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# INTERNATIONAL GCSE CHEMISTRY

Paper 1

Tuesday 15 May 2018

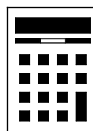
07:00 GMT

Time allowed: 1 hour 30 minutes

## Materials

For this paper you must have:

- a pencil and a ruler
- a scientific calculator
- the periodic table (enclosed).



## Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- Show all your working.

## Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 90.
- You are expected to use a scientific calculator where appropriate.
- A periodic table is provided as a loose insert.

For Examiner's Use

Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
<b>TOTAL</b>	



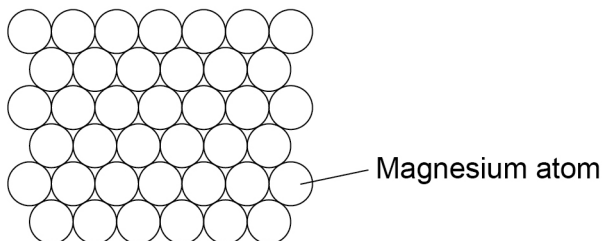
Answer **all** questions in the spaces provided.

0 1

This question is about magnesium and magnesium oxide.

**Figure 1** shows an arrangement of atoms in magnesium metal.

**Figure 1**



0 1 . 1

Complete the following sentences about metals.

**[3 marks]**

Metals are good conductors of \_\_\_\_\_ and  
\_\_\_\_\_. Metals can be hammered into shape. This is  
because the \_\_\_\_\_ of atoms are able to slide over each other.

0 1 . 2

Magnesium is often mixed with other metals to produce a more useful material.

What are mixtures of metals called?

Tick **one** box.

**[1 mark]**

Alloys

Compounds

Molecules

Polymers



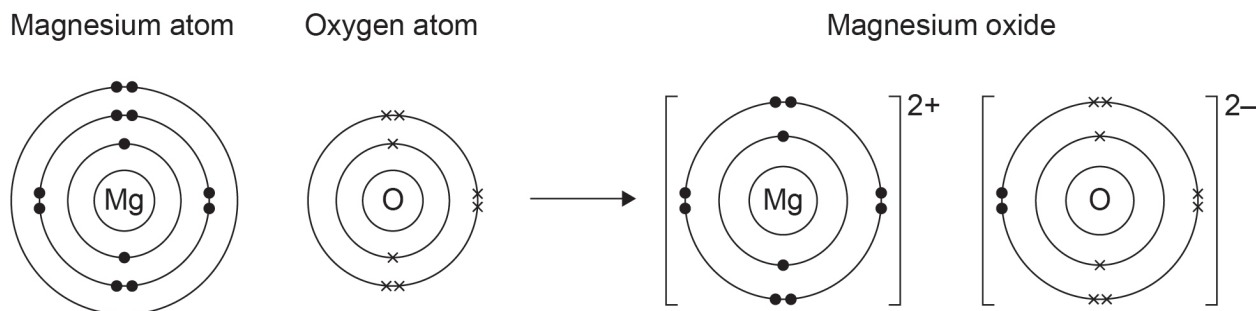
0 1 . 3

Magnesium reacts with oxygen to form magnesium oxide.

Figure 2 shows how this happens.

The dots (•) and crosses (x) represent electrons.

Figure 2



Describe what happens to the electrons when magnesium reacts with oxygen to produce magnesium oxide.

Use Figure 2 to help you answer this question.

[3 marks]

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Question 1 continues on the next page

Turn over ►



0 1 . 4

The formula of magnesium oxide is MgO.

Calculate the relative formula mass ( $M_r$ ) of magnesium oxide.

Relative atomic masses ( $A_r$ ): Mg = 24      O = 16

[1 mark]

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0 1 . 5

Calculate the percentage by mass of magnesium in magnesium oxide, MgO.

[1 mark]

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Percentage = \_\_\_\_\_ %

0 1 . 6

Magnesium oxide is an ionic compound with a high melting point.

Explain why magnesium oxide has a high melting point.

Refer to the structure of the compound in your answer.

[4 marks]

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0 5

0 2

A student investigates the reactivity of four metals, **A**, **B**, **C** and **D**.

This is the method the student uses.

- 1 Add a piece of metal **A** to some cold water and another piece to some dilute hydrochloric acid.
- 2 Observe the rate of bubbling.
- 3 Repeat steps 1 and 2 with metals **B**, **C** and **D**.

0 2 . 1

The student wants to ensure the investigation is a fair test.

Give **two** variables the student should control.

[2 marks]

1 \_\_\_\_\_

\_\_\_\_\_

2 \_\_\_\_\_

\_\_\_\_\_

**Table 1** shows the student's results.

**Table 1**

Metal	Reaction with cold water	Reaction with dilute hydrochloric acid
<b>A</b>	No reaction	Bubbles made slowly
<b>B</b>	Bubbles made very slowly	Bubbles made rapidly
<b>C</b>	No reaction	No reaction
<b>D</b>	Bubbles made quite quickly	Bubbles made rapidly

0 2 . 2

Write down metals **A**, **B**, **C** and **D** in order of reactivity.

[1 mark]

\_\_\_\_\_ most reactive

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ least reactive



0 2 . 3 Metal **D** is calcium.

Calcium reacts with water to produce calcium hydroxide,  $\text{Ca}(\text{OH})_2$ , and hydrogen gas,  $\text{H}_2$

Write the balanced equation for this reaction.

[2 marks]

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0 2 . 4 Give the test for hydrogen gas.

[1 mark]

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0 2 . 5 The student wants to confirm that metal **D** is calcium.

The student does a flame test on the solution formed when calcium reacts with dilute hydrochloric acid.

Describe what the student would see during the test.

[1 mark]

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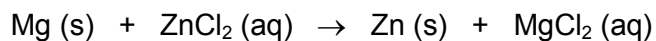
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**0 2 . 6** The student does another experiment using a displacement reaction.

The student reacts magnesium with zinc chloride solution.

The equation for the reaction is



The student makes the following observations:

- the reaction mixture becomes warm
- a solid forms on the surface of the magnesium.

Explain the student's observations.  
Refer to the chemicals in the equation.

**[2 marks]**

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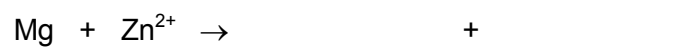
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**0 2 . 7** Complete the ionic equation for the reaction in question **02.6**

**[1 mark]**



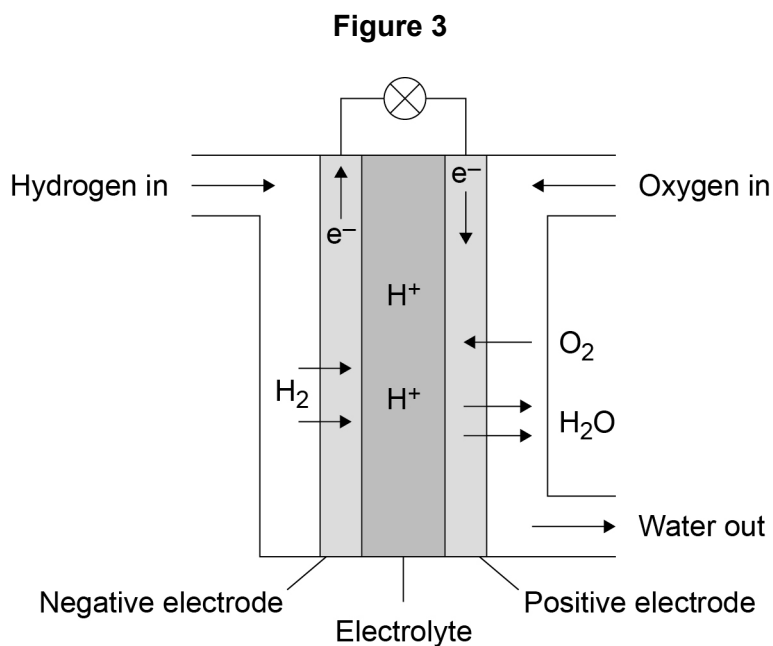
**10**





0 3

Figure 3 shows a hydrogen fuel cell.



0 3 . 1

What is the **useful** type of energy produced by fuel cells?  
Tick **one** box.

[1 mark]

Activation energy

Electrical energy

Kinetic energy

Thermal energy

0 3 . 2

Write a word equation for the overall chemical reaction that takes place in the hydrogen fuel cell.

[1 mark]

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Question 3 continues on the next page

Turn over ►



03.3

Some fuel cells use electrodes made from solid platinum. Engineers are developing electrodes made from porous carbon structures coated with platinum nanoparticles.

What is the maximum size of a nanoparticle?  
Tick **one** box.

[1 mark]

1 nm

10 nm

100 nm

1000 nm

03.4

Suggest **one** advantage of using electrodes coated with platinum nanoparticles instead of solid platinum electrodes.

[1 mark]

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03.5

Hydrogen gas forms hydrogen ions at the negative electrode in a fuel cell.

Complete the half equation for this reaction.

[2 marks]



03.6

Why is the reaction in question **03.5** described as an oxidation reaction?

[1 mark]

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0 4 . 1 Group 1 metals have different properties from the transition metals.

Tick **two** properties of Group 1 metals.

[2 marks]

Form coloured compounds

Have ions with +1 charge

Have ions with different charges

React with water, releasing hydrogen

Strong and hard

Useful as catalysts

0 4 . 2 Sodium is a metal in Group 1 of the periodic table.

An atom of sodium has the symbol  ${}_{11}^{23}\text{Na}$

Give the number of protons and neutrons in an atom of sodium.

[2 marks]

Number of protons \_\_\_\_\_

Number of neutrons \_\_\_\_\_

0 4 . 3 Explain why an atom of sodium has no overall charge.  
Use the relative electrical charges of sub-atomic particles in your explanation.

[2 marks]

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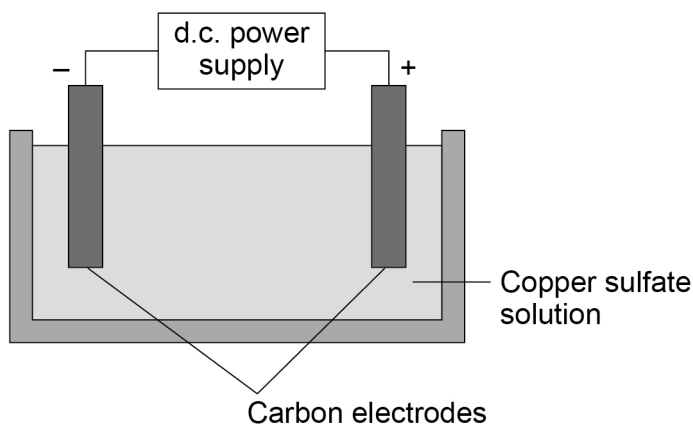


0 5

**Figure 4** shows the apparatus used for the electrolysis of copper sulfate solution,  $\text{CuSO}_4$  (aq).

This solution contains copper ions and sulfate ions.

**Figure 4**



0 5 . 1

Explain why copper ions move to the negative electrode in **Figure 4**.

[2 marks]

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0 5 . 2

Suggest why **solid** copper sulfate does **not** conduct electricity. Give your answer in terms of particles.

[1 mark]

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Question 5 continues on the next page

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The negative electrode becomes coated with copper during the electrolysis of copper sulfate solution.

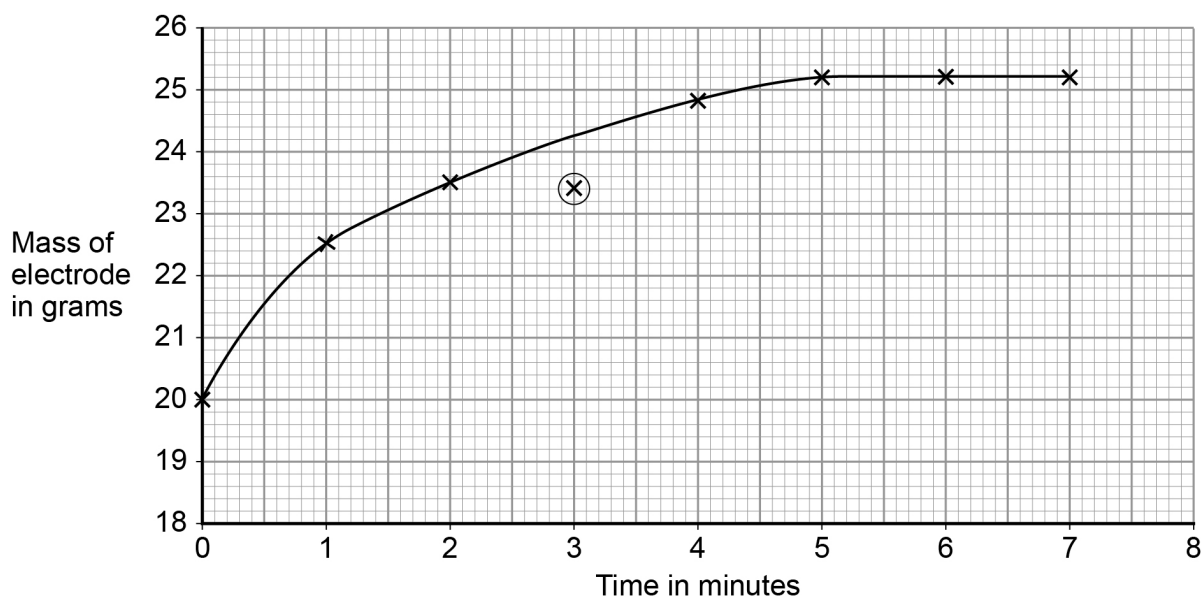
A student investigates how the mass of the negative electrode changes with time.

This is the method the student uses.

- 1 Measure the initial mass of the negative electrode.
- 2 Set up the apparatus as in **Figure 4**.
- 3 Allow the electricity to flow for 1 minute.
- 4 Remove the negative electrode and wipe with absorbent paper.
- 5 Measure the mass of the negative electrode.
- 6 Repeat steps 2 to 5 until seven sets of results have been collected.

The graph in **Figure 5** shows the student's results.

**Figure 5**



0 5 . 3

The student thinks the anomalous result at 3 minutes is caused because they forgot to wipe the electrode with absorbent paper in step 4.

Explain whether the student is correct.

[2 marks]

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0 5 . 4

Calculate the mass of copper deposited in 5 minutes.

[1 mark]

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Mass = \_\_\_\_\_ g

0 5 . 5

Calculate the mean mass of copper deposited per minute for the first 5 minutes.

[2 marks]

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Mean mass per minute = \_\_\_\_\_ g/min

0 5 . 6

Suggest why the mass of the negative electrode remains constant after 5 minutes.

[1 mark]

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Question 5 continues on the next page

Turn over ►



0 5 . 7

The student also investigates the electrolysis of sodium sulfate solution.

This solution contains:

- sodium ( $\text{Na}^+$ ) ions
- hydrogen ( $\text{H}^+$ ) ions
- sulfate ( $\text{SO}_4^{2-}$ ) ions
- hydroxide ( $\text{OH}^-$ ) ions.

The student observes that:

- the mass of each electrode does not change
- bubbles are produced at each electrode.

Explain these observations.

[3 marks]

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12

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0 6

This question is about alcohols.

0 6 . 1

Some ethanol is dissolved in water.

What is the pH of the solution?

Tick **one** box.

[1 mark]

5

7

9

11

A student measured the boiling points of some alcohols.

**Table 2** shows the student's results.**Table 2**

Alcohol	Formula	Boiling point in °C
Methanol	CH <sub>3</sub> OH	62
Ethanol	C <sub>2</sub> H <sub>5</sub> OH	78
Propanol	C <sub>3</sub> H <sub>7</sub> OH	100
Butanol	C <sub>4</sub> H <sub>9</sub> OH	X
Pentanol	C <sub>5</sub> H <sub>11</sub> OH	135



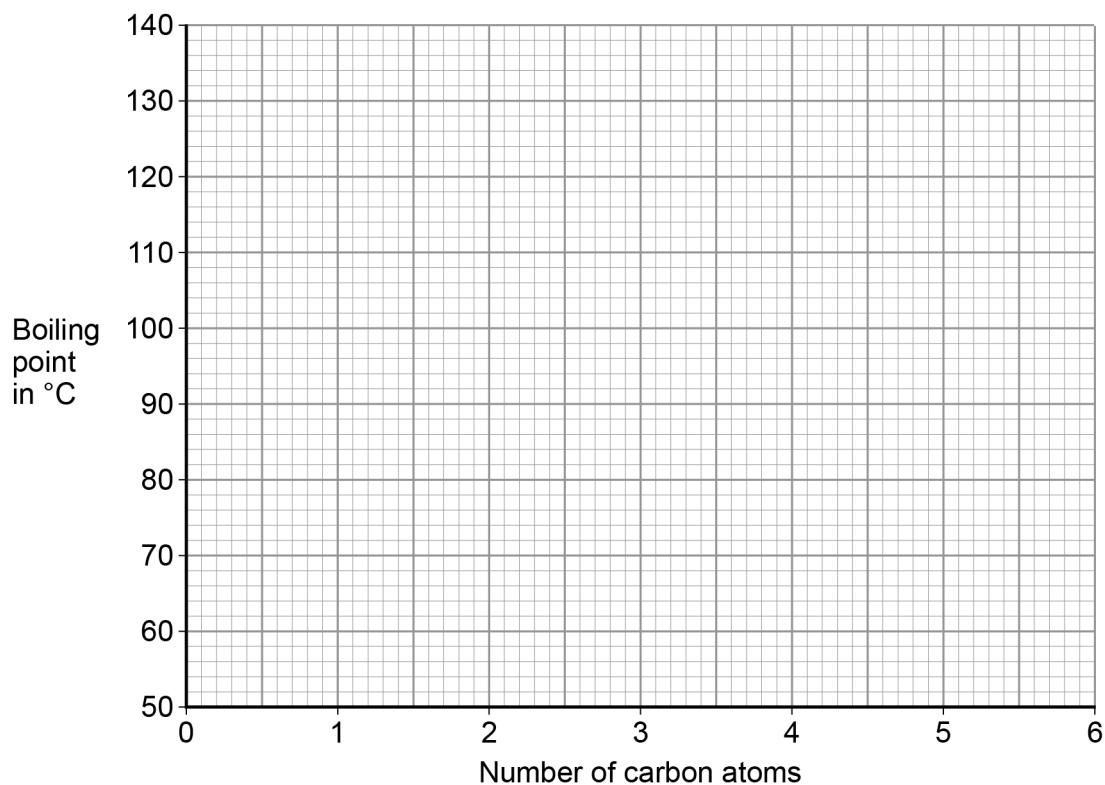
0 6 . 2

On **Figure 6** plot a graph of the boiling point of each alcohol against the number of carbon atoms in the formula of the alcohol.

Draw a line of best fit.

[3 marks]

**Figure 6**



0 6 . 3

Use your graph in **Figure 6** to find the boiling point of butanol.

[1 mark]

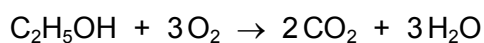
Boiling point of butanol = \_\_\_\_\_ °C

**Question 6 continues on the next page**

Turn over ►



0 6 . 4 Ethanol, C<sub>2</sub>H<sub>5</sub>OH, can be burnt in oxygen to produce carbon dioxide and water.



Calculate the maximum mass of carbon dioxide produced by burning 2.3 g of ethanol.

Relative atomic masses ( $A_r$ ): C = 12      H = 1      O = 16

[3 marks]

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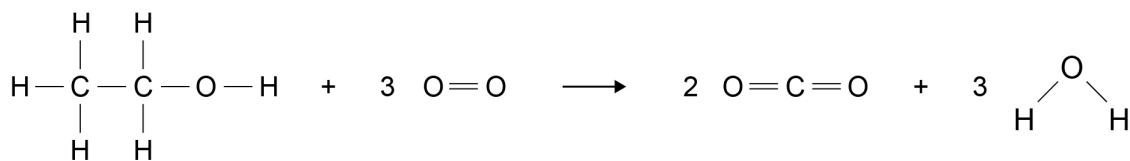
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Maximum mass produced = \_\_\_\_\_ g



The equation for the combustion of ethanol can be written using displayed structures.



The total energy required to break the bonds in the reactants is 4728 kJ/mol.

**Table 3** shows the bond energies of the bonds in the products.

**Table 3**

Bond	Bond energy in kJ/mol
C=O	805
O-H	464

**0 6 . 5** Calculate the total energy released in bond formation in this reaction.

**[3 marks]**

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Total energy released = \_\_\_\_\_ kJ/mol

**0 6 . 6** Calculate the overall energy change for the combustion of ethanol.

**[1 mark]**

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Overall energy change = \_\_\_\_\_ kJ/mol

**12**

Turn over ►



0 7

This question is about the production of sulfuric acid by the contact process.

0 7 . 1

What is the formula of sulfuric acid?

Tick **one** box.

**[1 mark]**HSO<sub>4</sub>H(SO<sub>4</sub>)<sub>2</sub>H<sub>2</sub>SO<sub>4</sub>H<sub>2</sub>(SO<sub>4</sub>)<sub>2</sub>

0 7 . 2

In the contact process, sulfur dioxide is reacted with oxygen to produce sulfur trioxide. The reaction requires a catalyst and is carried out at a temperature of 450 °C.

Name the catalyst used in this reaction.

**[1 mark]**

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0 7 . 3

Suggest why the use of a catalyst can reduce the energy costs in this process.

**[2 marks]**

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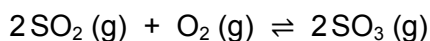
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0 7 . 4

The equation for the production of sulfur trioxide is shown below.



The pressure is increased when the reaction is at equilibrium.

Describe any effect this will have on the yield of sulfur trioxide,  $\text{SO}_3$ .

Give **one** reason for your answer.

[2 marks]

Effect \_\_\_\_\_

Reason \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

0 7 . 5

Table 4 shows the composition of a mixture of gases at equilibrium.

Table 4

Gas	Amount in moles
Sulfur dioxide	20
Oxygen	20
Sulfur trioxide	600

Calculate the total volume of the mixture at room temperature and pressure.

The molar gas volume at room temperature and pressure is  $24 \text{ dm}^3$ .

[2 marks]

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Total volume = \_\_\_\_\_  $\text{dm}^3$

8

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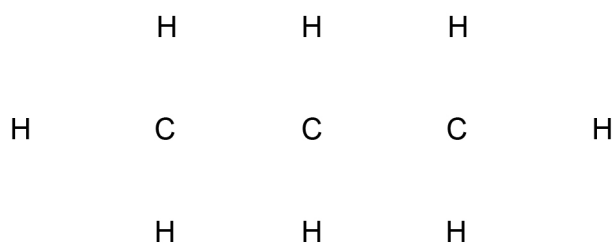
0 8

This question is about alkanes and the combustion of fuels.

0 8 . 1

Propane is an alkane.

Complete **Figure 7** to show the covalent bonds in propane.

**[1 mark]****Figure 7**

0 8 . 2

What is the general formula for alkanes?

Tick **one** box.

**[1 mark]** $C_nH_n$  $C_nH_{n+1}$  $C_nH_{2n}$  $C_nH_{2n+2}$ 

0 8 . 3

Diesel is a fuel composed mainly of alkanes.

Give **one** reason why the combustion of diesel may release sulfur dioxide into the atmosphere.

**[1 mark]**

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0 8 . 4

If diesel undergoes incomplete combustion it may produce tiny solid particles called particulates.

Give **one** reason why diesel may undergo incomplete combustion rather than complete combustion.

[1 mark]

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0 8 . 5

Black particulates are released during the incomplete combustion of diesel.

Suggest the name of the chemical found in black particulates.

[1 mark]

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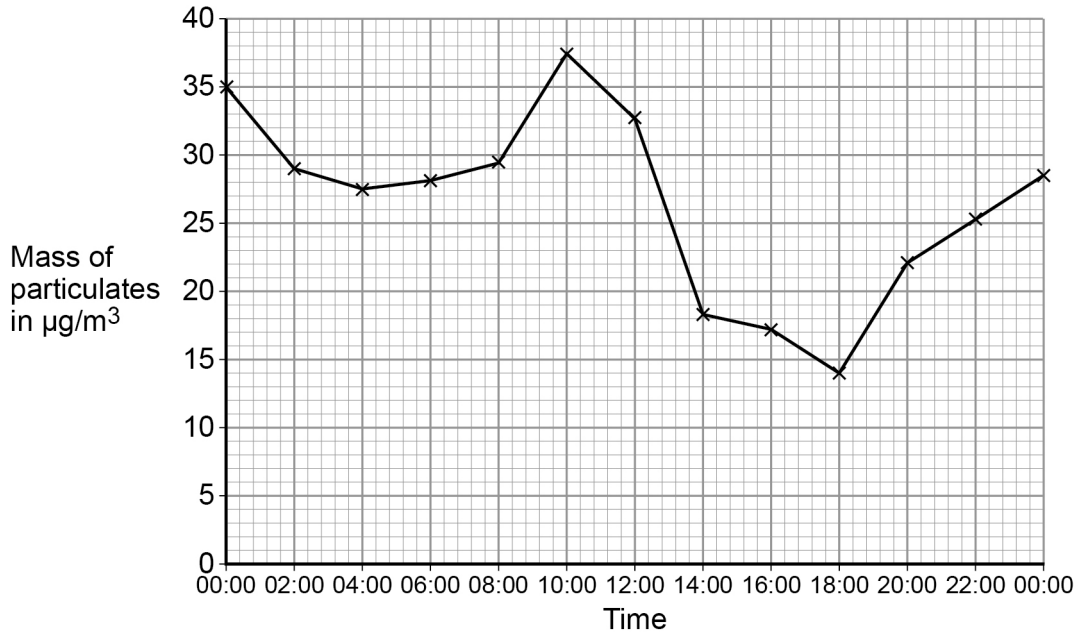
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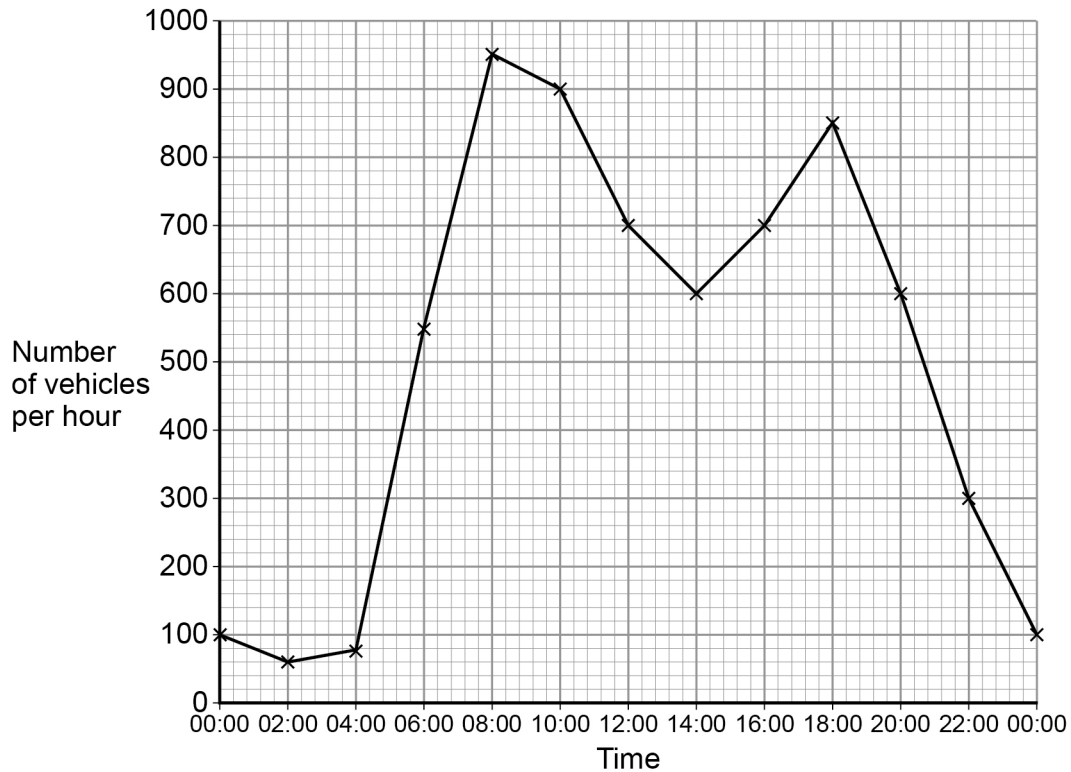
A scientist investigated the effect of road traffic on the mass of particulates in the atmosphere. Particulate levels were measured at a point next to a busy road in a city. Samples were taken at ground level during one day in the middle of the week.

The graph in **Figure 8** shows the particulate levels. The graph in **Figure 9** shows the number of vehicles passing the same point during the same day.

**Figure 8**



**Figure 9**



0 8 . 6

Discuss whether the results show a link between the number of vehicles and the mass of particulates.

[2 marks]

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0 8 . 7

Suggest **one** way to improve the investigation.

[1 mark]

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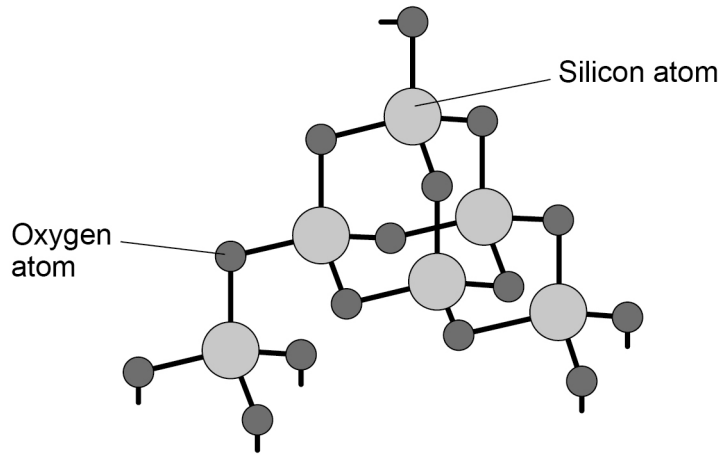


0 8 . 8

Some particulates are tiny sand particles blown by wind from the desert.

Sand is mostly composed of silicon dioxide,  $\text{SiO}_2$ , which has the structure shown in Figure 10.

Figure 10



Describe the structure of silicon dioxide.

You should include the number and type of bonds between atoms in the structure.

[4 marks]

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END OF QUESTIONS



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