

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
– *there may be more space than you need.*
- Show all the steps in any calculations and state the units.

- The total mark for this paper is 110.
- The marks for **each** question are shown in brackets
– *use this as a guide as to how much time to spend on each question.*

- Read each question carefully before you start to answer it.
- Write your answers neatly and in good English.
- Try to answer every question.
- Check your answers if you have time at the end.



2

P 8 0 1 3 7 A 0 2 2 8

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

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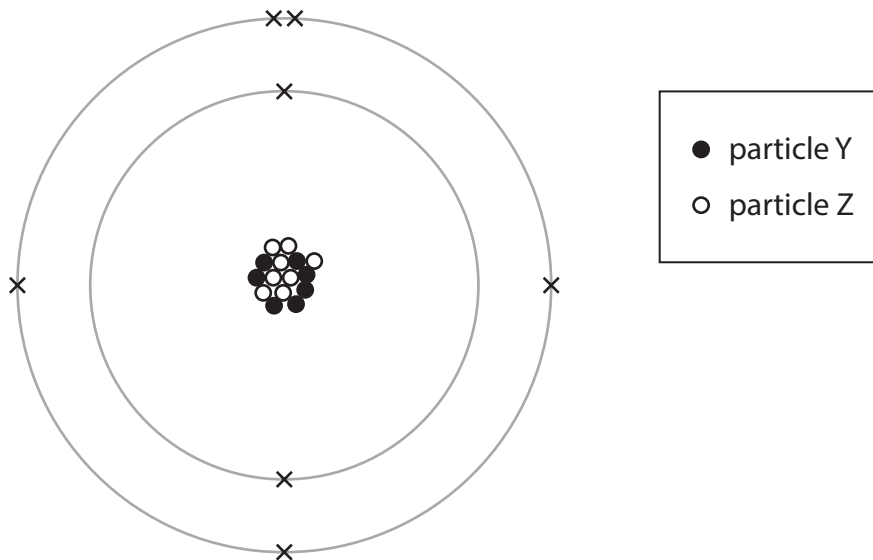
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Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

- 1** The diagram shows the structure of an atom of an element.



- (a) Give the name of particle Z.

(1)

- (b) Give the mass number of this atom.

(1)

- (c) Give the group number and period number for this element.

(2)

group number

period number



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(d) Give a reason why atoms of this element have no overall charge.

(1)

(e) (i) Identify this element.

(1)

(ii) Give the charge on an ion of this element.

(1)

(Total for Question 1 = 7 marks)



2 This question is about iron and its compounds.

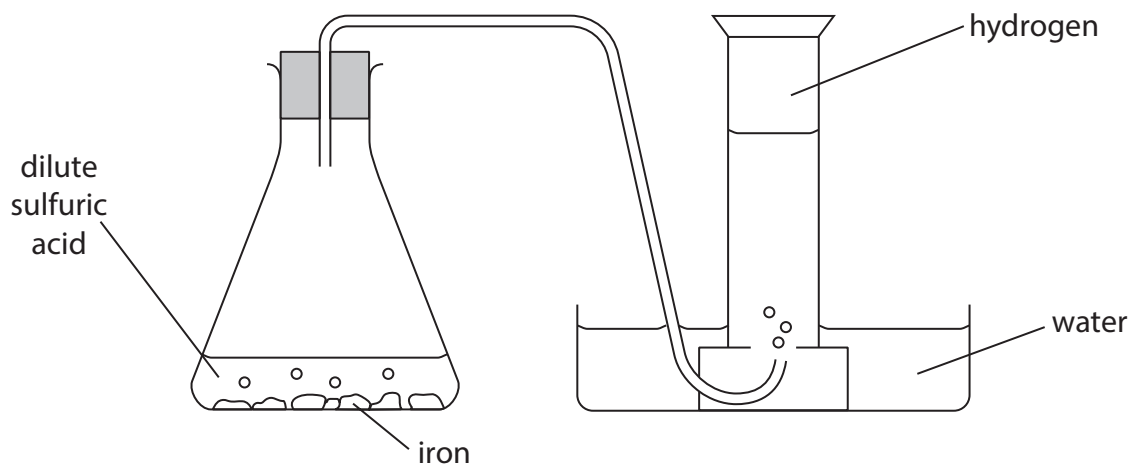
(a) Name the substances needed for iron to rust.

(2)

1

2

(b) A student uses this apparatus to react iron with dilute sulfuric acid and to collect the gas produced.



(i) Name a metal that can **safely** react with dilute sulfuric acid to produce the same volume of hydrogen gas in a shorter time.

(1)

(ii) Give a test to show that the gas produced is hydrogen.

(1)



(c) Which row gives the correct properties of iron(III) oxide?

(1)

	Nature of oxide	Structure of oxide
☐ A	acidic	giant ionic
☐ B	basic	simple molecular
☐ C	acidic	simple molecular
☐ D	basic	giant ionic

(Total for Question 2 = 5 marks)

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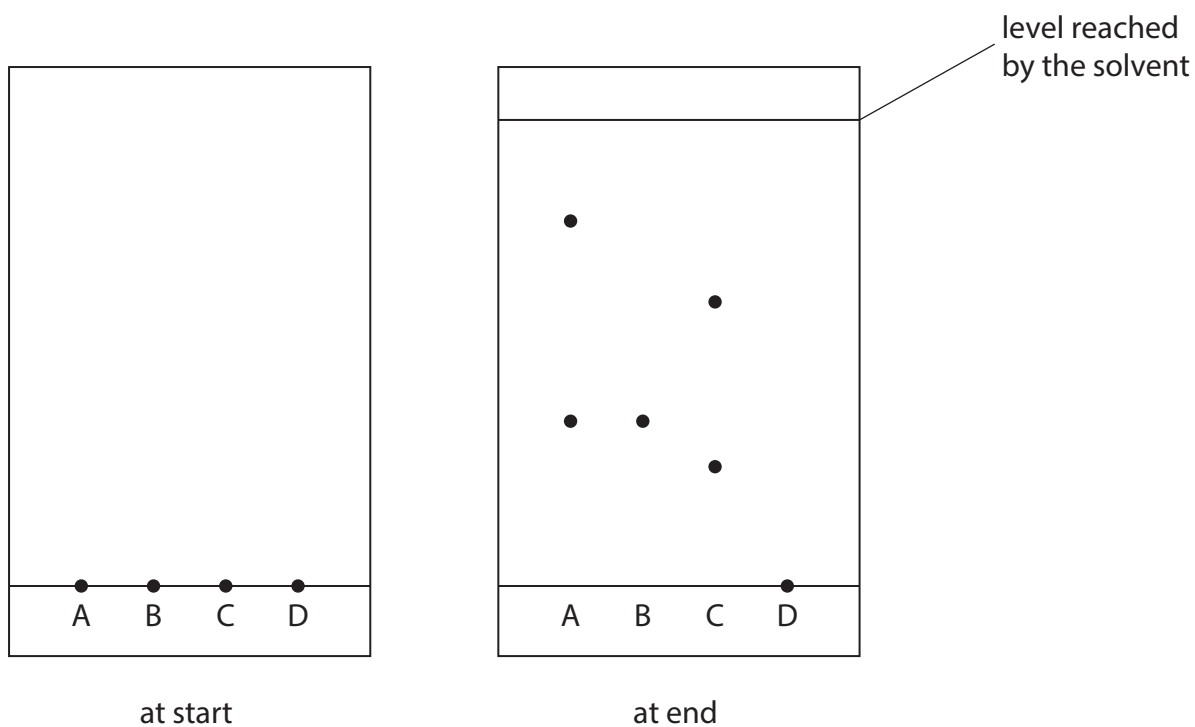
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- 3 A student uses paper chromatography in an experiment to separate the dyes in four different food colourings, A, B, C and D.

The diagram shows the appearance of the paper at the start and at the end of the experiment.



- (a) (i) Describe a method the student should use after putting a spot of each food colouring on the paper.

(3)

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(ii) Describe the composition of food colouring A.

(2)

(iii) Food colouring D is a mixture of dyes.

Suggest how the student could separate the dyes in food colouring D.

(1)

(b) Calculate the R_f value of the most soluble dye on the chromatogram.

(3)

$R_f =$

(Total for Question 3 = 9 marks)



4 This question is about physical changes.

(a) The table gives some physical processes.

Complete the table by giving the name of the change for each process.

(3)

Process	Name of change
water changes into ice	
solid iodine changes directly into a vapour	
sodium chloride crystals stirred in hot water	

(b) Explain why hot water evaporates more quickly than cold water.

(2)

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(c) A student is given a pure solid and an impure solid.

Describe how the student can identify which solid is pure and which solid is impure by measuring a physical property.

(3)

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(Total for Question 4 = 8 marks)



5 This question is about gases.

(a) The box lists the names of some gases.

argon	carbon dioxide	ethene
methane	nitrogen	sulfur dioxide

The table gives some statements about gases.

Complete the table by giving the correct gas from the box for each statement.

(4)

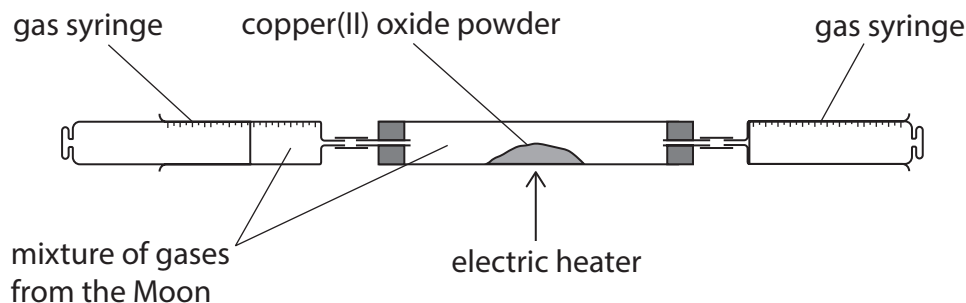
Statement	Gas
a gas that is about 1% by volume of air	
a gas that is the product of the complete combustion of a hydrocarbon	
a gas that can be used to make a polymer	
a gas that occurs as diatomic molecules	



(b) A scientist analyses a sample of gases from the Moon.

The sample is a mixture of the gases helium, hydrogen and neon.

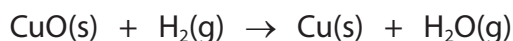
The scientist uses this apparatus to determine the percentage by volume of hydrogen in the mixture.



This is the scientist's method.

- record the total volume of the gases in the apparatus
- heat the copper(II) oxide powder using the electric heater
- use the gas syringes to pass the gases over the heated copper(II) oxide powder several times
- allow the remaining gases to cool to room temperature and record the volume

This is the equation for the reaction between copper(II) oxide and hydrogen.



(i) Give a reason why helium and neon are unreactive.

(1)

(ii) Give a reason why the scientist allows the remaining gases to cool before recording the volume.

(1)

(iii) Give a reason why the scientist uses an electric heater rather than a Bunsen burner.

(1)



- (iv) At the start of the experiment, the initial volume of gas in the apparatus is 157.0 cm^3

At the end of the experiment, the final volume of gas is 106.7 cm^3

Calculate the percentage by volume of hydrogen in the mixture of gases.

Give your answer to one decimal place.

(3)

percentage =%

- (v) Explain why the reaction between copper(II) oxide and hydrogen is a redox reaction.

(2)

(Total for Question 5 = 12 marks)

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6 This question is about ionic compounds.

- (a) The table gives the formulae of some positive ions, some negative ions, and some compounds containing these ions.

	NH_4^+	Mg^{2+}	Al^{3+}
Cl^-		MgCl_2	
O^{2-}	no compound formed		Al_2O_3
NO_3^-	NH_4NO_3	$\text{Mg}(\text{NO}_3)_2$	$\text{Al}(\text{NO}_3)_3$

- (i) Complete the table by giving the three missing formulae.

(3)

- (ii) Give the name of the compound with the formula NH_4NO_3

(1)

- (iii) Calculate the mass, in grams, of nitrogen in 100 g of NH_4NO_3

[for N $A_r = 14$]

[for NH_4NO_3 $M_r = 80$]

(2)

mass = g

- (b) Magnesium chloride (MgCl_2) is an ionic compound.

The magnesium ions and chloride ions are held together by ionic bonding.

- (i) State the meaning of the term **ionic bonding**.

(2)

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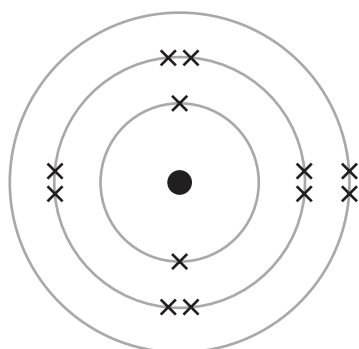
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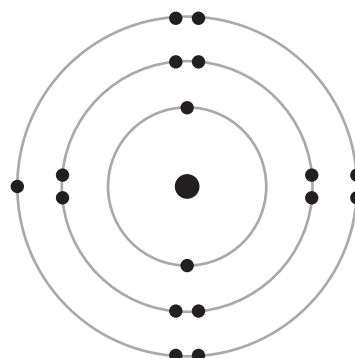


- (ii) Magnesium chloride forms when magnesium reacts with chlorine.

The diagram shows the arrangement of electrons in a magnesium atom and in a chlorine atom.



magnesium atom



chlorine atom

Describe, in terms of electrons, what happens when magnesium chloride forms.

(2)

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- (iii) Describe a test to show that magnesium chloride contains chloride ions.

(2)

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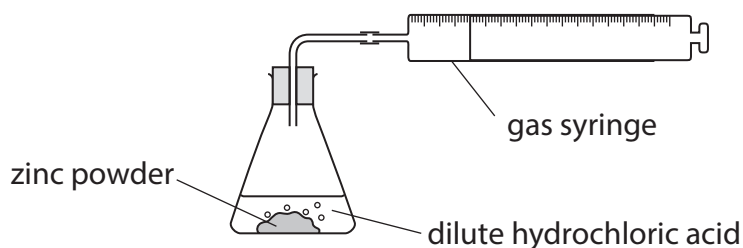
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(Total for Question 6 = 12 marks)



7 This question is about rates of reaction.

A student uses this apparatus to investigate the rate of reaction between zinc and dilute hydrochloric acid.



The zinc powder is in excess.

The student measures the volume of gas in the syringe every minute for 8 minutes.

The table shows the student's results.

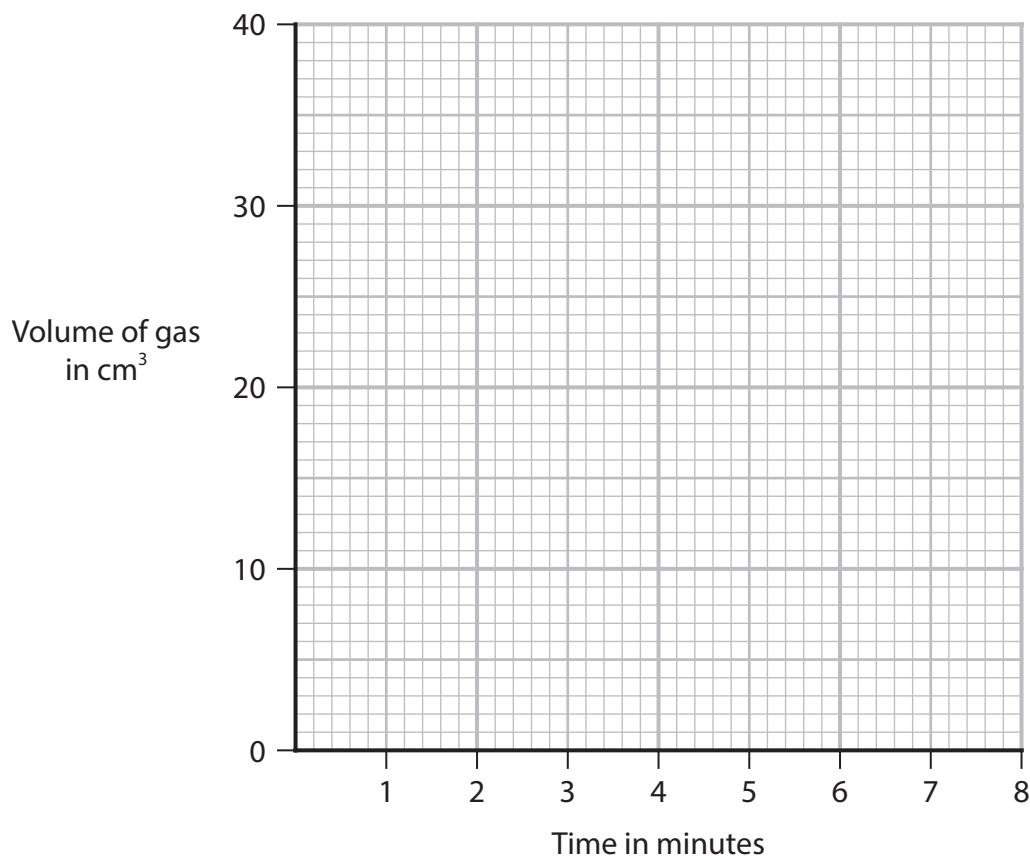
Time in minutes	0	1	2	3	4	5	6	7	8
Volume of gas in cm ³	0	16	18	30	36	40	40	40	40

(a) (i) Plot the student's results on the grid.

(1)

(ii) Draw a curve of best fit, ignoring the anomalous result.

(1)



(iii) Suggest a mistake the student could have made to cause the anomalous result.

(1)

(iv) Draw a tangent to the curve at 4 minutes.

(1)

(v) Use the tangent to determine the rate of reaction at 4 minutes.

Include a unit in your answer.

(3)

rate = unit =

(b) Explain why the last four readings for the volume of gas are the same.

(2)

(Total for Question 7 = 9 marks)

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8 The table shows the displayed formulae of six organic compounds.

<p>A</p> <pre> H H H H — C — C — C — H H C H H </pre>	<p>B</p> <pre> H H H H — C — C = C — C — H H H H </pre>	<p>C</p> <pre> H H H H — C — C — C — H H H H </pre>
<p>D</p> <pre> H H — C — H H </pre>	<p>E</p> <pre> H H H — C — C — H H — C — C — H H H </pre>	<p>F</p> <pre> H H H — C — C — H Br Br </pre>

(a) Use the letters A to F to answer these questions.

You may use each letter once, more than once, or not at all.

(i) Give the letter of the compound that is **not** a hydrocarbon.

(1)

(ii) Give the letter of the compound that will decolourise bromine water.

(1)

(iii) Give the letter of the saturated compound with the empirical formula CH_2

(1)

(iv) Give the letter of the compound that has the same molecular formula as butane.

(1)

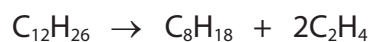
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(b) This equation represents a reaction that occurs during cracking.



(i) Give the temperature and the catalyst needed for cracking.

(2)

temperature

catalyst

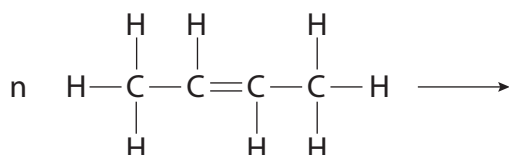
(ii) Explain why cracking is a useful process.

Refer to the products of the reaction in your answer.

(4)

(c) Complete the equation for the polymerisation of compound B.

(3)



(Total for Question 8 = 13 marks)



9 This question is about copper and copper compounds.

(a) A sample of copper contains two isotopes.

- ^{63}Cu with relative abundance 62.5%
- ^{65}Cu with relative abundance 37.5%

Calculate the relative atomic mass (A_r) of copper in the sample.

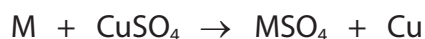
(2)

$A_r = \dots\dots\dots$

(b) Copper can be produced by reacting copper(II) sulfate solution with a metal, M.

M is not the symbol for the metal.

This is the equation for the reaction.



- (i) 100.00 g of M produces 158.75 g of copper when reacted with an excess of copper(II) sulfate solution.

Calculate the relative atomic mass (A_r) of M.

[for Cu $A_r = 63.5$]

(2)

$A_r = \dots\dots\dots$

- (ii) Use the Periodic Table to identify M.

(1)



10 This question is about zinc sulfate.

- (a) Soluble salts such as zinc sulfate can be prepared by the reaction between a metal oxide and an acid.

This is the word equation for the reaction.



- (i) State the name of this type of reaction.

(1)

- (ii) State, in terms of protons, what happens in this reaction.

(1)

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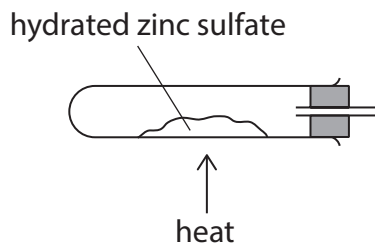


Describe a method the student should use to prepare dry crystals of hydrated zinc sulfate.

(6)

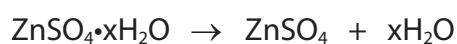


(c) The student uses this apparatus to find the value of x in the formula $\text{ZnSO}_4 \cdot x\text{H}_2\text{O}$



When heated, the hydrated solid decomposes completely.

This is the equation for the reaction.



The table shows the student's results.

mass of empty tube in g	24.82
mass of tube + $\text{ZnSO}_4 \cdot x\text{H}_2\text{O}$ in g	39.17
mass of tube + ZnSO_4 in g	32.87

Show that the value of x is 7.

[for ZnSO_4 $M_r = 161$]

[for H_2O $M_r = 18$]

(3)



- (d) Zinc sulfate solution reacts with ammonium hydroxide solution to form the insoluble solid, zinc hydroxide.

This is the equation for the reaction.



- (i) A student reacts a solution containing 0.250 mol of ammonium hydroxide with an excess of zinc sulfate.

The reaction produces 11.3 g of zinc hydroxide.

Calculate the percentage yield of zinc hydroxide in this reaction.

[for $\text{Zn}(\text{OH})_2$ $M_r = 99$]

(3)

percentage yield =%

- (ii) The student repeats the experiment and correctly calculates a percentage yield of 107%.

Suggest why this percentage yield is greater than 100%.

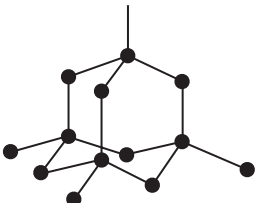
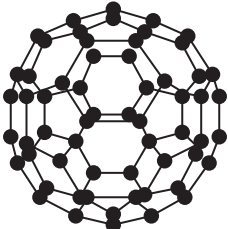
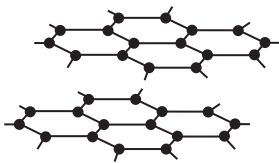
(1)

(Total for Question 10 = 15 marks)



11 This question is about carbon.

The table shows the structures of three different forms of carbon.

Diamond	C_{60} fullerene	Graphite
		

(a) Give the reason why these forms of carbon are elements.

(1)

(b) Explain, in terms of its structure, why graphite can act as a lubricant.

(2)

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(c) Explain why diamond has a much higher boiling point than C_{60} fullerene.

Refer to structure and bonding in your answer.

(5)

QUESTION 11 CONTINUES ON BACK PAGE



(d) Calculate the mass, in g, of one molecule of C_{60} fullerene.

Give your answer in standard form.

[one mole contains 6.02×10^{23} particles]

[for C $A_r = 12$]

(3)

mass = g

(Total for Question 11 = 11 marks)

TOTAL FOR PAPER = 110 MARKS

