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

**F**

Foundation 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 | |
| 9 | |
| 10 | |
| **TOTAL** | |

*Do not write outside the box*

**0 1** This question is about water.

A student investigated pure water.

The student measured:

- the boiling point of pure water
- the pH of pure water.

**0 1 . 1** Complete the sentences.

Choose answers from the box.

**[2 marks]**

| | | | | | |
|---|---|---|---|---|---|
| **0** | **4** | **7** | **10** | **25** | **100** |

Pure water has a boiling point of _____ °C.

Pure water has a pH of _____.

**0 1 . 2** What could the student use to measure the pH of pure water?

**[1 mark]**

_____

_____

*Do not write outside the box*

A different student investigated sea water.

Sea water contains dissolved solids.

This is the method used.

1. Measure a 50 $cm^3$ sample of the sea water.
2. Heat the sample until all the water has evaporated.
3. Measure the mass of solid that remains.
4. Repeat steps 1 to 3 three more times.

**0 1 . 3** Which **two** pieces of equipment were needed in this investigation?

**[2 marks]**

Tick (✓) **two** boxes.

- Balance ☐
- Measuring cylinder ☐
- Ruler ☐
- Thermometer ☐
- Timer ☐

**Question 1 continues on the next page**

*Do not write outside the box*

**0 1 . 4** **Table 1** shows the results.

**Table 1**

| Sea water sample | Mass of solid that remained in grams |
|---|---|
| 1 | 1.73 |
| 2 | 1.70 |
| 3 | 1.75 |
| 4 | 1.78 |

Calculate the mean mass of solid that remained.

**[2 marks]**

Mean mass = _____ g

**0 1 . 5** A 50 $cm^3$ sample of sea water from a different source contained 1.50 g of dissolved solids.

Calculate the mass of dissolved solids in 1000 $cm^3$ of this sea water.

**[2 marks]**

Mass = _____ g

*Do not write outside the box*

Sodium chloride is a dissolved solid in sea water.

Sodium chloride contains sodium ions and chloride ions.

**0 1 . 6** Complete the sentence.

Choose the answer from the box.

**[1 mark]**

| | | |
|---|---|---|
| **crimson** | **lilac** | **yellow** |

The student tested sea water for sodium ions using a flame test.

The colour of the flame was _____.

**0 1 . 7** Complete the sentence.

Choose the answer from the box.

**[1 mark]**

| | | |
|---|---|---|
| **brown** | **green** | **white** |

The student tested sea water for chloride ions by adding nitric acid and silver nitrate solution.

The colour of the precipitate formed was _____.

**11**

**Turn over for the next question**

*Do not write outside the box*

**0 2** This question is about hydrocarbons in crude oil.

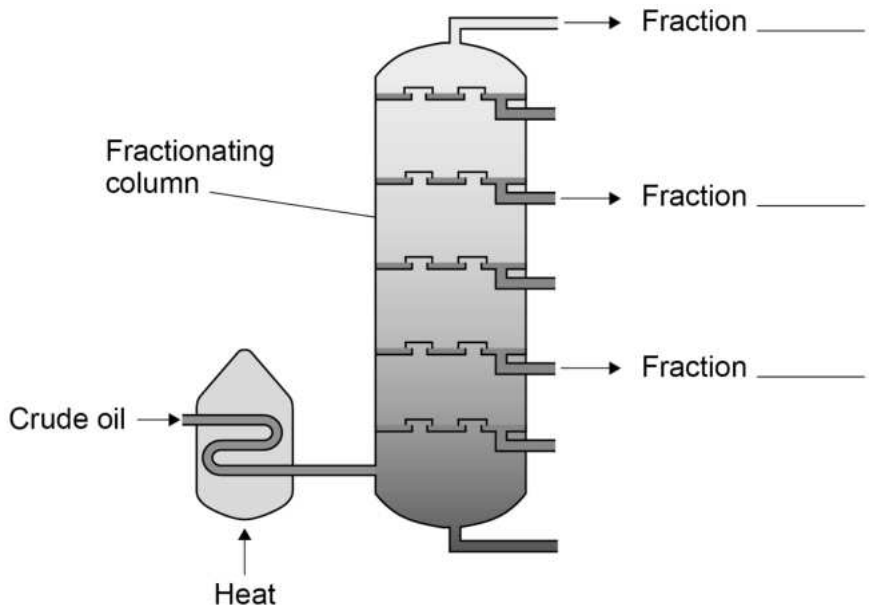
**0 2 . 1** **Table 2** shows information about three fractions obtained from crude oil.

**Table 2**

| Fraction | Boiling point range in °C |
|---|---|
| **A** | 200–300 |
| **B** | 100–150 |
| **C** | Below 30 |

**Figure 1** shows the fractionating column used to separate fractions **A**, **B** and **C**.

**Figure 1**




The temperature of the fractionating column is:

- 30 °C at the top
- 400 °C at the bottom.

Complete **Figure 1** to show where fractions **A**, **B** and **C** are collected.

**[1 mark]**

*Do not write outside the box*

**0 2 . 2** **Table 3** shows information about three fractions obtained from crude oil.

**Table 3**

| Fraction | Range of number of carbon atoms in each molecule |
|---|---|
| Petrol | 5–12 |
| Diesel oil | 15–19 |
| Heavy fuel oil | 20–40 |

Complete the sentences.

Choose answers from the box.

**[2 marks]**

| lower | the same | higher |
|---|---|---|

Compared to petrol, the viscosity of heavy fuel oil is _____.

Compared to petrol, the flammability of diesel oil is _____.

**Question 2 continues on the next page**

**Table 4** shows the percentage of two fractions obtained from two different sources of crude oil.

**Table 4**

| Source | Percentage (%) of fraction | |
|---|---|---|
| | **Kerosene** | **Heavy fuel oil** |
| **J** | 13 | 30 |
| **K** | 4 | 44 |

**0 2 . 3** Complete **Figure 2**.

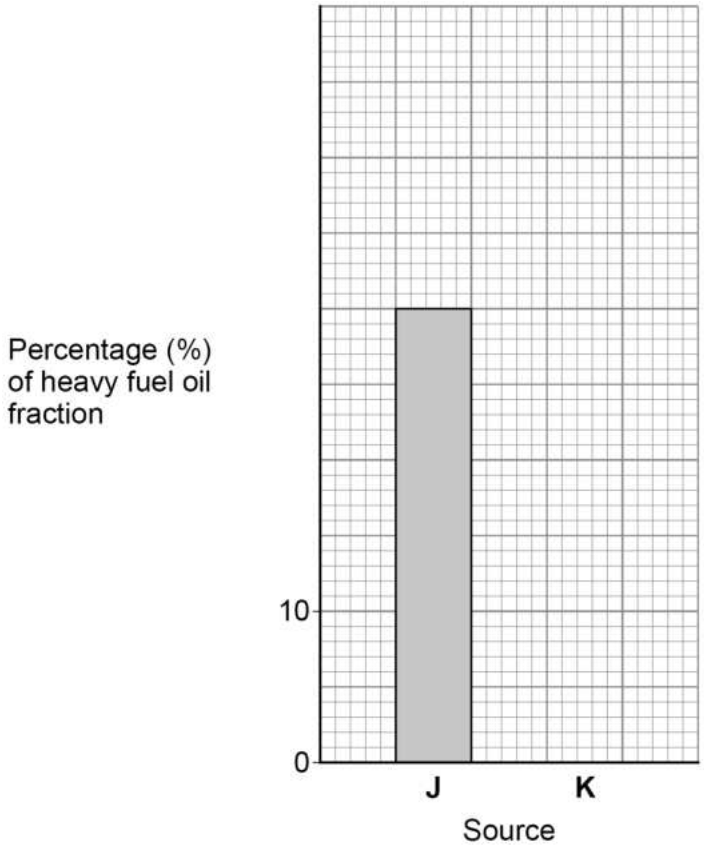
You should:

- complete the *y*-axis scale
- plot the percentage of the heavy fuel oil fraction obtained from source **K**.

Use **Table 4**.

**[2 marks]**

**Figure 2**



*Do not write outside the box*

**0 2 . 4** Kerosene is in higher demand than heavy fuel oil.

Suggest why crude oil from source **J** is in higher demand than crude oil from source **K**.

Use **Table 4**.

**[1 mark]**

Large hydrocarbon molecules can be cracked to produce smaller hydrocarbon molecules including alkanes.

**0 2 . 5** Which **two** of the following can be used to crack large hydrocarbon molecules?

**[2 marks]**

Tick (✓) **two** boxes.

- A catalyst ☐
- A fertiliser ☐
- Air ☐
- Ozone ☐
- Steam ☐

**0 2 . 6** Alkanes have the general formula $C_nH_{2n+2}$

Complete the formula of the alkane molecule containing 11 carbon atoms.

**[1 mark]**

$C_{11}H$___

*Do not write outside the box*

**0 2 . 7** $C_2H_6$ is an alkane.

Which type of bond is found in a $C_2H_6$ molecule?

**[1 mark]**

Tick (✓) **one** box.

A double bond between two carbon atoms. ☐

A double bond between two hydrogen atoms. ☐

A single bond between two carbon atoms. ☐

A single bond between two hydrogen atoms. ☐

**0 2 . 8** Which **two** substances are produced when alkanes completely combust?

**[2 marks]**

Tick (✓) **two** boxes.

Carbon ☐

Carbon dioxide ☐

Carbon monoxide ☐

Hydrogen ☐

Water ☐

**12**

*Do not write outside the box*

**Turn over for the next question**

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

*Do not write outside the box*

**0 3** This question is about the Earth's atmosphere.

**Table 5** shows:

- the estimated percentages of gases in the Earth's early atmosphere
- the percentages of gases in the Earth's atmosphere today.

**Table 5**

| Gas | Estimated percentage (%) in the Earth's early atmosphere | Percentage (%) in the Earth's atmosphere today |
|---|---|---|
| Nitrogen | 1.8 | **X** |
| Oxygen | 0.2 | 20.95 |
| Carbon dioxide | 96.0 | 0.04 |
| Other gases | 2.0 | 0.92 |

**0 3 . 1** Calculate value **X** in **Table 5**.

**[1 mark]**

**X** = _____ %

**0 3 . 2** Which **two** other gases may have been in the Earth's early atmosphere?

**[2 marks]**

Tick (✓) **two** boxes.

- Ammonia ☐
- Coal ☐
- Limestone ☐
- Methane ☐
- Poly(ethene) ☐

*Do not write outside the box*

Algae and plants increased the percentage of oxygen in the Earth's atmosphere.

The same process in algae and plants decreased the percentage of carbon dioxide in the Earth's atmosphere.

**0 3 . 3** Which process in algae and plants increased the percentage of oxygen in the Earth's atmosphere?

**[1 mark]**

Tick (✓) **one** box.

- Fermentation ☐
- Photosynthesis ☐
- Rusting ☐
- Sedimentation ☐

**0 3 . 4** Which **two** other processes decreased the percentage of carbon dioxide in the Earth's atmosphere?

**[2 marks]**

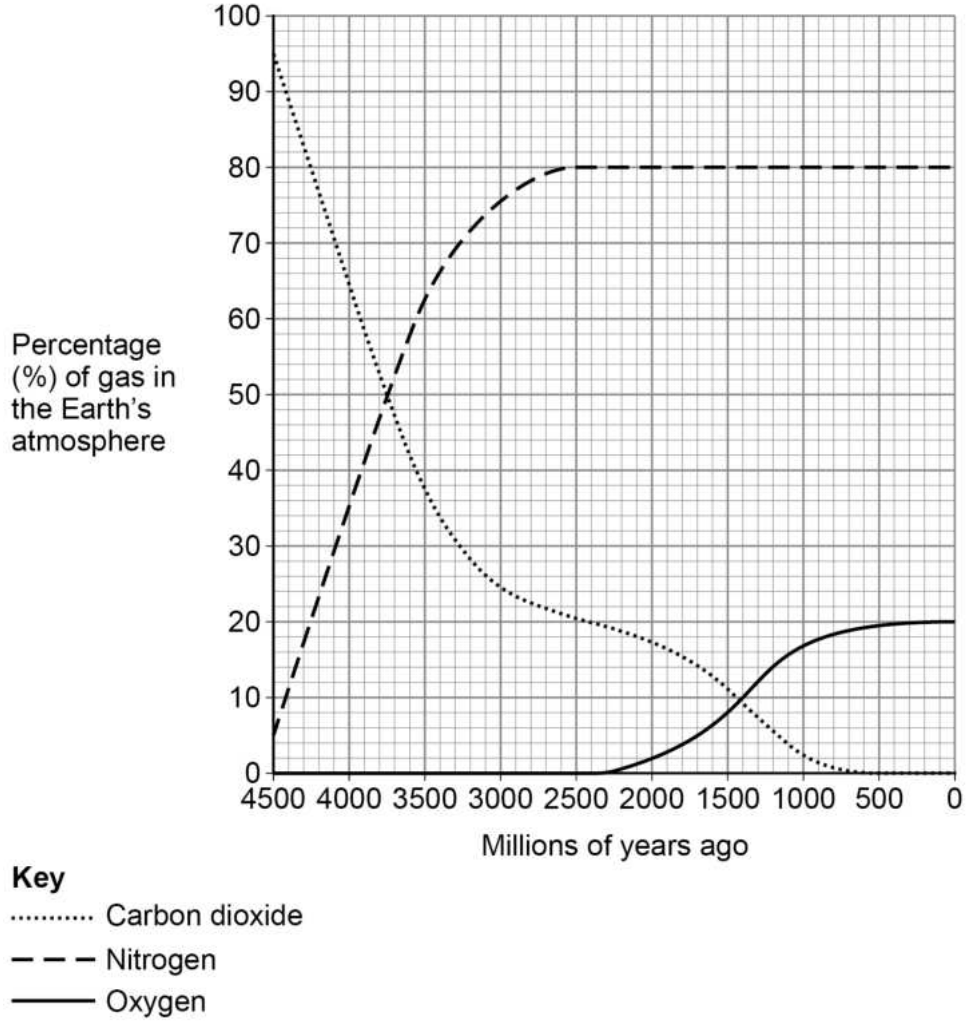
Tick (✓) **two** boxes.

- Burning fossil fuels ☐
- Dissolving carbon dioxide in oceans ☐
- Eruption of volcanoes ☐
- Evolution of animals ☐
- Formation of sedimentary rocks ☐

*Do not write outside the box*

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

**Figure 3**




**0 3 . 5** When was the percentage of oxygen in the Earth's atmosphere 8%?

Use **Figure 3**.

**[1 mark]**

_____ millions of years ago

**0 3 . 6** When did the percentage of nitrogen in the Earth's atmosphere become constant?

Use **Figure 3**.

**[1 mark]**

_____ millions of years ago

*Do not write outside the box*

**0 3 . 7** Crude oil was formed from an ancient biomass as the Earth's atmosphere evolved.

What did this ancient biomass mainly consist of?

**[1 mark]**

Tick (✓) **one** box.

Limestone ☐

Plankton ☐

Sand ☐

**0 3 . 8** Most of the percentages of the gases in **Figure 3** are estimated values.

Why have scientists used estimated values for the percentages of the gases in **Figure 3**?

**[1 mark]**

_____

_____

**10**

**Turn over for the next question**

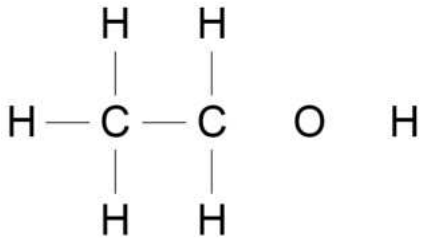
*Do not write outside the box*

**0 4** This question is about ethanol.

**0 4 . 1** The formula of ethanol is $C_2H_5OH$

Complete the displayed structural formula of ethanol.

**[1 mark]**



**0 4 . 2** Which is **one** use of ethanol?

**[1 mark]**

Tick (✓) **one** box.

As a protective coating on aluminium ☐

In hand gel to kill microbes ☐

To test for the presence of hydrogen gas ☐

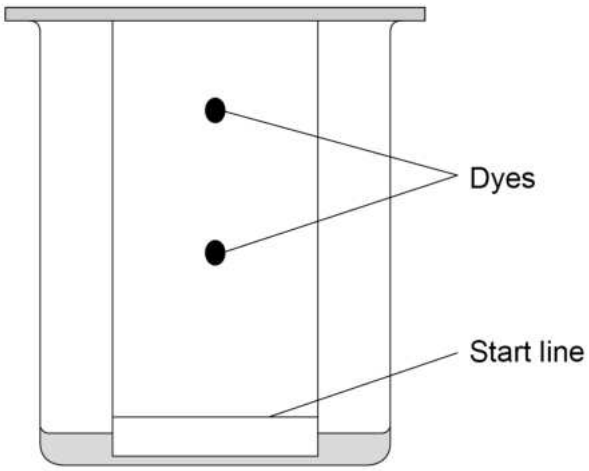
*Do not write outside the box*

**0 4 . 3** Ethanol is used as a solvent in some inks.

A student used paper chromatography to show that an ink contained two different dyes.

**Figure 4** shows the apparatus at the end of the investigation.

**Figure 4**




Describe a method the student could have used for the investigation.

**[4 marks]**

*Do not write outside the box*

**0 4 . 4** Ethanol can be produced from sugar solution by fermentation.

What must be added to sugar solution to produce ethanol?

**[1 mark]**

E5 and E10 are types of fuel used in cars.

These fuels contain ethanol and petrol.

**Table 6** shows information about E5 and E10.

**Table 6**

| Fuel | Percentage (%) by mass of ethanol | Percentage (%) by mass of petrol |
|---|---|---|
| E5 | 5 | 95 |
| E10 | 10 | 90 |

**0 4 . 5** Calculate the mass of ethanol in 4.4 kg of E5.

Give your answer in grams.

Use **Table 6**.

**[3 marks]**

Mass = _____ g

*Do not write outside the box*

**0 4 . 6** The ethanol in E5 and E10 is produced from sugar.

Sugar is produced from plants.

Explain why the production of E10 removes more carbon dioxide from the atmosphere than the production of E5.

Use **Table 6**.

**[3 marks]**

**0 4 . 7** **Table 7** shows the energy content of ethanol and petrol.

**Table 7**

| | **Energy content in MJ (megajoules) per kg** |
|---|---|
| Ethanol | 30.0 |
| Petrol | 46.4 |

Suggest **one** disadvantage of using E10 instead of E5.

Complete the sentence.

**[1 mark]**

A disadvantage of using E10 is that _____

_____

**14**

*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 5** Ammonia is produced in the Haber process.

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

**0 5 . 1** Draw **one** line from each raw material to the source of that raw material.

**[2 marks]**

| **Raw material** | **Source of raw material** |
|---|---|
| | Air |
| | Clay |
| Nitrogen | |
| | Limestone |
| Hydrogen | |
| | Natural gas |
| | Sand |

**0 5 . 2** What are the states of nitrogen and of hydrogen when used in the Haber process?

**[1 mark]**

Tick (✓) **one** box.

| **State of nitrogen** | **State of hydrogen** | |
|---|---|---|
| Gas | Gas | ☐ |
| Gas | Liquid | ☐ |
| Liquid | Gas | ☐ |
| Liquid | Liquid | ☐ |

*Do not write outside the box*

**0 5 . 3** The word equation for the production of ammonia is:

nitrogen + hydrogen ⇌ ammonia

The atom economy of the reaction is 100%.

How does the word equation show that the atom economy is 100%?

**[1 mark]**

Tick (✓) **one** box.

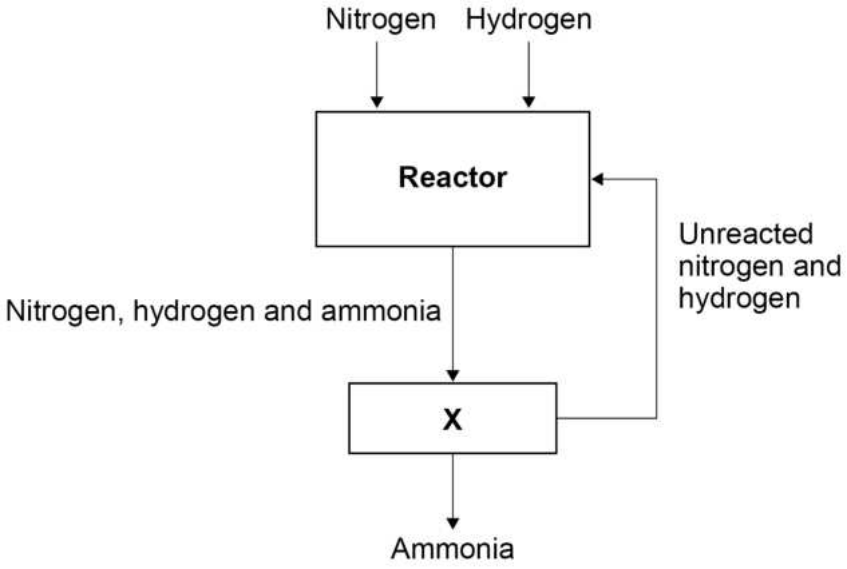
The reaction is reversible. ☐

There are two reactants. ☐

There is one product. ☐

**0 5 . 4** **Figure 5** represents the Haber process.

**Figure 5**




A mixture of nitrogen, hydrogen and ammonia enters **X**.

Complete the sentences.

Choose answers from the box.

**[2 marks]**

| | | | |
|---|---|---|---|
| **evaporated** | **filtered** | **liquefied** | **recycled** |

In **X**, the mixture is cooled.

The ammonia can be removed from **X** because the ammonia is

_____.

The unreacted nitrogen and hydrogen are

_____.

**Table 8** shows the percentage yield of ammonia at different pressures.

**Table 8**

| Pressure in atmospheres | Percentage (%) yield of ammonia |
|---|---|
| 50 | 20 |
| 100 | 33 |
| 150 | 44 |
| 200 | 52 |
| 250 | 59 |
| 300 | 64 |

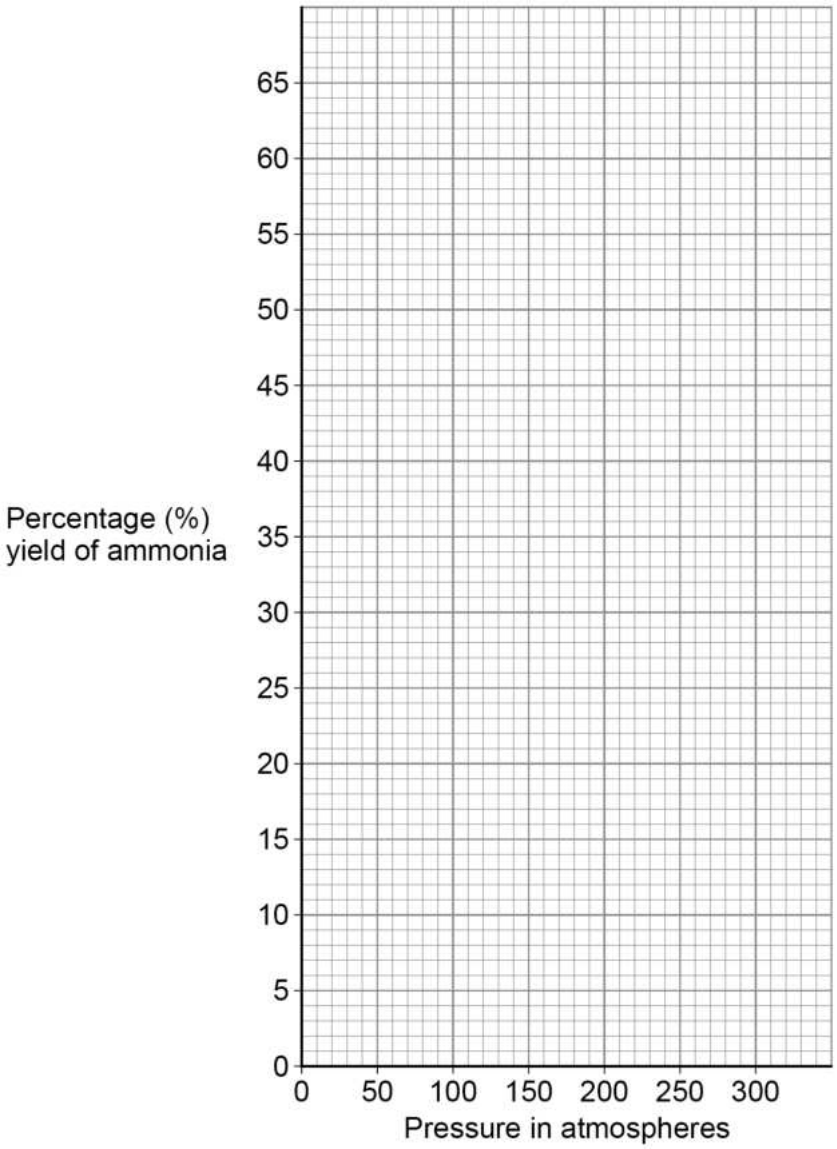
*Do not write outside the box*

**0 5 . 5** Plot the data from **Table 8** on **Figure 6**.

Draw a line of best fit.

**[3 marks]**

**Figure 6**




**0 5 . 6** What is the effect of increasing the pressure on the percentage yield of ammonia?

Use **Table 8**.

**[1 mark]**

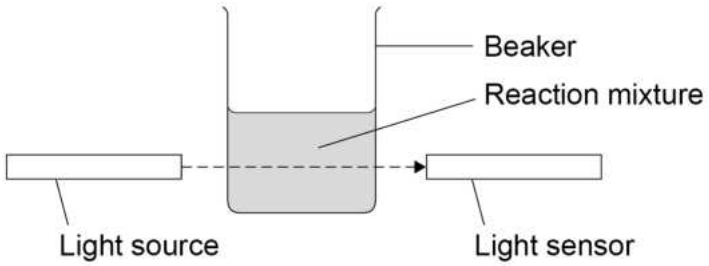
**10**

*Do not write outside the box*

**0 6** A student investigated the rate of reaction between sodium thiosulfate solution and hydrochloric acid.

**Figure 7** shows the apparatus used.

**Figure 7**




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

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 $cm^3$ of sodium thiosulfate solution into the beaker.

2. Add 10 $cm^3$ 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.

**0 6 . 1** Balance the equation for this reaction.

**[1 mark]**

$$Na_2S_2O_3 + 2\,HCl \rightarrow \_\_\_\_\ NaCl + H_2O + SO_2 + S$$

*Do not write outside the box*

**0 6 . 2** The mixture becomes cloudy because the sulfur produced is a solid.

What is the state symbol for a solid?

**[1 mark]**

Tick (✓) **one** box.

(aq) ☐

(g) ☐

(l) ☐

(s) ☐

**0 6 . 3** The student monitored the cloudiness of the reaction mixture using a light sensor.

What other piece of equipment could be used to monitor the cloudiness of the reaction mixture?

**[1 mark]**

Tick (✓) **one** box.

A balance ☐

A cross on a piece of paper ☐

A gas syringe ☐

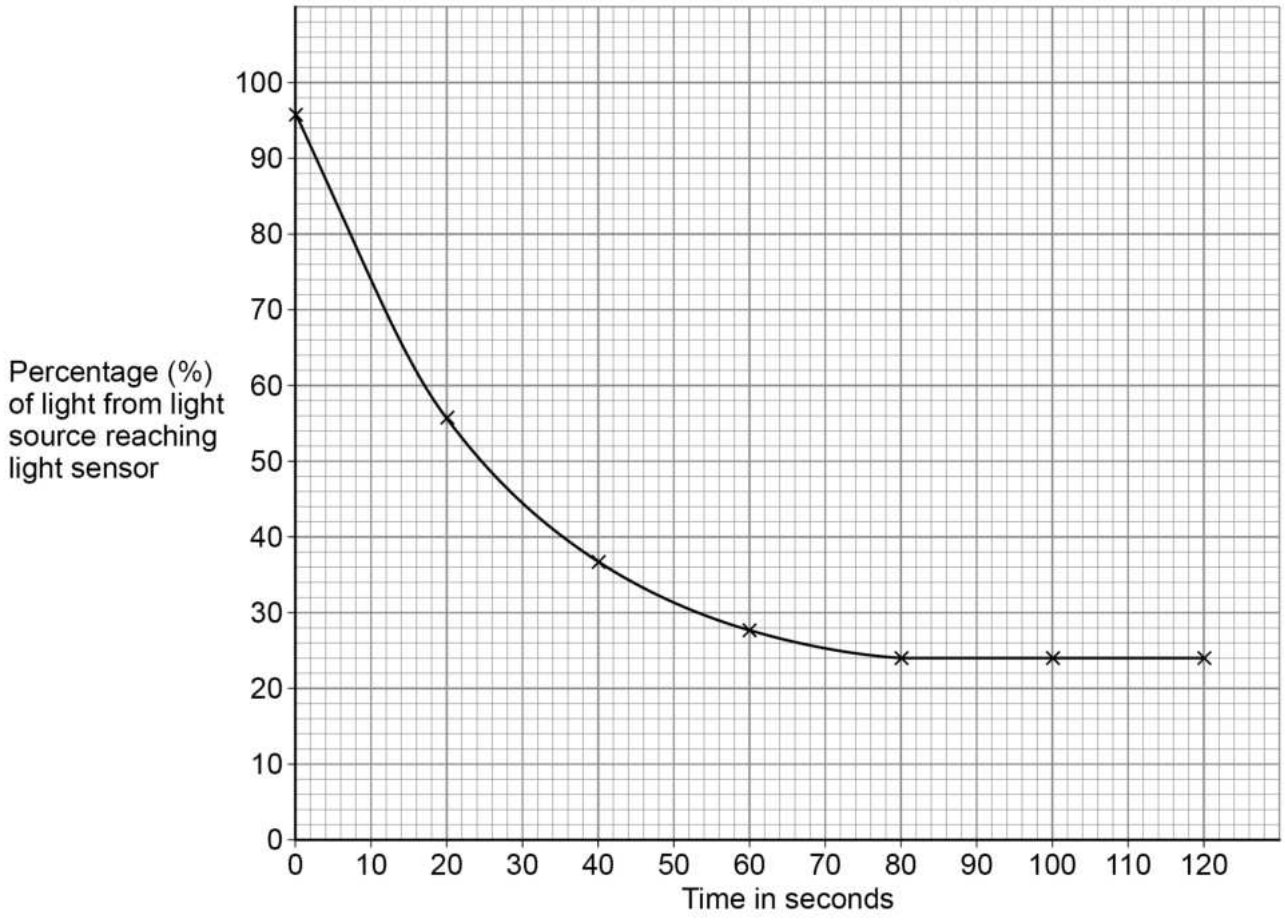
A thermometer ☐

**Question 6 continues on the next page**

*Do not write outside the box*

**Figure 8** shows the results.

**Figure 8**




**0 6 . 4** What happened to the rate of reaction between 40 and 60 seconds?

Use **Figure 8**.

**[1 mark]**

Tick (✓) **one** box.

The rate of reaction decreased. ☐

The rate of reaction stayed at zero. ☐

The rate of reaction increased. ☐

*Do not write outside the box*

**0 6 . 5** The student stopped taking measurements after 120 seconds because the percentage of light reaching the sensor stayed constant.

Why did the percentage of light reaching the sensor stay constant?

**[1 mark]**

Tick (✓) **one** box.

No light was reaching the sensor. ☐

One of the reactants was used up. ☐

The reaction was too vigorous. ☐

**0 6 . 6** The student repeated the experiment using sodium thiosulfate solution of a higher concentration.

How would the line of best fit for sodium thiosulfate solution of a higher concentration compare with the line of best fit on **Figure 8**?

**[1 mark]**

Tick (✓) **one** box.

Initially the line of best fit would be less steep. ☐

Initially the line of best fit would be the same steepness. ☐

Initially the line of best fit would be steeper. ☐

**Question 6 continues on the next page**

*Do not write outside the box*

**0 6 . 7** The student then investigated the effect of changing the temperature on the rate of reaction.

The student used sodium thiosulfate solution and hydrochloric acid which had been kept in an ice bath.

Which are **two** effects of using reactants kept in an ice bath rather than at room temperature?

**[2 marks]**

Tick (✓) **two** boxes.

Fewer reactant particles have the activation energy. ☐

The reactant particles collide more frequently. ☐

The reactant particles have more energy. ☐

The reactant particles move more slowly. ☐

There are fewer reactant particles in the same volume. ☐

**8**

*Do not write outside the box*

**0 7** This question is about fertilisers.

Ammonium nitrate is a fertiliser containing nitrogen.

**0 7 . 1** Complete the sentence.

Choose the answer from the box.

**[1 mark]**

| | | |
|---|---|---|
| **hydrochloric acid** | **nitric acid** | **sulfuric acid** |

Ammonium nitrate is produced by reacting ammonia with

_____.

**0 7 . 2** Ammonium nitrate fertiliser is sold in 600 kg bags.

A farmer spreads 40 bags of ammonium nitrate fertiliser on land with an area of 800 000 $m^2$.

Calculate the mass of ammonium nitrate fertiliser spread per $m^2$ of land.

**[2 marks]**

_____

_____

_____

Mass per $m^2$ = _____ $kg/m^2$

**Question 7 continues on the next page**

*Do not write outside the box*

**0 7 . 3** A scientist works for a company which makes ammonium nitrate fertiliser.

The scientist investigates the effect of different fertilisers on crop growth.

The scientist concludes that the ammonium nitrate fertiliser improves crop growth more than other fertilisers.

Suggest **one** reason why this conclusion might **not** be valid.

**[1 mark]**

*Do not write outside the box*

A different fertiliser containing nitrogen has the formula $K_2NH_4PO_4$

**0 7 . 4** How many atoms of nitrogen are in the formula $K_2NH_4PO_4$?

**[1 mark]**

---

**0 7 . 5** Nitrogen and potassium in the fertiliser $K_2NH_4PO_4$ are important for good crop growth.

Which other element in the fertiliser $K_2NH_4PO_4$ is important for good crop growth?

**[1 mark]**

Tick (✓) **one** box.

Hydrogen ☐

Oxygen ☐

Phosphorus ☐

**0 7 . 6** Some fertilisers are mixtures of different compounds in fixed proportions.

What name is given to a mixture of different compounds in fixed proportions?

**[1 mark]**

---

7

**Turn over for the next question**

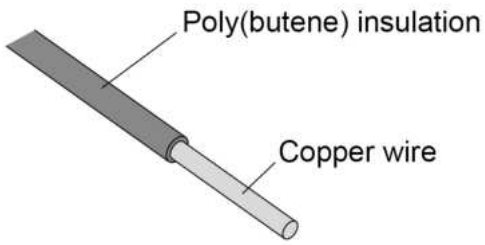
*Do not write outside the box*

**0 8** This question is about copper wire and copper compounds.

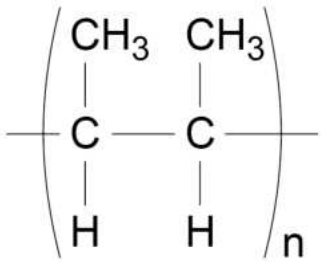
Copper is used to make electrical wires.

**Figure 9** shows how copper electrical wire is insulated using an addition polymer called poly(butene).

**Figure 9**




**0 8 . 1** The addition polymer poly(butene) has the displayed structural formula:

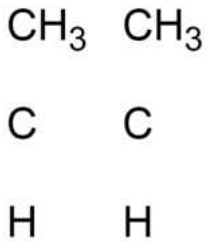



Poly(butene) is produced from the monomer butene.

Complete **Figure 10** to show the displayed structural formula of butene.

**[2 marks]**

**Figure 10**



*Do not write outside the box*

Copper can be obtained by recycling scrap copper wire.

**0 8 . 2** Suggest why poly(butene) insulation must be removed from scrap copper wire before the copper is recycled.

**[1 mark]**

**0 8 . 3** Describe how scrap copper wire can be recycled to make new copper water pipes.

**[2 marks]**

**0 8 . 4** Suggest **two** reasons why recycling scrap copper is more sustainable than extracting copper from copper ores.

**[2 marks]**

1

2

**Question 8 continues on the next page**

*Do not write outside the box*

Copper sulfate is a compound of copper.

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

**0 8 . 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 _____

_____

Result _____

_____

**0 8 . 6** Describe **one** test to show the presence of sulfate ions in copper sulfate solution.

Give the result of the test.

**[2 marks]**

Test _____

_____

Result _____

_____

**11**

*Do not write outside the box*

**Turn over for the next question**

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

**0 9** 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 9** shows the results.

**Table 9**

| 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 |

*Do not write outside the box*

**0 9 . 1** Determine the mass of the empty test tube.

**[1 mark]**

Mass of empty test tube = _____ g

**0 9 . 2** Explain why the mass of the test tube and contents decreased.

**[2 marks]**

**0 9 . 3** Suggest why the test tube and contents were heated until the mass did not change.

**[1 mark]**

**Question 9 continues on the next page**

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

**0 9 . 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]**

Energy taken in (3 significant figures) = _____ kJ

**0 9 . 5** What type of reaction takes place when hydrated cobalt chloride is heated?

**[1 mark]**

**8**

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**Turn over for the next question**

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**1 0** This question is about life cycle assessments (LCAs).

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

**Table 10** shows information about milk bottles of equal volume.

**Table 10**

| | **Glass** | **Polymer** |
|---|---|---|
| Raw materials | Limestone<br>Sand<br>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 10**.

**[6 marks]**

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**1 0 . 2** Milk is also sold in cardboard cartons.

A carton is made using 40 $cm^3$ of cardboard.

The density of the cardboard is 0.40 $g/cm^3$.

Calculate the mass of the carton.

Use the equation:

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

**[3 marks]**

Mass = _____ g

9

**END OF QUESTIONS**

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