to drink.

Waste water produced after use in the home is called sewage.

Figure 12 shows how water is collected from rivers and returned to rivers after use.

Figure 12



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Explain what happens to water in **Process A** and in **Process B** in **Figure 12**.

Do **not** refer to use of water in the home.

[6 marks]

9

END OF QUESTIONS

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