

**Candidate Name**

**Candidate Number**

**Centre Name**

**Centre Number**


**Paper 2: Chemistry**

**Model Paper**

**(2 hours)**

It is necessary to respond on the answer sheets provided alongside this question paper. Additionally, it would help if you had a soft pencil (preferably of type B or HB), a clean eraser, and a dark blue or black pen.

**INSTRUCTIONS:**

- You must write your name, candidate number, and center name on the answer sheets in the designated spaces.
- The objective section consists of 25 questions, and you must attempt all of them.
- Each question has four options labeled A, B, C, and D. Select the option that you think is correct. Mark it on the multiple-choice answer sheet using a soft pencil.
- Attempt all the questions from the subjective section using a dark blue or black pen.
- It is important to follow the instructions provided on the answer sheets.
- Do not use correction fluid.
- Avoid writing on any bar codes.
- You are allowed to use a calculator if needed.

**INFORMATION:**

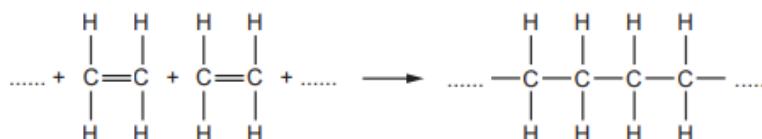
- This paper has a total of 100 marks.
- In the objective section, there are 25 questions, each carrying one mark. There is no negative marking for incorrect responses.
- Subjective section comprises 75 marks

- The number of marks assigned for every question or its parts is indicated within brackets ( ).
- Rough work must be completed on this question paper.

### Objective Questions

Total Marks: 25

1. Ethene undergoes the formation of an addition polymer, as illustrated.



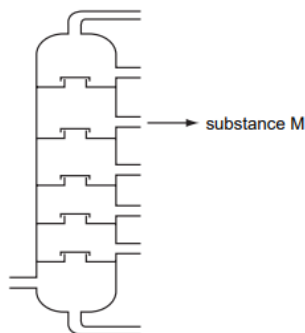
Which of the following descriptions applies to this polymer?

- A saturated compound named poly(ethane)
  - A saturated compound termed poly(ethene)
  - An unsaturated compound labeled poly(ethane)
  - An unsaturated compound designated poly(ethene)
2. The table displays the bonds existing and absent in compound X.

bond	
C—C	✓
C=C	x
C—H	✓
C—O	✓
C=O	✓
O—H	✓

What category does compound X belong to?

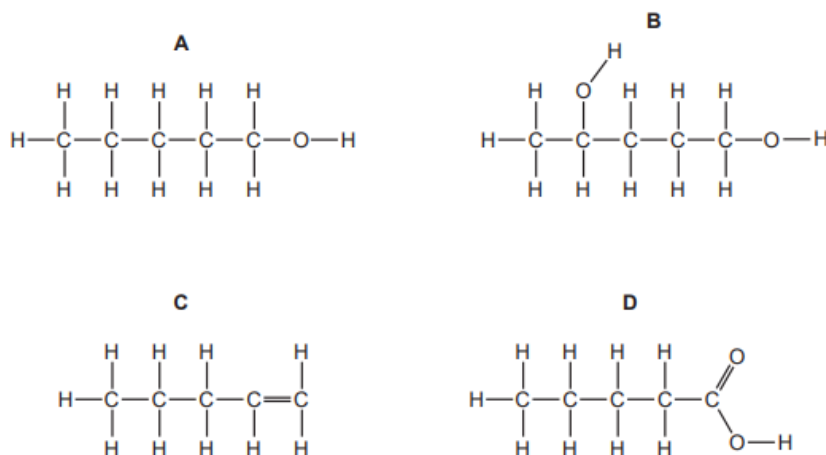
- Carboxylic acid
  - Alcohol
  - Alkene
  - Alkane
3. The diagram illustrates an industrial procedure. Substance M is among the materials generated from this process and is utilized as fuel for aircraft.



What process is depicted here, and what substance does M represent?

	process	substance M
<b>A</b>	thermal decomposition	petrol
<b>B</b>	fractional distillation	paraffin
<b>C</b>	fractional distillation	petrol
<b>D</b>	thermal decomposition	paraffin

4. Which diagram depicts the structure of pentanoic acid?



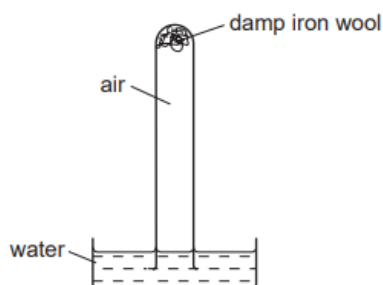
5. Which airborne pollutant does not impact respiratory function?

- |                    |                    |
|--------------------|--------------------|
| a) Carbon monoxide | c) Nitrogen oxides |
| b) Lead compounds  | d) Sulfur dioxide  |

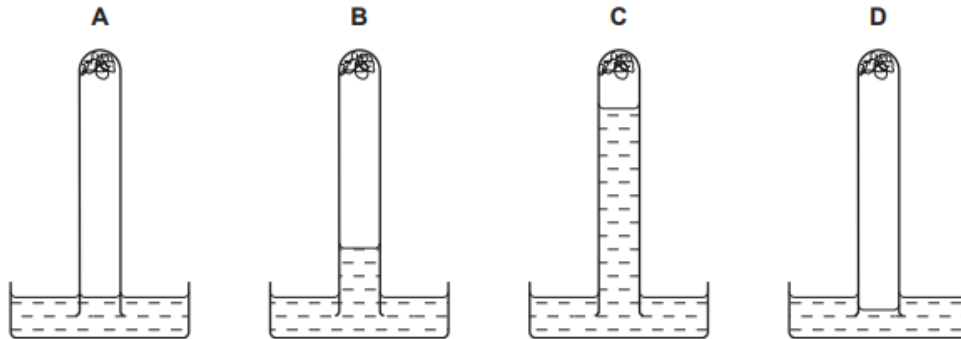
6. Which option describes the use of oxygen?

- |  |   |
|--|---|
| a) As the gas in a lamp                    | c) To react with methane in a Bunsen burner |
| b) To react with ethene to produce ethanol | d) To react with hematite to form iron      |

7. The depicted apparatus is arranged and left as is for a week.



Which diagram illustrates the water level after the week?



8. Which statement regarding rusting is inaccurate?

- a) Rusting requires only oxygen.
- b) Applying paint can prevent iron gates from rusting.
- c) Rust is hydrated iron (III) oxide.
- d) Both water and oxygen are necessary for rusting.

9. Carbon monoxide is emitted from the exhaust of vehicles burning fossil fuels.

Which row illustrates the reasons why carbon monoxide is considered a pollutant?

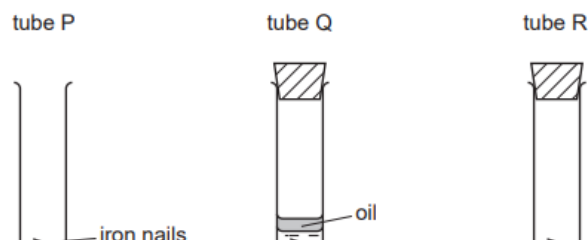
	Acidic	Toxic
A	yes	Yes
B	no	no
C	No	Yes
D	yes	no

10. Which gas listed is considered an atmospheric pollutant?

- 1. carbon monoxide
- 2. nitrogen dioxide
- 3. sulfur dioxide

- a) 1 only
- b) 2 only
- c) 3 only
- d) 1, 2, and 3

11. The diagram depicts experiments concerning the rusting of iron.



The suggested results are as follows:

1. In tube P, the iron nails rust.
2. In tube Q, the iron nails do not rust.
3. In tube R, the iron nails do not rust.

Which of these results is accurate?

- |                 |                 |
|-----------------|-----------------|
| a. 1 and 2 only | c. 2 and 3 only |
| b. 1 and 3 only | d. 1, 2         |

12. Four steel paper clips undergo the described treatment before being submerged in a beaker of water.

Which paper clip corrodes the fastest?

- |                                    |                                     |
|------------------------------------|-------------------------------------|
| a) coated with grease              | c) electroplated with zinc          |
| b) dipped in paint and left to dry | d) washed with soap and then rinsed |

13. Acid rain forms when sulfur dioxide and nitrogen oxides dissolve in rainwater.

Which issue is not a consequence of acid rain?

- |                         |                          |
|-------------------------|--------------------------|
| a) respiratory problems | c) corrosion of statues  |
| b) tree mortality       | d) decreased pH of lakes |

14. A factory burns coal containing high sulfur content.

Which pollutant is most likely to cause tree mortality?

- |                    |                   |
|--------------------|-------------------|
| a) carbon dioxide  | c) lead compounds |
| b) carbon monoxide | d) sulfur dioxide |

15. Argon is an inert gas employed for filling light bulbs.

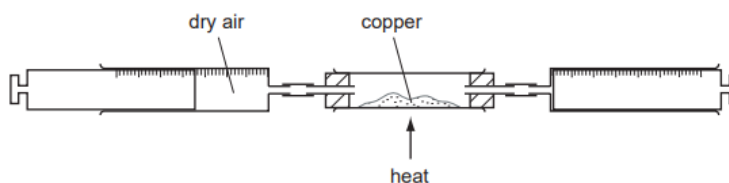
What is the estimated proportion of argon in the atmosphere?

- |        |        |
|--------|--------|
| a) 1%  | c) 79% |
| b) 20% | d) 99% |

16. What is the application of oxygen?

- |                             |                    |
|-----------------------------|--------------------|
| a) inflating balloons       | c) preserving food |
| b) illuminating light bulbs | d) producing steel |

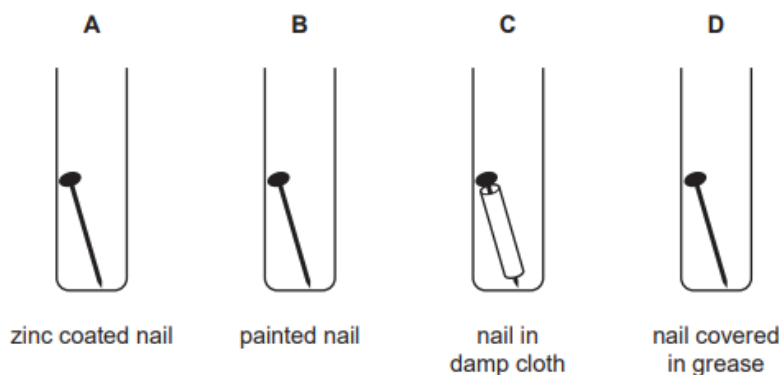
17. Dry air is flowed over heated copper until all the oxygen has undergone a reaction.



The gas volume after the reaction is  $120\text{ cm}^3$ . What was the initial volume of dry air?

- a)
- b)  $132\text{ cm}^3$
- c)  $150\text{ cm}^3$
- d)  $180\text{ cm}^3$
- e)  $600\text{ cm}^3$

18. Which iron nail undergoes rusting?



19. Which compound is not employed as a fertilizer?

- a) ammonium phosphate
- b) ammonium sulfate
- c) calcium carbonate
- d) potassium nitrate

20. Which elements are contained in NPK fertilizers?

- a) nitrogen, phosphorus, potassium
- b) nitrogen, potassium, calcium
- c) sodium, phosphorus, potassium
- d) sodium, potassium, calcium

21. What elements are present in an NPK fertilizer?

- a) nickel, phosphorus, potassium
- b) nickel, potassium, calcium
- c) nitrogen, phosphorus, potassium
- d) nitrogen, potassium, calcium

22. Which compound includes two out of the three essential elements required for a comprehensive fertilizer?

- a) ammonium chloride
- b) ammonium nitrate
- c) ammonium phosphate
- d) ammonium sulfate

23. A fertilizer sample undergoes testing by heating it with aqueous sodium hydroxide. A colorless gas is generated, which causes red litmus paper to turn blue.

Which essential element for plant growth must be present?

- a) nitrogen
- b) phosphorus
- c) potassium
- d) Sulfur

**24. Which two substances, upon reaction, would produce a salt containing two of the essential elements supplied by fertilizers?**

- |  |                                       |
|--|---------------------------------------|
| a) potassium hydroxide and nitric acid   | c) sodium hydroxide and nitric acid   |
| b) potassium hydroxide and sulfuric acid | d) sodium hydroxide and sulfuric acid |

**25. Fertilizers are employed to supply three essential elements required for plant growth. Which two compounds would yield a fertilizer containing all three of these elements?**

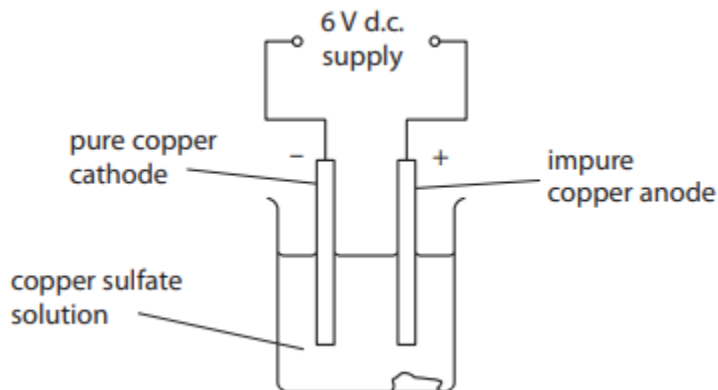
- |  |  |
|--|--|
| a) $\text{Ca}(\text{NO}_3)_2$ and $(\text{NH}_4)_2\text{SO}_4$ | c) $\text{KNO}_3$ and $(\text{NH}_4)_2\text{SO}_4$ |
| b) $\text{Ca}(\text{NO}_3)_2$ and $(\text{NH}_4)_3\text{PO}_4$ | d) $\text{KNO}_3$ and $(\text{NH}_4)$              |

## Theoretical Questions

**TOTAL Marks: 45**

Q1: (a) Copper sulfate solution was subjected to electrolysis using copper electrodes. [6]

The mass of each electrode was measured before immersion in the solution.



The electrolysis was conducted over a duration of time.

Subsequently, the electrodes were withdrawn, cleaned, and dried, and their masses were rechecked.

The table displays the masses of the electrodes both before and after electrolysis.

	Mass of electrode before electrolysis /g	Mass of electrode after electrolysis / g	Change in mass
Mass of impure copper anode	40.0	35.0	5.0 g decreases
Mass of pure copper cathode	10.0	14.8	4.8 g increases

Explain these results.

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(c) During an electrolysis experiment, oxide ions,  $O^{2-}$ , produce oxygen gas,  $O_2$ .

Write the balanced half equation for the reaction. [4]

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(d) Sodium chloride is an ionic compound composed of sodium ions,  $Na^+$ , and chloride ions,  $Cl^-$ .

When molten sodium chloride undergoes electrolysis, sodium metal, and chlorine gas are generated.

Explain how the sodium ions and chloride ions in solid sodium chloride are transformed into sodium and chlorine through electrolysis. [6]

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{Total Marks 16}

Q2: (a) The ions present in sodium chloride solution are:

- Sodium ions,  $Na^+$
- Chloride ions,  $Cl^-$
- Hydrogen ions,  $H^+$
- Hydroxide ions,  $OH^-$

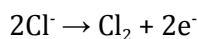
Sodium chloride solution undergoes electrolysis using a direct electric current.

(i) Which of these ions will be attracted to the cathode during the electrolysis of sodium chloride solution? [2]

Put a cross ( X ) in the box next to your answer.

- A. H<sup>+</sup> ions only
- B. H<sup>+</sup> and Na<sup>+</sup> ions
- C. Cl<sup>-</sup> ions only
- D. Cl<sup>-</sup> and OH<sup>-</sup> ions

(ii) Chlorine is one of the products of the electrolysis. The half-equation for the production of chlorine is:



Explain how the half-equation shows that chloride ions are oxidized. [5]

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(iii) The electrolysis of sodium chloride solution does not yield metallic sodium. Describe what modification you would implement to the electrolyte to obtain metallic sodium. [5]

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{Total Marks 12}

Q3: This query pertains to acids. When hydrogen chloride and ethanoic acid are mixed with water, they dissolve. In water, all molecules of hydrogen chloride ionize, whereas only about 1% of ethanoic acid molecules ionize.

- a) A solution is prepared by dissolving 1 g of hydrogen chloride in 1 dm<sup>3</sup> of water. Which description best fits this solution? [1]

Please select one option:

- 1) Concentrated solution of a strong acid
- 2) Concentrated solution of a weak acid
- 3) A dilute solution of a strong acid
- 4) A dilute solution of a weak acid

(b) Which solution would exhibit the lowest pH? [1]

Please select one option:

- a. mol/dm<sup>3</sup> ethanoic acid solution
- b. mol/dm<sup>3</sup> hydrogen chloride solution
- c. mol/dm<sup>3</sup> ethanoic acid solution
- d. mol/dm<sup>3</sup> hydrogen chloride solution

A student examined the concentration of a sodium hydroxide solution through titration with a 0.0480 mol/dm<sup>3</sup> ethane dioic acid solution. Here's the method employed.

1. Dispense 25.0 cm<sup>3</sup> of the sodium hydroxide solution into a conical flask using a 25.0 cm<sup>3</sup> pipette.
2. Introduce two drops of indicator into the sodium hydroxide solution.
3. Fill a burette with the 0.0480 mol/dm<sup>3</sup> ethane dioic acid solution up to the 0.00 cm<sup>3</sup> mark.
4. Gradually add the ethane dioic acid solution to the sodium hydroxide solution until the indicator changes color.
5. Determine the volume of the ethane dioic acid solution used by reading the burette.

(c) Propose two enhancements to the method to enhance result accuracy. [4]

- 1.....  
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- 2.....  
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(d) Ethane dioic acid is in solid form at room temperature.[4]

Determine the mass of ethane dioic acid (H<sub>2</sub>C<sub>2</sub>O<sub>4</sub>) required to prepare a 250 cm<sup>3</sup> solution with a concentration of 0.0480 mol/dm<sup>3</sup>.

Relative formula mass (M<sub>r</sub>): H<sub>2</sub>C<sub>2</sub>O<sub>4</sub> = 90

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

{Total Marks 10}

Q4: This query concerns cycloalkenes. Cycloalkenes are hydrocarbon molecules with a ring structure and a double carbon-carbon bond. They exhibit similar reactivity to alkenes.

- a) Explain a method to test for the presence of the double carbon-carbon bond in cycloalkene molecules. Provide the outcome of the test. [4]

Test.....

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Result.....

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(d) Determine the mass percentage of chlorine in a molecule of  $C_6H_{10}Cl_2$ . [3]

Relative atomic masses ( $A_r$ ): H = 1, C = 12, Cl = 35.5

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Percentage by mass = \_\_\_\_\_ %.

{Total Marks 7}

## Practical Questions

Total Marks: 30

Q1: Water sourced from reservoirs in Britain is utilized for drinking purposes.



(a) What are the primary procedures employed in treating water from reservoirs?

Provide one rationale for each step. [3]

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(b) Certain individuals utilize water filters to purify water before consumption.

(i) Water filters eliminate hardness from hard water. What component in water filters is responsible for removing hardness from water? [3]

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(d) Consuming hard water offers health advantages. Enumerate the health benefits of drinking hard water. [4]

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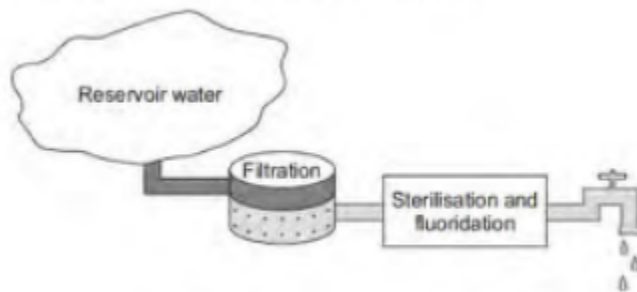
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{Total Marks 10}

Q2: The diagram illustrates three phases in the treatment of reservoir water.



(a) (i) What substance is removed from the reservoir water during filtration? [1]

Tick (✓) one box.

Bacteria ☐

Dissolved Nitrate ☐

Solids ☐

(ii) What substance is introduced to sterilize the water? [1]

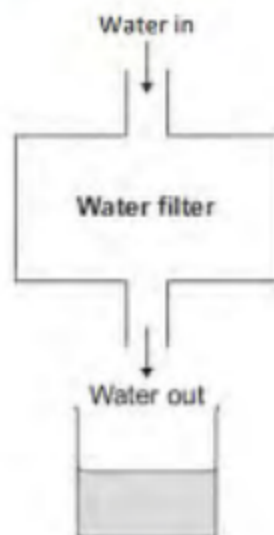
Tick (✓) one box.

Calcium ☐

Chlorine ☐

Magnesium ☐

(b) The diagram depicts a home water filter.



A student gathered a water sample from the filter.

The student was able to ascertain the presence of dissolved salts in the filtered water without employing a chemical test. Explain the method used. [3]

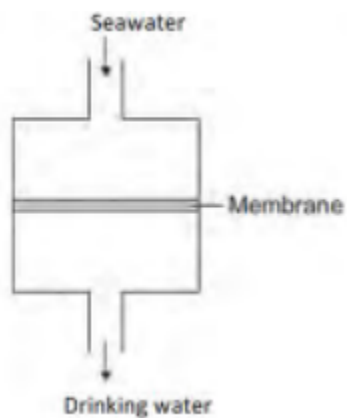
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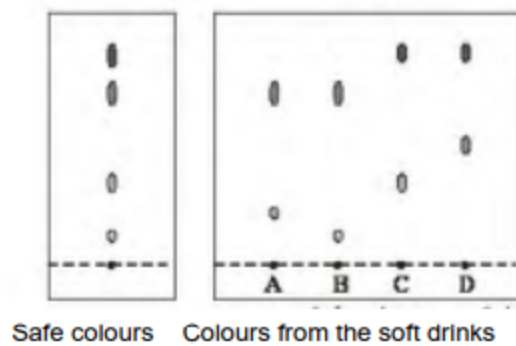
(c) Seawater is pushed through a membrane to produce drinking water.



Suggest a reason why water molecules can traverse the membrane, whereas sodium ions and chloride ions cannot. [3]

{Total Marks 8}

Q3: Chromatography was conducted on a sample of soft drinks to verify that they solely contained colors deemed safe. This represents the outcome.



Based on the chromatography results, what conclusions can be drawn regarding the safety of the colors present in soft drinks A, B, C, and D?

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{Total Marks 6}

Q4: Outline a safe procedure for producing pure copper sulfate crystals from copper carbonate and dilute sulfuric acid. Utilize the details provided in the figure above to assist you.

Ensure to identify all the apparatus you intend to utilize in your method.

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{Total Marks 6}