

Please check the examination details below before entering your candidate information

Candidate surname

Other names

Centre Number

Candidate Number

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## Pearson Edexcel International GCSE (9–1)

**Tuesday 13 June 2023**

Morning (Time: 1 hour 15 minutes)

Paper  
reference

**4CH1/2C**

### Chemistry

**UNIT: 4CH1**

**PAPER: 2C**

**You must have:**

Calculator

Total Marks

### Instructions

- 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.

### Information

- The total mark for this paper is 70.
- The marks for **each** question are shown in brackets  
– *use this as a guide as to how much time to spend on each question.*

### 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.

Turn over ►

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# The Periodic Table of the Elements

1												3		4	5	6	7	0	
		<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <b>Key</b>                      relative atomic mass                      atomic symbol                      name                      atomic (proton) number                 </div>										<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     1  <b>H</b>                      hydrogen                      1                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     4  <b>He</b>                      helium                      2                 </div>						
<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     7  <b>Li</b>                      lithium                      3                 </div>		<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     9  <b>Be</b>                      beryllium                      4                 </div>												<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     11  <b>B</b>                      boron                      5                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     12  <b>C</b>                      carbon                      6                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     14  <b>N</b>                      nitrogen                      7                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     16  <b>O</b>                      oxygen                      8                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     19  <b>F</b>                      fluorine                      9                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     20  <b>Ne</b>                      neon                      10                 </div>
<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     23  <b>Na</b>                      sodium                      11                 </div>		<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     24  <b>Mg</b>                      magnesium                      12                 </div>												<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     27  <b>Al</b>                      aluminium                      13                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     28  <b>Si</b>                      silicon                      14                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     31  <b>P</b>                      phosphorus                      15                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     32  <b>S</b>                      sulfur                      16                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     35.5  <b>Cl</b>                      chlorine                      17                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     40  <b>Ar</b>                      argon                      18                 </div>
<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     39  <b>K</b>                      potassium                      19                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     40  <b>Ca</b>                      calcium                      20                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     45  <b>Sc</b>                      scandium                      21                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     48  <b>Ti</b>                      titanium                      22                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     51  <b>V</b>                      vanadium                      23                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     52  <b>Cr</b>                      chromium                      24                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     55  <b>Mn</b>                      manganese                      25                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     56  <b>Fe</b>                      iron                      26                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     59  <b>Co</b>                      cobalt                      27                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     59  <b>Ni</b>                      nickel                      28                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     63.5  <b>Cu</b>                      copper                      29                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     65  <b>Zn</b>                      zinc                      30                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     70  <b>Ga</b>                      gallium                      31                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     73  <b>Ge</b>                      germanium                      32                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     75  <b>As</b>                      arsenic                      33                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     79  <b>Se</b>                      selenium                      34                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     80  <b>Br</b>                      bromine                      35                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     84  <b>Kr</b>                      krypton                      36                 </div>		
<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     85  <b>Rb</b>                      rubidium                      37                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     88  <b>Sr</b>                      strontium                      38                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     89  <b>Y</b>                      yttrium                      39                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     91  <b>Zr</b>                      zirconium                      40                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     93  <b>Nb</b>                      niobium                      41                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     96  <b>Mo</b>                      molybdenum                      42                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     [98]  <b>Tc</b>                      technetium                      43                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     101  <b>Ru</b>                      ruthenium                      44                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     103  <b>Rh</b>                      rhodium                      45                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     106  <b>Pd</b>                      palladium                      46                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     108  <b>Ag</b>                      silver                      47                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     112  <b>Cd</b>                      cadmium                      48                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     115  <b>In</b>                      indium                      49                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     119  <b>Sn</b>                      tin                      50                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     122  <b>Sb</b>                      antimony                      51                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     128  <b>Te</b>                      tellurium                      52                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     127  <b>I</b>                      iodine                      53                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     131  <b>Xe</b>                      xenon                      54                 </div>		
<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     133  <b>Cs</b>                      caesium                      55                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     137  <b>Ba</b>                      barium                      56                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     139  <b>La*</b>                      lanthanum                      57                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     178  <b>Hf</b>                      hafnium                      72                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     181  <b>Ta</b>                      tantalum                      73                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     184  <b>W</b>                      tungsten                      74                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     186  <b>Re</b>                      rhenium                      75                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     190  <b>Os</b>                      osmium                      76                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     192  <b>Ir</b>                      iridium                      77                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     195  <b>Pt</b>                      platinum                      78                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     197  <b>Au</b>                      gold                      79                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     201  <b>Hg</b>                      mercury                      80                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     204  <b>Tl</b>                      thallium                      81                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     207  <b>Pb</b>                      lead                      82                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     209  <b>Bi</b>                      bismuth                      83                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     [209]  <b>Po</b>                      polonium                      84                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     [210]  <b>At</b>                      astatine                      85                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     [222]  <b>Rn</b>                      radon                      86                 </div>		
<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     [223]  <b>Fr</b>                      francium                      87                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     [226]  <b>Ra</b>                      radium                      88                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     [227]  <b>Ac*</b>                      actinium                      89                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     [261]  <b>Rf</b>                      rutherfordium                      104                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     [262]  <b>Db</b>                      dubnium                      105                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     [266]  <b>Sg</b>                      seaborgium                      106                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     [264]  <b>Bh</b>                      bohrium                      107                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     [277]  <b>Hs</b>                      hassium                      108                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     [268]  <b>Mt</b>                      meitnerium                      109                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     [271]  <b>Ds</b>                      darmstadtium                      110                 </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">                     [272]  <b>Rg</b>                      roentgenium                      111                 </div>	Elements with atomic numbers 112-116 have been reported but not fully authenticated								

\* The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.

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

**Answer ALL questions.**

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

- 1** Use the Periodic Table to help you answer this question.
- (a) (i) Name the element with atomic number 14. (1)
- (ii) Name the element in Group 2 and Period 3. (1)
- (iii) Name an element that is a liquid at room temperature. (1)
- (iv) Give the electronic configuration of an atom of phosphorus. (1)
- (v) Give the formula of sodium sulfide. (1)
- (b) Explain, in terms of electron configuration, why neon is unreactive. (2)

**(Total for Question 1 = 7 marks)**



2 This question is about gases in the atmosphere.

(a) Which of these gases has the lowest percentage by volume in the atmosphere? (1)

- A argon
- B carbon dioxide
- C nitrogen
- D oxygen

(b) When copper(II) carbonate is heated, copper(II) oxide and carbon dioxide form.

(i) What is the name of this type of reaction? (1)

- A addition
- B decomposition
- C oxidation
- D substitution

(ii) Which colour change occurs when copper(II) carbonate is heated? (1)

- A blue to black
- B blue to orange
- C green to black
- D green to orange

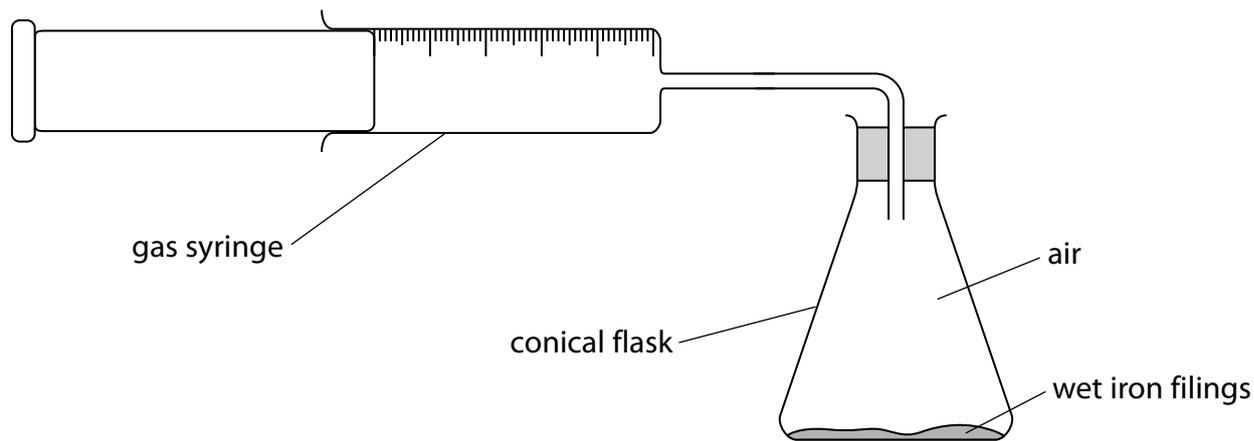
(iii) Give the chemical equation for this reaction. (1)

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(c) A student uses this apparatus to find the percentage of oxygen in a sample of air.



The student leaves the apparatus until there is no further change in volume of gas in the syringe.

These are the student's results.

volume of gas in flask and connecting tube in $\text{cm}^3$	280
volume of gas in syringe at start in $\text{cm}^3$	100
volume of gas in syringe at end in $\text{cm}^3$	27

Calculate the percentage of oxygen in the sample of air.

Give your answer to two significant figures.

(4)

percentage of oxygen = \_\_\_\_\_ %



(d) Explain why an increasing amount of carbon dioxide in the atmosphere is likely to cause a problem for the environment.

(2)

**(Total for Question 2 = 10 marks)**

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3 This question is about alcohols.

Ethanol can be manufactured using two different methods.

- hydration of ethene
- fermentation of glucose

This is the equation for hydration.



(a) Complete the equation for fermentation.

(2)



(b) The table gives some information about the two methods.

	Hydration	Fermentation
Reagents	ethene and steam	aqueous glucose
Catalyst		enzymes in yeast
Temperature in °C	300	
Pressure in atmospheres		1
Rate of process	fast	slow
Purity of product	pure	impure

(i) Complete the table by giving the missing information.

(3)



(ii) Explain one advantage and one disadvantage of using fermentation rather than hydration to produce ethanol.

You should use information from the table to help your answer.

(4)

advantage

disadvantage

(c) Explain why fermentation needs to occur in the absence of air.

(2)

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(d) Propanol has this percentage composition by mass.

$$\text{C} = 60.0\% \quad \text{H} = 13.3\% \quad \text{O} = 26.7\%$$

(i) Show by calculation that the empirical formula of propanol is  $\text{C}_3\text{H}_8\text{O}$ .

(3)

(ii) Draw the displayed formula of propanol.

(1)

**(Total for Question 3 = 15 marks)**

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4 A student does a titration to find the concentration of potassium hydroxide solution.

This is the student's method.

- add  $25.0\text{ cm}^3$  of the potassium hydroxide solution to a conical flask
- add a few drops of methyl orange indicator to the conical flask
- fill a burette with dilute sulfuric acid and record the initial burette reading
- place the conical flask on a white tile
- add the acid from the burette to the mixture in the conical flask, swirling the flask continuously
- when the indicator changes colour at the end point, record the final burette reading

Repeat the titration to obtain concordant results.

(a) Give the name of the most suitable piece of apparatus to measure out  $25.0\text{ cm}^3$  of potassium hydroxide solution.

(1)

(b) Give the colour of methyl orange in potassium hydroxide solution and in dilute sulfuric acid.

(2)

colour in potassium hydroxide solution

colour in dilute sulfuric acid

(c) State why the student places the conical flask on a white tile.

(1)

(d) State why the student swirls the flask continuously.

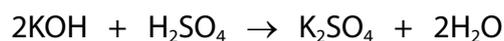
(1)

(e) State what is meant by the term **concordant results**.

(1)

(f) The student finds that 15.00 cm<sup>3</sup> of sulfuric acid of concentration 0.180 mol/dm<sup>3</sup> neutralises 25.0 cm<sup>3</sup> of potassium hydroxide solution.

This is the equation for the reaction.

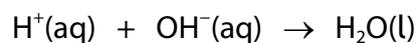


Calculate the concentration of the potassium hydroxide solution.

(3)

concentration = mol/dm<sup>3</sup>

(g) This is the ionic equation for the reaction between an acid and an alkali.



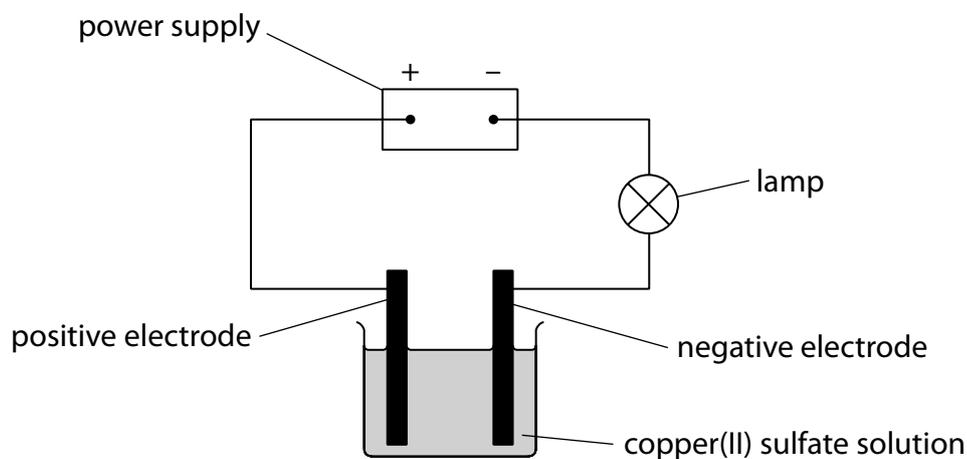
Explain why the OH<sup>-</sup> ion is a proton acceptor in this reaction.

(2)

**(Total for Question 4 = 11 marks)**

- 5 When copper(II) sulfate solution is electrolysed, copper forms at the negative electrode.

A student uses this apparatus to investigate the electrolysis of copper(II) sulfate solution.



- (a) Describe how the student could test a sample of copper(II) sulfate solution to show that it contains copper(II) ions.

(2)

- (b) Describe how copper metal forms at the negative electrode.

(3)

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(c) State the appearance of the copper that forms on the negative electrode. (1)

(d) Oxygen forms at the positive electrode.

(i) Give a test for oxygen. (1)

(ii) Complete the half-equation for the formation of oxygen at the positive electrode. (2)



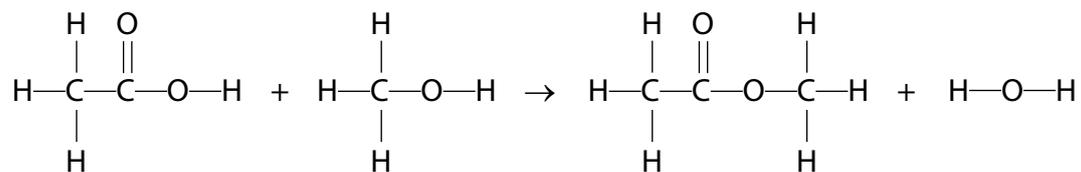
(iii) State why the formation of oxygen at the positive electrode is an oxidation reaction. (1)

**(Total for Question 5 = 10 marks)**



6 Ethanoic acid reacts with methanol to form an ester.

The equation shows the displayed formulae for the reactants and products.



(a) (i) Give the name of a suitable catalyst to increase the rate of this reaction. (1)

(ii) State how you would know that an ester has formed. (1)

(iii) Give the name of this ester. (1)

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(b) The table shows the number of bonds in the reactants and the number of bonds in the products.

Bond	C—H	C—C	C—O	C=O	O—H
Number of bonds in reactants	6	1	2	1	2
Number of bonds in products	6	1	2	1	2

(i) State which two bonds need to be broken in the reactants. (1)

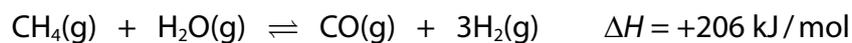
(ii) Explain why the enthalpy change in this reaction is approximately 0 kJ/mol. (2)

(Total for Question 6 = 6 marks)



7 Methane reacts with steam to form carbon monoxide and hydrogen.

This is the equation for the reaction.



(a) State why carbon monoxide is poisonous to humans.

(1)

(b) Explain the effect, if any, on the yield of hydrogen at equilibrium when a nickel catalyst is used.

(2)

(c) The reaction conditions for this reaction are a temperature of 700 °C and a pressure of 5 atmospheres.

(i) The temperature of the reaction mixture is reduced to 600 °C, but the pressure is kept at 5 atmospheres.

Explain the effect on the yield of hydrogen at equilibrium.

(2)

- (ii) The pressure of the reaction mixture is reduced to 4 atmospheres, but the temperature is kept at 700°C.

Explain the effect on the yield of hydrogen at equilibrium.

(2)

- (d) Calculate the volume, in  $\text{dm}^3$ , of methane gas at rtp needed to produce 6.6 tonnes of hydrogen gas.

[at rtp, molar volume =  $24 \text{ dm}^3$       1 tonne =  $10^6 \text{ g}$ ]

Give your answer in standard form.

(4)

volume of methane =  $\text{dm}^3$

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**(Total for Question 7 = 11 marks)**

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**TOTAL FOR PAPER = 70 MARKS**

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