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Thursday 16 May 2019 – Morning

GCSE (9–1) Combined Science B (Twenty First Century Science)

J260/02 Chemistry (Foundation Tier)

Time allowed: 1 hour 45 minutes

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You must have:
- the Data Sheet (for GCSE Chemistry B (Inserted))
- a ruler (cm/mm)

You may use:
- a scientific or graphical calculator
- an HB pencil

J260002

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- The Data Sheet will be found inside this document.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Answer **all** the questions.
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.

INFORMATION
- The total mark for this paper is **95**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in the question marked with an asterisk (*****).
- This document consists of **24** pages.

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Answer **all** the questions.

1 Lithium metal is a group 1 element. Lithium atoms have the electron arrangement 2.1.

(a) Which of the following statements about the atoms of **all** group 1 elements are **true** and which are **false**?

Tick (✓) **one** box in each row.

Statement	True	False
They all have 2 electrons in their first shell.		
They all have 1 electron in their outer shell.		
They all have the same number of electrons.		
They all have the same number of electron shells.		

[2]

(b) The elements on the left of the periodic table are all metals.

Which two statements about atoms of these elements are **true**?

Tick (✓) **two** boxes.

They have a small number of electrons in their outer shell. ☐

They do not contain electrons. ☐

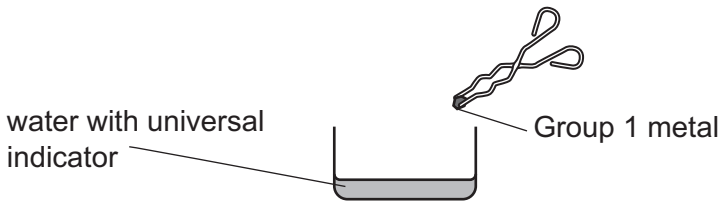
They lose electrons easily. ☐

They form covalent bonds by gaining electrons. ☐

[2]

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(c) Beth is a chemistry teacher. She does experiments to show the reactivity of the Group 1 metals with water.



She places a small piece of lithium into the water with universal indicator and records her observations. She repeats this method with sodium and then potassium.

Beth's observations are shown in the table.

Metal	Observations
Lithium	Fizzes slowly. Indicator turns blue.
Sodium	Fizzes quickly. Sodium melts and moves quickly on surface of water. Indicator turns blue.
Potassium	Fizzes quickly. Potassium melts and purple flame formed. Indicator turns blue.

(i) How do the observations show the trend in reactivity going down Group 1 of the Periodic Table?

.....

.....

..... **[2]**

(ii) All the metals fizz when added to water and the universal indicator turns blue.

Draw lines to connect each observation with the product that causes it.

Observation	Product
Fizzing	Hydrogen gas released
	Oxygen gas released
	Presence of water
Indicator turns blue	
	Presence of hydroxide ions

[2]

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2 Many countries with sunny climates get most of their salt from seawater.

The seawater is trapped in shallow pools and left in the sun. After some time, piles of solid salt form.

(a) Complete the sentences to explain how solid salt forms.

Put a (ring) around each correct choice to complete the sentences.

The **heat** / **light** from the sun **decreases** / **increases** the temperature in the shallow pools.

This causes the **water** / **salt** to **evaporate** / **dissolve**.

[3]

(b) The piles of solid salt contain a mixture of salt and sand.

Sand is insoluble in water.

Jack plans an experiment to find the percentage of pure salt in the mixture. These are the steps he plans. They are **not** in the correct order.

A Add water to the mixture and stir.

B Collect a sample of the mixture.

C Filter and collect the solution.

D Heat the solution until all water has gone.

E Weigh the pure salt.

F Weigh the mixture.

(i) Put the steps in the correct order.

B					

[3]

(ii) Jack finds that his method makes very small crystals.

How could he change step **D** so that he makes larger crystals?

.....

.....

..... **[2]**

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(iii) Jack used 10.0 g of the mixture for his sample.

He used a dish to weigh the pure salt he made.

Mass of empty dish = 50.0 g

Mass of dish with pure salt = 58.4 g

Calculate the **mass of pure salt** he made.

Mass of pure salt = ... g **[1]**

(iv) The percentage of pure salt in the mixture can be calculated using the formula:

$$\text{Percentage} = \frac{\text{mass of pure salt}}{\text{mass of mixture}} \times 100$$

Calculate the **percentage** of pure salt in the sample.

Percentage = ... % **[2]**

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3 Tennis rackets used to be made of wood, but wood was not strong enough to make bigger rackets and so designers considered using other materials.

The table shows the properties of some materials they considered.

Material	**Stiffness (GPa)**	**Density (g/cm^3)**	**Strength (MPa)**
Steel (iron alloy)	210	7.8	400
Aluminium alloy	71	2.7	300
Graphite	90	2.0	500
PVC	4	1.0–2.0	50

(a) Which **two** materials in the table contain mainly metals?

..... and .....

[1]

(b) Graphite tennis rackets are made from a polymer combined with graphite fibres.

What is the name for a type of material that is made from two or more substances combined together?

Put a (ring) around the correct answer.

ceramic **composite** **metal** **plastic**

[1]

(c) A sample of PVC has a mass of 12.0 g and a volume of 8.0 cm^3.

Calculate the density of PVC.

Density = ... g/cm^3 **[2]**

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(d)* A company decides to make a new tennis racket. They want the new racket to be stiff, light and strong.

The company considers using **steel**, **aluminium alloy** or **graphite** for the new racket.

Decide which of these three materials is the best choice for the racket by discussing their advantages and disadvantages.

Use data from the table to support your answer.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[6]**

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4 Mia adds magnesium to dilute hydrochloric acid.

(a) Complete the word and balanced symbol equations for the reaction between magnesium and hydrochloric acid.

magnesium + hydrochloric acid → ..... + hydrogen

..... + ... HCl → $MgCl_2$ + ...

[3]

(b) Mia measures the volume of hydrogen gas every 30 seconds.

Which piece of apparatus could she use to measure the volume of hydrogen collected?

Put a (ring) around the correct answer.

balance **beaker** **gas syringe** **pipette** **thermometer**

[1]

(c) She plots her results on a graph.

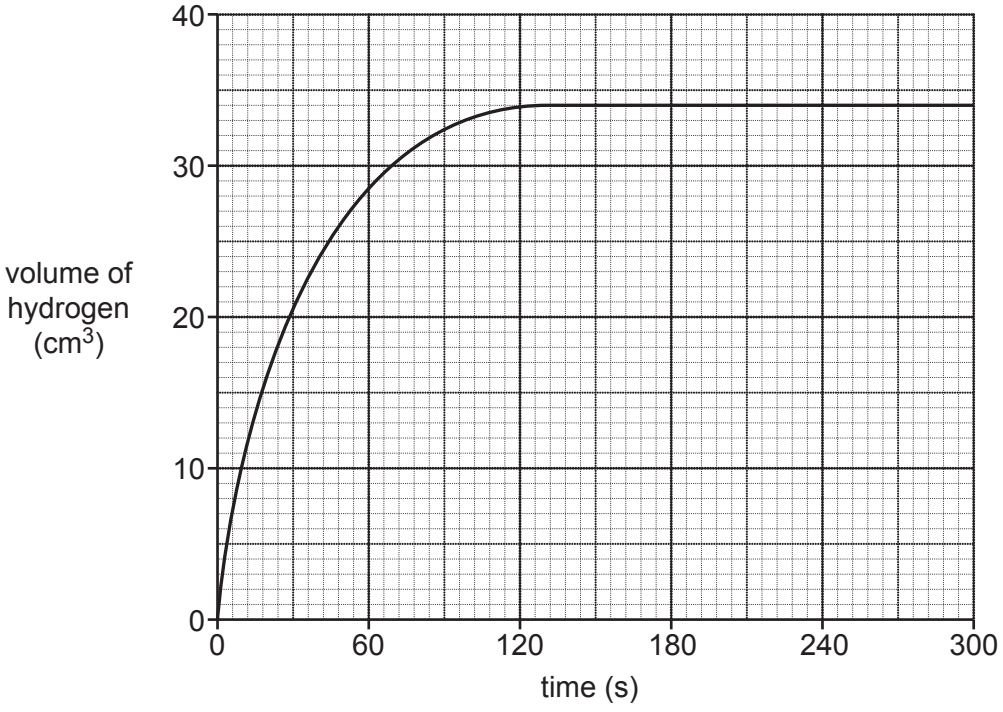


Fig. 4.1

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(i) Which statement is the best description of what is happening during the first 12 s of the reaction in **Fig. 4.1**?

Tick (✓) **one** box.

No reaction is happening. ☐

The reaction is at its fastest. ☐

The reaction is speeding up. ☐

The reaction is at a constant rate. ☐

[1]

(ii) Which statement is the best description of what is happening after 300 seconds in **Fig. 4.1**?

Tick (✓) **one** box.

The reaction has stopped. ☐

The reaction is at its fastest. ☐

The reaction is getting faster. ☐

The reaction is at a constant rate. ☐

[1]

(iii) Using **Fig. 4.1** how long did it take to collect 20 cm^3 of hydrogen?

Time = ... s **[1]**

(iv) Using **Fig. 4.1**, what is the total volume of hydrogen collected in this experiment?

Total volume = ... cm^3 **[1]**

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5 Zinc is made by heating zinc oxide with carbon.

zinc oxide + carbon $\longrightarrow$ zinc + carbon dioxide

$2ZnO(s) + C(s) \longrightarrow 2Zn(g) + CO_2(g)$

(a) (i) The zinc oxide is reduced by the carbon to make zinc.

What does **reduced** mean in this situation?

Tick (✓) **one** box.

The mass of zinc oxide increases. ☐

The zinc oxide reacts with air. ☐

Zinc oxide loses energy. ☐

Zinc oxide loses oxygen. ☐

[1]

(ii) Zinc can be made by heating zinc oxide with carbon.

Aluminium **cannot** be made by heating aluminium oxide with carbon.

Which two statements explain why?

Tick (✓) **two** boxes.

Aluminium is less reactive than zinc. ☐

Aluminium is more reactive than carbon. ☐

Aluminium oxide is very rare. ☐

Zinc is less reactive than carbon. ☐

Zinc oxide melts when it is heated. ☐

[2]

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(b) Aluminium is made by passing electricity through molten aluminium oxide.

(i) What state is molten aluminium oxide in?

Put a (ring) around the correct answer.

gas **liquid** **solvent** **solution**

[1]

Fig. 5.1 shows the ions in molten aluminium oxide.

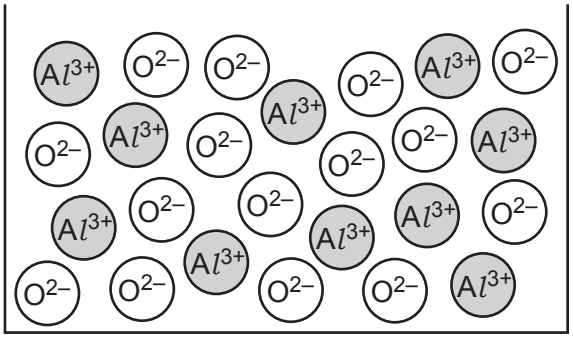


Fig. 5.1

(ii) Molten aluminium oxide conducts electricity. Solid aluminium oxide does not.

Explain why, using **Fig. 5.1** to help you.

.....

..... **[2]**

(iii) A positive and negative electrode are used to pass electricity through molten aluminium oxide. A product is made at each electrode.

Draw lines to join each **electrode** with the correct **product** formed.

Use **Fig. 5.1** to help you.

Electrode	**Product made**
	Aluminium
	Aluminium oxide
Negative	
	Water
	Hydrogen
Positive	
	Oxygen

[2]

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6 Atoms contain a nucleus surrounded by electrons.

(a) The nucleus contains protons and neutrons.

Which statements about the nucleus are **true** and which are **false**?

Tick (✓) **one** box in each row.

Statement	True	False
Most of the mass of the atom is in the nucleus.		
Neutrons have a positive charge.		
The nucleus has an overall positive charge.		
The nucleus takes up most of the space of the atom.		

[3]

(b) An atom of strontium has an atomic number of 38 and a mass number of 88.

How many protons, electrons, and neutrons are in an atom of strontium?

Protons = ...

Electrons = ...

Neutrons = ...

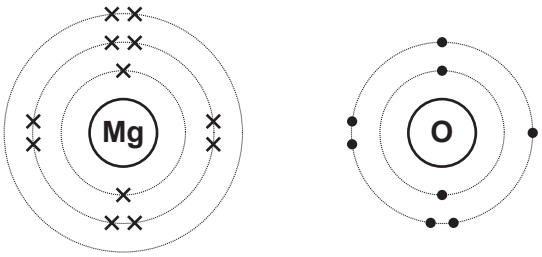
[2]

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(c) Magnesium atoms react with oxygen atoms to form magnesium oxide.

Magnesium oxide contains magnesium ions and oxygen ions.

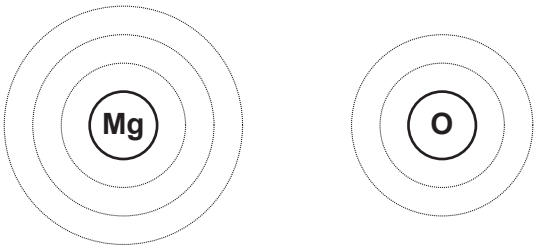
Fig. 6.1 shows the number and arrangement of electrons in a magnesium atom and an oxygen atom.



magnesium atom **oxygen atom**

Fig. 6.1

(i) Complete **Fig. 6.2** to show the number and arrangement of electrons in a magnesium **ion** and an oxygen **ion**.



magnesium ion **oxygen ion**

Fig. 6.2 **[2]**

(ii) What are the charges on each ion?

Choose from this list.

+1 –1 +2 –2 +3 –3

Charge on magnesium ion = ...

Charge on oxygen ion = ...

[2]

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7 Some metals react with bromine to form metal bromides.

(a) The table shows information about some metal bromides.

Complete the table by filling in the blank spaces.

Name of bromide	Metal ion	Bromide ion	Formula of metal bromide	Relative formula mass
Potassium bromide	K^+	Br^-	KBr	119.0
Rubidium bromide	Rb^+	Br^-	RbBr	.....
Calcium bromide	Ca^{2+}	Br^-	.....	199.9
Strontium bromide	Sr^{2+}	Br^-	$SrBr_2$	.....

[3]

(b) Metal bromides have high melting points.

Which statements about metal bromides are **true** and which are **false**?

Tick (✓) **one** box in each row.

Statement	True	False
Bonds between metal ions and bromide ions are strong.		
Metal bromides have covalent bonds.		
When metal bromides melt they lose electrons.		
It takes a lot of energy to separate the ions.		

[2]

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8 Hydrogen peroxide (H_2O_2) is made in the body.

An enzyme breaks down hydrogen peroxide into oxygen gas and water before it can damage cells in the body.

(a) Ali adds this enzyme to some hydrogen peroxide.

He measures the volume of oxygen gas made.

(i) The hydrogen peroxide does not break down to make oxygen gas until Ali adds the enzyme.

Which statement explains why?

Tick (✓) **one** box.

The enzyme is a catalyst. ☐

The enzyme changes the concentration of the hydrogen peroxide. ☐

The enzyme causes the temperature to increase. ☐

The enzyme provides energy to the reaction. ☐

[1]

(ii) Ali then adds the enzyme to different concentrations of hydrogen peroxide.

He finds that the reaction is faster when the concentration of hydrogen peroxide solution is higher.

Explain why the reaction is faster.

Use ideas from the particle model in your answer.

.....

.....

.....

..... **[2]**

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(b) Ali does more experiments.

He makes some solutions of hydrogen peroxide with different pH values.

(i) Describe **one** method of measuring the pH of each solution.

.....

.....

..... **[2]**

(ii) Ali adds the enzyme to these solutions of hydrogen peroxide with different pH values.

He finds that the rate of reaction **increases** when pH values increase from 1 to 6.

He finds that the rate of reaction **decreases** when pH values increase from 6 to 7.

Use ideas about enzymes to explain these results.

.....

.....

..... **[2]**

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9 James uses charcoal as a fuel for his barbecue.

Charcoal is a form of carbon. When charcoal burns in plenty of oxygen it forms carbon dioxide.

$C(s) + O_2(g) \longrightarrow CO_2(g)$

(a) How could you test that the gas formed is carbon dioxide?

.....

.....

..... **[2]**

(b) Explain why burning charcoal **without** enough oxygen can cause a health hazard.

.....

.....

..... **[2]**

(c) **Fig. 9.1** shows the reaction profile for charcoal burning in air.

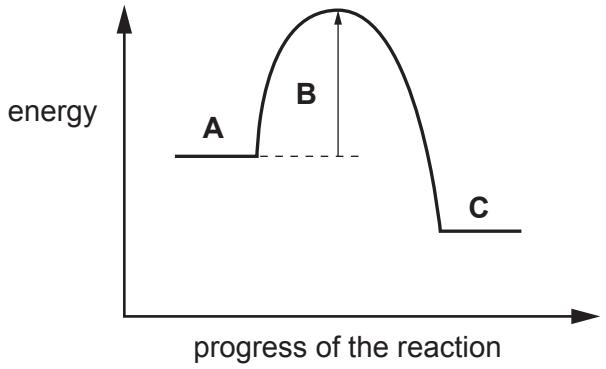


Fig. 9.1

(i) Draw lines to connect each letter with its correct label.

Letter	Label
A	Reactants
B	Products
C	Energy change of reaction
	Activation energy

[2]

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(ii) Complete the sentences to explain what **Fig. 9.1** shows.

Use words from the list.

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

less than **more than** **the same as**

given out **taken in** **endothermic** **exothermic**

The energy of the reactants is ..... the energy of the products.

This means that energy is ..... and so the reaction is

.....

[2]

(d) James uses a firelighter.

The firelighter burns with a hot flame which makes the charcoal start to burn.

Which two statements explain how the firelighter makes the charcoal start to burn?

Tick (✓) **two** boxes.

More charcoal particles have enough energy to react.	☐
The activation energy decreases.	☐
The burning firelighter takes energy from the charcoal.	☐
The charcoal particles increase in energy.	☐
The reaction becomes more exothermic.	☐

[2]

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10 Alkanes are a family of hydrocarbons in crude oil. They all have the same general formula, C_nH_{2n+2}.

Table 10.1 shows some information about alkanes.

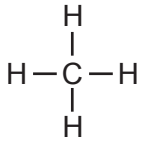
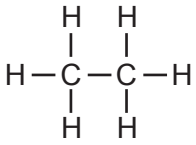
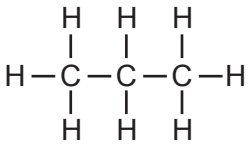
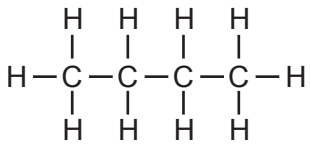
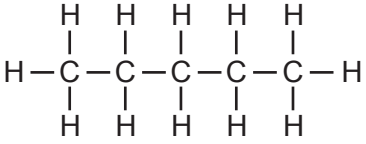
Alkane	Number of carbons	Molecular formula	Empirical formula	Structural formula	Melting point (°C)	Boiling point (°C)
Methane	1	CH_4	CH_4		–182	–161
Ethane	2	C_2H_6	CH_3		–183	–88
Propane	3	C_3H_8	.....		–188	–42
Butane	4	C_4H_{10}	.....			0
Pentane	5	C_5H_{12}	C_5H_{12}		–130	36
Hexane	6	.....	C_3H_7	.....	–95	

Table 10.1

(a) (i) Complete the blank spaces in **Table 10.1** to show the missing formulae. **[3]**

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(ii) Which statements about a **structural formula** are **true** and which are **false**?

Tick (✓) **one** box in each row.

Statement	True	False
It shows the simplest ratio of atoms in a molecule.		
It shows how many atoms are in a molecule.		
It shows how the atoms in a molecule are arranged.		
It shows the molecule in 3D.		

[2]

(b) (i) Predict the **boiling point** of hexane.

Use the data in **Table 10.1** to help you.

Boiling point = ... °C **[1]**

(ii) Explain why it is difficult to use the data in **Table 10.1** to predict the **melting point** of butane.

.....

.....

..... **[1]**

(iii) What is the state of pentane at 25 °C?

Explain your answer.

State: .....

Explanation: .....

..... **[2]**

(iv) Explain the trend in boiling points in **Table 10.1**.

Use ideas about energy and intermolecular forces in your answer.

.....

.....

.....

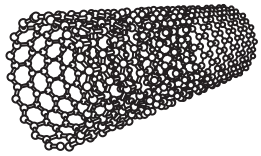
..... **[2]**

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11 Carbon nanotubes were discovered in 1991.

Materials made from nanotubes can be used instead of steel because nanotubes are very strong. They are a few nanometres wide and up to 1 cm long.

The structure of a nanotube is shown below.



(a) (i) Nanotubes are nanoparticles.

Which statement explains why nanotubes are nanoparticles?

Tick (✓) **one** box.

They have covalent bonds. ☐

Their diameters are between 1 to 100 nm. ☐

They are made of carbon. ☐

They are hollow tubes. ☐

[1]

(ii) Which two statements explain why nanotubes are very strong?

Tick (✓) **two** boxes.

Bonds between carbon atoms are strong. ☐

Lots of bonds must be broken to break the tube. ☐

The nanotubes have a hollow centre. ☐

They are very small. ☐

They have a large surface area. ☐

[2]

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(iii) Nanotubes are a similar shape to a human hair but they are much smaller.

A human hair has a diameter of 0.001 mm.
A nanotube has a diameter of 2 nm and a length of 5 mm.

A scale model of a nanotube has the **same** diameter as a human hair.

What is the length of the scale model in mm?

$1\,nm = 1 \times 10^{-6}\,mm$

Length = ... mm **[3]**

(b) Short nanotubes can also be used to carry medicines into the body.

The medicine is put inside the tube and the tube is injected into the body.

Give **one** benefit and **one** risk of using nanotubes to carry medicines into the body.

Benefit

.....

.....

Risk

.....

..... **[2]**

END OF QUESTION PAPER

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