

**Paper Reference(s) 4CH1/1CR 4SD0/1CR**  
**Pearson Edexcel International GCSE (9–1)**

**Chemistry**

**UNIT: 4CH1**

**Science (Double Award) 4SD0**

**PAPER: 1CR**

**Total Marks**

**Friday 17 May 2024 – Morning**

**Time: 2 hours**

**In the boxes below, write your name, centre number and candidate number.**

<b>Surname</b>					
<b>Other names</b>					
<b>Centre Number</b>					
<b>Candidate Number</b>					

**YOU MUST HAVE**

**Calculator, ruler**

**YOU WILL BE GIVEN**

**Periodic Table  
Diagram Booklet**

**INSTRUCTIONS**

**Answer ALL questions.**

**Answer the questions in the spaces provided in this Question Paper or in the separate Diagram Booklet – there may be more space than you need.**

**Show all the steps in any calculations and state the units.**

## **INFORMATION**

**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.**

**There may be spare copies of some diagrams.**

## **ADVICE**

**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.**

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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 This question is about atomic structure.**

**(a) Look at the table for Question 1(a) in the Diagram Booklet. It shows the number of protons, neutrons and electrons in five species, V, W, X, Y and Z.**

**The letters represent the species but are NOT symbols from the Periodic Table.**

**Choose letters from the table to answer these questions.**

**Each letter may be used once, more than once or not at all.**

**(i) Which species is an atom?  
(1 mark)**

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**(continued on the next page)**

**Turn over**

**1(a) continued.**

**(ii) Which species is an ion with a positive charge?  
(1 mark)**

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**(iii) Which species is an ion with a 3<sup>−</sup> charge?  
(1 mark)**

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**(continued on the next page)**

**1 continued.**

- (b) (i) State what is meant by the term  
ATOMIC NUMBER.  
(1 mark)**

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- (ii) State what is meant by the term  
MASS NUMBER.  
(1 mark)**

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**(Total for Question 1 = 5 marks)**

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**Turn over**

**2 This question is about methane, CH<sub>4</sub>**

**Look at the diagram for Question 2 in the Diagram Booklet. It shows a Bunsen burner that uses methane.**

- (a) During combustion, methane reacts with a gas in the air.**

**Give the name of this gas.  
(1 mark)**

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- (b) Give the two products of the complete combustion of methane.  
(2 marks)**

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**(continued on the next page)**

**Turn over**



**2 continued.**

**(c) During the incomplete combustion of methane, carbon monoxide forms.**

**(i) Give a reason why carbon monoxide forms during incomplete combustion.  
(1 mark)**

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**(ii) State why carbon monoxide is poisonous.  
(1 mark)**

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**(continued on the next page)**

**Turn over**

**2 continued.**

**(d) The equation shows the reaction of methane with bromine.**



**Give the name of this type of chemical reaction.**

**(1 mark)**

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**(Total for Question 2 = 6 marks)**

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**3 This question is about elements, mixtures and compounds.**

**(a) Look at the list of words for Question 3(a) in the Diagram Booklet. It gives some methods used to separate mixtures.**

**Choose methods from the box to answer these questions.**

**(i) Identify a method to remove sand from a mixture of sand and seawater.  
(1 mark)**

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**(continued on the next page)**

**3(a) continued.**

- (ii) Identify a method to separate a mixture of liquids with different boiling points.  
(1 mark)**

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**(continued on the next page)**

**3 continued.**

**(b) Look at the diagram for Question 3(b) in the Diagram Booklet. It shows part of the structure of silicon dioxide.**

**Explain why silicon dioxide is a compound.  
(2 marks)**

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**(continued on the next page)**

**Turn over**

**3 continued.**

**(c) The molecular formula  
of the compound insulin  
is  $\text{C}_{257}\text{H}_{383}\text{N}_{65}\text{O}_{77}\text{S}_6$**

**(i) Determine the number  
of different elements  
in  $\text{C}_{257}\text{H}_{383}\text{N}_{65}\text{O}_{77}\text{S}_6$   
(1 mark)**

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**(continued on the next page)**

**3(c) continued.**

- (ii) Determine the number of atoms in a molecule of  $\text{C}_{257}\text{H}_{383}\text{N}_{65}\text{O}_{77}\text{S}_6$  (1 mark)**

**number of atoms = \_\_\_\_\_**

**(continued on the next page)**

**3 continued.**

**(d) Magnalium is a mixture of magnesium atoms and aluminium atoms.**

**Look at the diagram for Question 3(d) in the Diagram Booklet. It shows a sample of magnalium.**

**Calculate the percentage of magnesium atoms in this sample.  
(2 marks)**

**percentage = \_\_\_\_\_ %**

**(Total for Question 3 = 8 marks)**

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**Turn over**



**4 This question is about the alkali metals.**

**A teacher demonstrates the reaction between sodium and water.**

**Look at the diagram for Question 4 in the Diagram Booklet. The teacher fills a trough with water and then adds a piece of sodium.**

**(a) The sodium reacts with the water, forming bubbles of hydrogen gas and a colourless solution.**

**State two other observations that would be made.  
(2 marks)**

**Answer space continues on the next page.**

**1** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Turn over**

**4(a) continued.**

**2** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**(continued on the next page)**

**4 continued.**

**(b) Give a test to show that, at the end of the reaction, the solution contains sodium ions.  
(2 marks)**

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**(continued on the next page)**

**Turn over**

**4 continued.**

**(c) Lithium, sodium and potassium react in a similar way when added to water.**

**(i) State, with reference to the electronic configurations of atoms, why these elements have similar reactions.  
(1 mark)**

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**(continued on the next page)**

**4(c) continued.**

**(ii) The table shows the atomic radius of a lithium atom, a sodium atom and a potassium atom.**

<b>Atom</b>	<b>Atomic radius in cm</b>
<b>lithium</b>	<b><math>1.82 \times 10^{-12}</math></b>
<b>sodium</b>	<b><math>2.27 \times 10^{-12}</math></b>
<b>potassium</b>	<b><math>2.80 \times 10^{-12}</math></b>

**Deduce the relationship between the atomic radius and the reactivity of the metals.  
(1 mark)**

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**(Total for Question 4 = 6 marks)**

**Turn over**

**5 Chromatography is used to separate the components in a mixture.**

**(a) Look at Diagram 1 for Question 5(a) in the Diagram Booklet. It shows the apparatus used to separate the different dyes in a food colouring.**

**(i) Complete the diagram by adding the missing labels.  
(3 marks)**

**(ii) Give a reason why the baseline is drawn in pencil.  
(1 mark)**

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**(continued on the next page)**

**5 continued.**

**(b) Look at Diagram 2 for Question 5(b) in the Diagram Booklet. It shows a chromatogram produced from four different food colourings, W, X, Y and Z.**

**(i) Which two food colourings contain the same dye?  
(1 mark)**

☐ **A W and X**

☐ **B W and Y**

☐ **C X and Z**

☐ **D Y and Z**

**(continued on the next page)**

**Turn over**

**5(b) continued.**

- (ii) Calculate the  $R_f$  value of the dye in food colouring W.  
(2 marks)**

**$R_f =$  \_\_\_\_\_**

**(Total for Question 5 = 7 marks)**

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**Turn over**



**6 Look at the diagram for Question 6(a) in the Diagram Booklet. A student uses the apparatus to find the heat energy released by the combustion of liquid fuels.**

**(a) Explain what is meant by the term FUEL.  
(2 marks)**

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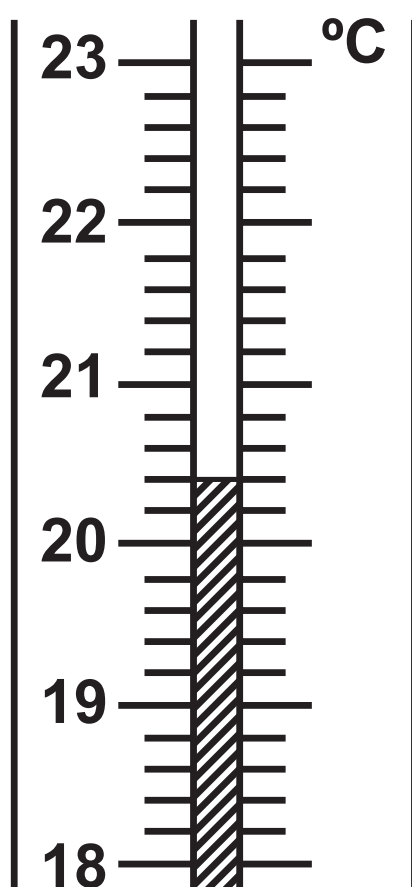
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**(continued on the next page)**

**6 continued.**

- (b) (i) In one experiment, the student uses liquid ethanol as the fuel.**

**The thermometer shows the temperature of the water at the start of the experiment.**



**Look at the table for Question 6(b)(i) in the Diagram Booklet. Complete the table by giving the temperatures to the nearest 0.1  $^{\circ}\text{C}$ .  
(2 marks)**

**(continued on the next page)**

**Turn over**

**6(b) continued.**

**(ii) The metal can contains water of mass 150 g.**

**Show, by calculation, that the heat energy change ( $Q$ ) for this reaction is approximately 36 000 J.  
(2 marks)**

**[for water,  $c = 4.2 \text{ J/g/}^\circ\text{C}$ ]**

**$Q =$  \_\_\_\_\_ J**

**(continued on the next page)**

**Turn over**

**6(b) continued.**

**(iii) In the experiment, 2.3 g of ethanol ( $M_r = 46$ ) is burned.**

**Calculate the molar enthalpy change ( $\Delta H$ ), in  $\text{kJ/mol}$ , for the combustion of ethanol,  $\text{C}_2\text{H}_5\text{OH}$**

**Include a sign in your answer.**

**Give your answer to two significant figures.  
(4 marks)**

**Answer space continues on the next page.**

**6(b)(iii) continued.**

**$\Delta H =$  \_\_\_\_\_ **kJ/mol****

**(continued on the next page)**

**6 continued.**

**(c) In this experiment, the calculated value of  $\Delta H$  is less than the value given in a data book.**

**Give a possible reason for the difference in values.  
(1 mark)**

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**(Total for Question 6 = 11 marks)**

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- 7 Look at the diagram for Question 7 in the Diagram Booklet. A student uses the apparatus to investigate the rate of reaction between dilute sulfuric acid and an excess of small pieces of zinc.**

**This is the student's method.**

**Step 1 use 50 cm<sup>3</sup> of dilute sulfuric acid**

**Step 2 add approximately 5g of small zinc pieces to the sulfuric acid**

**Step 3 quickly connect the gas syringe**

**Step 4 record the reading on the gas syringe every 30 seconds until the reaction stops**

**(continued on the next page)**

**7 continued.**

- (a) (i) Name a suitable piece of apparatus to measure the volume of sulfuric acid.  
(1 mark)**

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- (ii) Give a reason why the mass of zinc pieces does not need to be measured accurately.  
(1 mark)**

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**(continued on the next page)**

**Turn over**



**7(a) continued.**

- (iii) Give a reason why the student quickly connects the gas syringe in step 3.  
(1 mark)**

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- (iv) State how the student would know when the reaction stops.  
(1 mark)**

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**(continued on the next page)**

**7 continued.**

**(b) Look at the graph for Question 7(b) in the Diagram Booklet. It shows the volume of gas collected in the syringe during the experiment.**

**(i) A tangent to the curve has been drawn at a time of 80 s.**

**Use the tangent to calculate the rate of reaction at 80 s.**

**Show your working on the graph.**

**Give the unit.  
(3 marks)**

**rate of reaction = \_\_\_\_\_**

**unit \_\_\_\_\_**

**(continued on the next page)**

**Turn over**

**7(b) continued.**

- (ii) Explain the shape of the graph in these regions.  
(6 marks)**

**Answer space continues on the next 2 pages.**

**from 0 s to 60 s**

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**Turn over**

**7(b)(ii) continued.**

**from 60 s to 150 s**

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**7(b)(ii) continued.**

**from 150 s to 240 s**

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**(Total for Question 7 = 13 marks)**

**8 This question is about crude oil.**

**(a) Describe how crude oil is separated into fractions by fractional distillation.  
(4 marks)**

**Answer space continues on the next page.**

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**Turn over**

**8(a) continued.**

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**(continued on the next page)**

**8 continued.**

**(b) Some of the products of fractional distillation are then cracked.**

**This equation represents a reaction that occurs during cracking.**



**Explain why cracking is an important process in the oil industry.  
(4 marks)**

**Answer space continues on the next page.**

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**Turn over**



**8(b) continued.**

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**(continued on the next page)**

**Turn over**

**8 continued.**

**(c) Fuels obtained from crude oil may contain impurities.**

**Explain how an impurity found in fuels can cause an environmental problem.  
(3 marks)**

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**(Total for Question 8 = 11 marks)**

**Turn over**

- 9 (a) Look at the table for Question 9(a) in the Diagram Booklet. It shows the formulae of some positive and negative ions, and the formulae of some compounds containing these ions.
- (i) Complete the table by giving the formulae of the missing compounds.  
(3 marks)
- (ii) Give the name of the compound with the formula  $\text{ZnSO}_4$   
(1 mark)
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(continued on the next page)

**9 continued.**

**(b) Hydrogen chloride and magnesium chloride have different types of bonding and have different structures.**

**(i) Look at the diagram for Question 9(b)(i) in the Diagram Booklet. Complete the dot-and-cross diagram to show the outer shell electrons in a molecule of hydrogen chloride. (2 marks)**

**(continued on the next page)**

**9(b) continued.**

- (ii) Look at the diagrams for Question 9(b)(ii) in the Diagram Booklet. They show the electronic configuration of a magnesium atom and of a chlorine atom.**

**Draw the electronic configuration of a magnesium ion on page 18 of the Diagram Booklet.**

**Draw the electronic configuration of a chlorine ion on page 19 of the Diagram Booklet.**

**Show the charge on each ion.  
(3 marks)**

**(continued on the next page)**

**9(b) continued.**

- (iii) Explain why magnesium chloride has a much higher melting point than hydrogen chloride.**

**Refer to structure and bonding in your answer.  
(5 marks)**

**Answer space continues on the next 2 pages.**

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**Turn over**

**9(b)(iii) continued.**

[illegible]

**Turn over**

**9(b)(iii) continued.**

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**(Total for Question 9 = 14 marks)**

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- 10 This is the equation for the decomposition of hydrogen peroxide.



The rate of reaction increases when a catalyst of manganese(IV) oxide is added.

- (a) Describe how a catalyst increases the rate of a reaction.  
(2 marks)

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(continued on the next page)

**10 continued.**

- (b) A student adds  $50\text{ cm}^3$  of hydrogen peroxide solution to a glass container and then adds  $1.0\text{ g}$  of manganese(IV) oxide.**

**Look at the diagram for Question 10(b) in the Diagram Booklet. It shows the apparatus the student uses.**

- (i) Name the glass container the student uses.  
(1 mark)**

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**(continued on the next page)**

**10(b) continued.**

- (ii) The student waits until the hydrogen peroxide solution completely decomposes.**

**Describe how the student could then show that the manganese(IV) oxide was a catalyst and not a reactant.  
(3 marks)**

**Answer space continues on the next page.**

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**Turn over**

**10(b)(ii) continued.**

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**(Total for Question 10 = 6 marks)**

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**11 Diamond and graphite are both forms of the element carbon.**

**Diamond and graphite both have covalent bonds and giant covalent structures.**

**Look at the diagram for Question 11 in the Diagram Booklet. It represents the structure of diamond and the structure of graphite.**

**(a) Give a reason why diamond is an element.  
(1 mark)**

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**(continued on the next page)**

**11 continued.**

**(b) Describe the forces of attraction in a covalent bond.  
(2 marks)**

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**(continued on the next page)**

**11 continued.**

**(c) (i) Explain why graphite  
conducts electricity.  
(2 marks)**

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**(continued on the next page)**

**11(c) continued.**

- (ii) Explain why diamond is hard but graphite is soft.  
(4 marks)**

**Answer space continues on the next page.**

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**Turn over**



**11(c)(ii) continued.**

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**(continued on the next page)**

11 continued.

(d) Another form of carbon has molecules with the formula  $C_x$

$x$  represents the number of carbon atoms in each molecule.

Each molecule of  $C_x$  has a mass of  $1.40 \times 10^{-21}$  g.

One mole of  $C_x$  contains  $6.02 \times 10^{23}$  molecules.

Calculate the  $M_r$  of  $C_x$  and the value of  $x$   
(3 marks)

[for carbon,  $A_r = 12$ ]

Answer space continues on the next page.

Turn over

11(d) continued.

$M_r =$  \_\_\_\_\_

$X =$  \_\_\_\_\_

(Total for Question 11 = 12 marks)

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Turn over

**12 This question is about the metal tantalum, Ta.**

**Tantalum metal can be produced by heating tantalum chloride ( $\text{TaCl}_5$ ) and hydrogen gas in a furnace.**

**The other product of the reaction is hydrogen chloride.**

**(a) Look at the equation for Question 12(a) in the Diagram Booklet. Complete the equation for the reaction.  
(1 mark)**

**(continued on the next page)**

**12 continued.**

- (b) As tantalum chloride is heated, the mass of solid in the furnace decreases leaving tantalum as the only solid product.**

**Look at the table for Question 12(b) in the Diagram Booklet. It shows the mass of solid in the furnace at one-hour intervals.**

- (i) State how the data in the table shows that the reaction is complete.  
(1 mark)**

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**(continued on the next page)**

**12(b) continued.**

**(ii) Use the data to show that the  
formula of tantalum chloride  
is  $\text{TaCl}_5$   
(3 marks)**

**[for tantalum,  $A_r = 181$   
for chlorine,  $A_r = 35.5$ ]**

**Answer space continues on the next 2 pages.**

**12(b)(ii) continued.**

**[for tantalum,  $A_r = 181$**

**for chlorine,  $A_r = 35.5$ ]**

**12(b)(ii) continued.**

**[for tantalum,  $A_r = 181$   
for chlorine,  $A_r = 35.5$ ]**



**12 continued.**

**(c) Another method of extracting tantalum is by reacting tantalum(V) oxide with carbon.**

**This is the equation for the reaction.**



**(i) Explain why this is a redox reaction.  
(2 marks)**

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**(continued on the next page)**

**Turn over**

**12(c) continued.**

**(ii) 2000 mol of tantalum(V) oxide is heated with 500 000 g of carbon.**

**Show by calculation that the carbon is in excess.**

**(2 marks)**

**[for carbon,  $A_r = 12$ ]**

**(continued on the next page)**

**Turn over**

**12(c) continued.**

- (iii) Calculate the maximum mass, in grams, of tantalum that can be obtained from 2000 mol of tantalum(V) oxide.  
(2 marks)**

**[for tantalum,  $A_r = 181$ ]**

**Answer space continues on the next page.**

**12(c)(iii) continued.**

**[for tantalum,  $A_r = 181$ ]**

**mass = \_\_\_\_\_ g**

**(Total for Question 12 = 11 marks)**

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**TOTAL FOR PAPER = 110 MARKS**  
**END OF PAPER**