



SUBJECT: **Chemistry**
 PAPER NUMBER: I
 DATE: 22nd May 2024
 TIME: 9:00 a.m. to 11:05 a.m.

Useful data:

Relative atomic masses: C = 12, O = 16, Fe = 56, Zn = 65

Standard temperature and pressure (STP): 0 °C and 1 atm (760 mm Hg)

 The molar volume for gases at STP = 22.4 dm³

 Specific heat capacity of water = 4.2 J g⁻¹ °C⁻¹

 Faraday constant = 96500 C mol⁻¹

 Avogadro constant, L = 6.02 x 10²³
 $\Delta H = mc\Delta\theta$

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions. Write all your answers in the spaces provided in this booklet.
- The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated in brackets.
- You are reminded of the necessity for orderly presentation in your answers.
- In calculations you are advised to show all the steps in your working, giving your answer at each stage.
- The use of electronic calculators is permitted.
- A Periodic Table is printed on the back of this booklet.

For examiners' use only:

Question	1	2	3	4	5	6	7	8	9	10	11	12	Total
Score													
Maximum	6	6	6	6	6	6	6	6	6	6	20	20	100

Section A: Answer ALL questions.

1. Choose the appropriate terms from the word bank below to correctly fill in the blank spaces in the paragraph. Each term may be used **only** once or not at all.

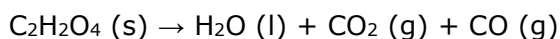
compound	filtered	impurities	water	pressure
condensed	0 °C	volume	mixture	100 °C

Sea water is not pure because it is a _____. When sea water is boiled fumes are observed and they can be _____ to form a liquid. This liquid is pure _____ and it freezes at _____. In reverse osmosis systems that are used to purify sea water, high _____ is applied across a special membrane which stops _____ from passing through.

(Total: 6 marks)

6

2. Oxalic acid, C₂H₂O₄, is a poisonous solid carboxylic acid. On heating it decomposes according to the equation:



a. Calculate the volume of carbon dioxide produced, measured at STP, when 1.5 moles of oxalic acid are heated.

_____ (3)

b. The mixture of gases produced in the reaction is bubbled into potassium hydroxide solution and one of the gases is absorbed.

i. Give the name or formula of the gas that is absorbed.

_____ (1)

ii. Give a balanced equation for the reaction between potassium hydroxide solution and the gas absorbed.

_____ (2)

(Total: 6 marks)

6

3. Rust, Fe_3O_4 , will form on any iron objects that are not protected.

a. Mention **TWO** factors that are needed for iron to rust.

Factor 1: _____ (1)

Factor 2: _____ (1)

b. Mention **ONE** way that a metal gate may be protected against rusting.

_____ (1)

c. Calculate the percentage of iron present in rust, Fe_3O_4 .

 _____ (3)

(Total: 6 marks)

6

4. The Table below contains statements. Some of the statements are **not** correct. Write TRUE or FALSE next to each statement as appropriate.

	Statement	True or False
a.	Common salt, sodium chloride, consists of molecules.	
b.	In graphite each carbon atom is bonded to three other carbon atoms.	
c.	Ionic compounds are soluble in water.	
d.	Diamond has a low sublimation temperature.	
e.	Methane is a covalent compound with a low boiling temperature.	
f.	When ionic compounds are dissolved in water they can conduct electricity.	

(Total: 6 marks)

6

Please turn the page.

5. Octane, C_8H_{18} , butane, C_4H_{10} , and ethane, C_2H_6 , belong to the same homologous series.

a. Which **ONE** of the three alkanes has the lowest boiling point?

_____ (1)

b. Which **ONE** of the three alkanes is a liquid at room temperature?

_____ (1)

c. Give a balanced equation to show the reaction of ethane, C_2H_6 , with chlorine gas, Cl_2 .

_____ (2)

d. Draw the structures of the **TWO** isomers of butane.

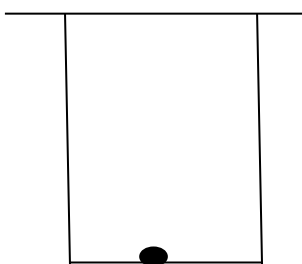
Isomer A	Isomer B

(2)

(Total: 6 marks)

6

6. A drop of bromine liquid is very carefully placed at the bottom of a gas jar in the fume cupboard and then covered with a glass plate as shown in the diagram.



After some time it is observed that the drop of bromine liquid has turned into a gas and that the reddish colour of bromine has spread throughout the gas jar.

a. Give the name of the process that has occurred inside the gas jar.

_____ (1)

- b. In the space below show clearly what occurs to the molecules of bromine in the gas jar, using **X** to represent a bromine molecule and Δ to represent air particles.



(2)

- c. Why is the experiment carried out in a fume cupboard?

_____ (1)

- d. The experiment is repeated, using a gas syringe to transfer 1 cm³ greenish yellow chlorine to the bottom of a gas jar of the same size and at the same temperature. It is observed that the process is faster with chlorine than with bromine. State **TWO** reasons for this observation.

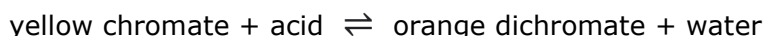
Reason 1: _____ (1)

Reason 2: _____ (1)

(Total: 6 marks)

6

7. Orange potassium dichromate, K₂Cr₂O₇, and yellow potassium chromate, K₂CrO₄, can be in equilibrium in solution as shown by the equation below:



- a. What does the equilibrium sign \rightleftharpoons mean?

_____ (1)

- b. State **TWO** observations that can be made when water is added to the mixture.

Observation 1: _____ (1)

Observation 2: _____ (1)

- c. i. If dilute sodium hydroxide is added to the mixture, to which side will the equilibrium shift?

_____ (1)

- ii. Explain your answer to part c.i.

 _____ (2)

(Total: 6 marks)

6

8. a. Air is a mixture of gases. What is the approximate percentage of nitrogen in air?
 _____ (1)

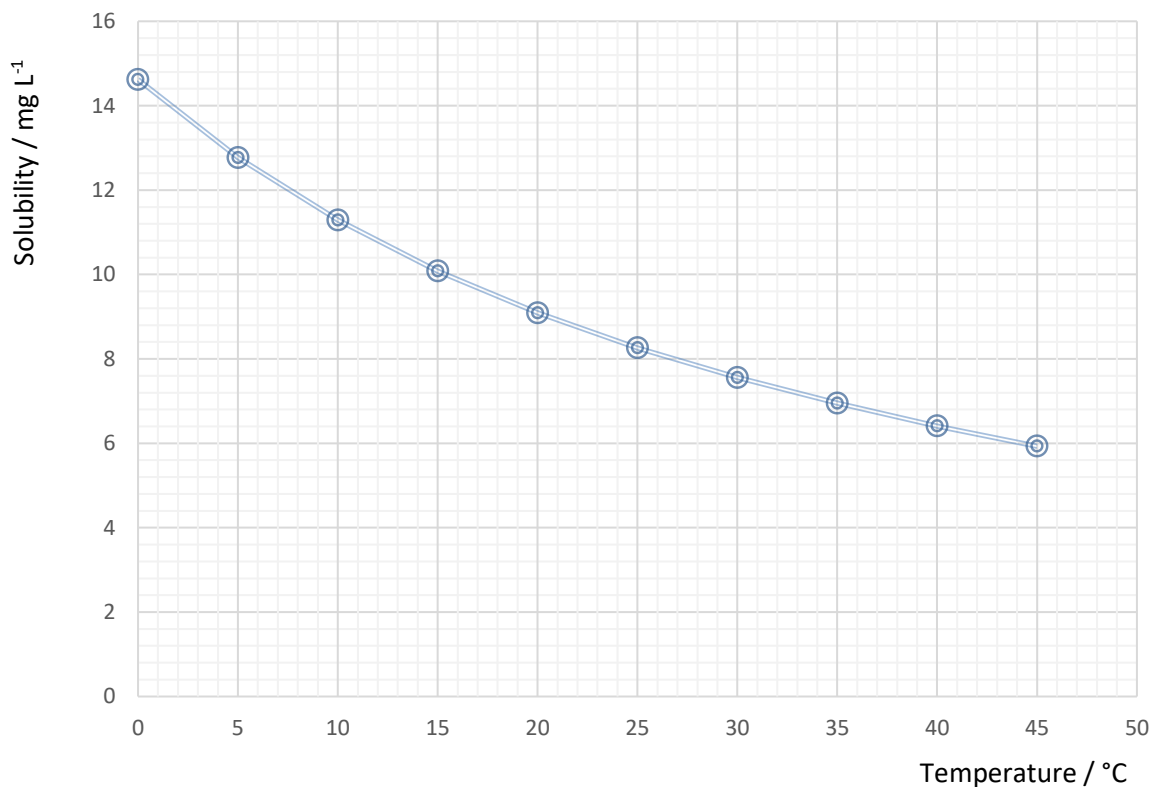
b. The percentages of nitrogen and oxygen dissolved in sea water at atmospheric pressure are different from their percentages in the air that we breathe. Explain.
 _____ (1)

c. Concentrated sulfuric acid is hygroscopic while sodium hydroxide is deliquescent. Explain the terms below.

Hygroscopic: _____ (1)

Deliquescent: _____ (1)

d. The graph below shows how the solubility of oxygen at atmospheric pressure in pure water changes as the temperature increases.



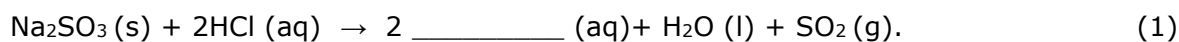
i. What does the shape of the graph indicate about the solubility of oxygen at atmospheric pressure in fresh water as the temperature increases?
 _____ (1)

ii. Use the graph to find the approximate solubility of oxygen in fresh water at 40 °C.
 _____ (1)

(Total: 6 marks)

6

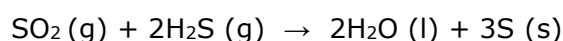
9. a. i. Complete the equation below:



ii. Describe a simple test to show that the gas in part a.i. is sulfur dioxide.

_____ (1)

b. Sulfur dioxide reacts with hydrogen sulfide according to the following equation:



This reaction is a redox reaction.

i. Give the change that is observed during this reaction.

_____ (1)

ii. Give the name or formula of the substance oxidised.

_____ (1)

iii. Give the name or formula of the oxidising agent in this reaction.

_____ (1)

iv. Hydrogen sulfide gas has a nasty smell of rotten eggs. Why is hydrogen sulfide a dangerous gas?

_____ (1)

(Total: 6 marks)

6

10. Complete the Table below using appropriate chemicals chosen from the bank below. Each substance can **only** be used once.

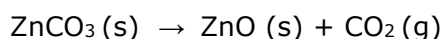
KBr Al(OH) ₃ Ca(HCO ₃) ₂ NH ₄ Cl Pb(NO ₃) ₂ Na ₂ SO ₄					
		Substance			
a.	Gives a pungent smelling gas when heated with an alkali				
b.	Gives a lilac colour in a flame				
c.	Gives a bright yellow precipitate with potassium iodide solution				
d.	Reacts with both acids and alkalis				
e.	Gives a white precipitate with barium chloride solution				
f.	Causes hardness in water				

(Total: 6 marks)

6

Section B: Answer ALL questions.

11. a. A group of students are given 12.5 g of zinc carbonate. They are asked to heat the solid to constant mass, to weigh the mass of solid that is formed and to find the mass of carbon dioxide that is released into the atmosphere. The equation for the reaction is:



- i. Use the equation to calculate the maximum mass of the carbon dioxide that can be released in the experiment.

(7)

- ii. What colour change can be observed during the reaction?

(2)

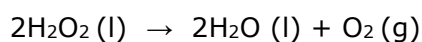
- iii. Draw a labelled diagram to show how the experiment can be carried out, using a crucible to hold the solid.

(4)

- iv. Mention **ONE** precaution to be taken when the mass of the remaining solid is measured.

(1)

- b. Oxygen can be prepared by the catalytic decomposition of hydrogen peroxide according to the equation:



- i. Give the name or formula of the catalyst that may be used in this reaction.

(1)

- ii. Draw a labelled diagram to show how this reaction may be carried out in the laboratory. In your answer include the name of the reaction vessel, the reactants, and the method used to collect the gas produced.

- iii. State a test to show the presence of oxygen.

(4)

(1)

20

(Total: 20 marks)

12. Consider the substances below.

hydrochloric acid, HCl	sodium chloride, NaCl
barium hydroxide, Ba(OH) ₂	magnesium oxide, MgO
concentrated sulfuric acid, H ₂ SO ₄	potassium hydroxide, KOH
lead(II) nitrate, Pb(NO ₃) ₂	lead(II) sulfate, PbSO ₄

- a. i. From the substances above choose **TWO** substances that can be reacted together in solution to form lead(II) chloride.

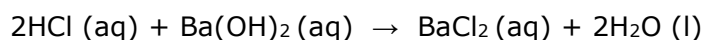
Substance 1: _____ (1)

Substance 2: _____ (1)

- ii. How can the lead(II) chloride formed in part a.i. be collected?

_____ (1)

- b. Hydrochloric acid, HCl, can react with a solution of barium hydroxide, Ba(OH)₂, according to the equation:



- i. Name the type of reaction.

_____ (1)

This question continues on next page.

ii. Give a balanced ionic equation for the reaction.

_____ (3)

iii. The reaction can be carried out using a titration method. Name the indicator that may be used in the experiment.

_____ (1)

iv. In the experiment in part b.iii. 15.6 cm^3 hydrochloric acid of concentration 0.5 mol dm^{-3} reacted with 25.0 cm^3 barium hydroxide solution. Calculate the concentration of the barium hydroxide solution.

_____ (7)

c. Potassium hydroxide and magnesium oxide are both bases but only one gives a colour change with moist red litmus paper.

i. Which one does **not** give a colour change with moist red litmus?

_____ (1)

ii. Give **ONE** reason for your answer to part c.i.

_____ (1)

d. Concentrated sulfuric acid, H_2SO_4 , reacts with solid sodium chloride, NaCl .

i. Give a balanced equation for the reaction.

_____ (2)

ii. Name the salt formed in the reaction in part d.i.

_____ (1)

(Total: 20 marks)

20

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SUBJECT: **Chemistry**
 PAPER NUMBER: IIA
 DATE: 24th May 2024
 TIME: 9:00 a.m. to 11:05 a.m.

Useful data:

Relative atomic masses: Li = 7, B = 11, C = 12, O = 16

Standard temperature and pressure (STP): 0 °C and 1 atm (760 mm Hg)

The molar volume for gases at STP = 22.4 dm³

Specific heat capacity of water = 4.2 J g⁻¹ °C⁻¹

Faraday constant = 96500 C mol⁻¹

Avogadro constant, L = 6.02 x 10²³

$\Delta H = mc\Delta\theta$

$Q = It$

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
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Score															
Maximum	6	6	6	6	6	6	6	6	6	6	20	20	20	20	100

Section A: Answer ALL questions.

1. Most elements in the Periodic Table have isotopes.

a. Define the term isotope.

_____ (2)

b. Silver has two isotopes ^{107}Ag and ^{109}Ag . If the relative atomic mass of silver is 108, calculate the percentage abundance of **each** of the two isotopes in silver.

_____ (1)

c. Calculate the relative atomic mass of Lithium given the percentage abundances of its isotopes are 7.5% of ^6Li and 92.5% of ^7Li .

_____ (2)

d. Is $^{36.5}\text{Cl}$ an isotope of chlorine?

_____ (1)

(Total: 6 marks)

6

2. PTFE is a polymer commonly known by its trade name as Teflon[®].

a. Is PTFE a natural or a synthetic polymer?

_____ (1)

b. The formula of the monomer of PTFE is C_2F_4 . Write the empirical formula of the monomer.

_____ (1)

c. Draw the repeating unit of the PTFE polymer, showing **all** the bonds.

_____ (3)

d. State **ONE** use of PTFE in everyday life.

_____ (1)

(Total: 6 marks)

6

3. Nitrogen is a highly unreactive element.

a. Explain why the nitrogen molecule is highly unreactive.

_____ (1)

b. State the raw material from which nitrogen is obtained industrially.

_____ (1)

c. Give the temperature and pressure that are used in industry for nitrogen and hydrogen to react together.

_____ (2)

d. Write a balanced equation for the reaction between ammonia and copper(II) oxide.

_____ (2)

(Total: 6 marks)

6

4. From the word bank below choose an appropriate substance to complete the Table.

Plaster of Paris (CaSO ₄ .½H ₂ O)	Baking soda (NaHCO ₃)	Quicklime (CaO)
Ethanoic acid (CH ₃ COOH)	Butane (C ₄ H ₁₀)	Washing soda (Na ₂ CO ₃ .10H ₂ O)

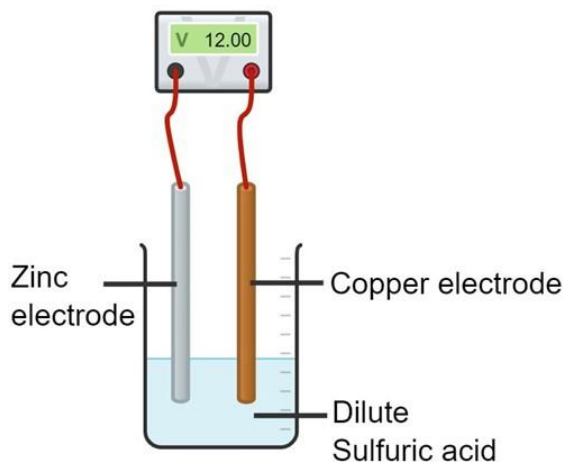
		Substance
a.	Used as domestic LPG gas.	
b.	Used to make casts.	
c.	Used to soften hard water.	
d.	Used to increase pH in soil.	
e.	Present in vinegar.	
f.	Used in baking powder.	

(Total: 6 marks)

6

Please turn the page.

5. A simple cell changes chemical energy into electrical energy. The cell contains two metallic electrodes in an electrolyte as shown in the diagram.



a. The more reactive metal reacts with the acid and goes into solution as ions. State the more reactive metal in the cell.

_____ (1)

b. Give a half equation to show the formation of ions by the more reactive metal.

_____ (3)

c. Name the particles that move through the external circuit.

_____ (1)

d. State whether the voltage of the cell would increase, decrease, or stay the same if the zinc electrode is replaced by an iron electrode.

_____ (1)

(Total: 6 marks)

6

6. Underline the correct answer:

a. What is the rate of a chemical reaction? (1)

- i. The amount of reactant at the end of the reaction.
- ii. The change in temperature during a chemical reaction.
- iii. The change in concentration of a reactant or product with time.

b. Which factor does **not** affect the rate of a chemical reaction? (1)

- i. Temperature.
- ii. Surface area of reactants.
- iii. The humidity of the surroundings.

- c. How does the rate of reaction change when a catalyst is in powder form instead of a single solid piece? (1)
- i. The rate increases.
 - ii. The rate decreases.
 - iii. The rate remains the same.
- d. What is the role of a catalyst in a chemical reaction? (1)
- i. Increases the activation energy.
 - ii. Changes the rate of the reaction without being consumed (used up).
 - iii. Provides energy for the reaction.
- e. Which of the following is **not** a characteristic of a catalyst? (1)
- i. It is unchanged at the end of the reaction.
 - ii. It is specific to a particular reaction.
 - iii. It changes the reactants.
- f. Which factor influences the rate of reaction according to the collision theory? (1)
- i. Pressure.
 - ii. Temperature.
 - iii. Both the above.

(Total: 6 marks)

6

7. Write balanced chemical equations for the reactions described below.

- a. Magnesium burns in air to produce a white ash.

_____ (2)

- b. Calcium carbonate decomposes on heating to produce a gas which turns limewater milky.

_____ (2)

- c. Reddish brown copper filings turn black when they are heated in air.

_____ (2)

(Total: 6 marks)

6

Please turn the page.

8. Indicate whether the following statements are True or False and explain your answer. No equations are required.

a. Hydrogen is the most abundant gas in the Earth's atmosphere.

TRUE or FALSE: _____

Explanation: _____

_____ (2)

b. When hydrogen burns in oxygen an odourless gas is produced which condenses into a colourless liquid.

TRUE or FALSE: _____

Explanation: _____

_____ (2)

c. Potassium metal reacts very slowly with hydrochloric acid.

TRUE or FALSE: _____

Explanation: _____

_____ (2)

6

(Total: 6 marks)

9. Explain the following statements. No equations are required.

a. When a very small piece of sodium metal is placed in a beaker containing a colourless aqueous solution of phenolphthalein indicator a new compound is formed. This compound causes the colour of the indicator to change.

_____ (2)

b. Group 1 metals are known as alkali metals.

_____ (1)

c. Aluminium doors and windows do not require a lot of maintenance.

_____ (1)

d. There are **TWO** main advantages for recycling copper rather than extracting it from the ground.

_____ (2)

6

(Total: 6 marks)

10. This question is about pollutant gases.

a. The ozone layer plays a crucial role in protecting life on Earth. However, human activities have led to the depletion of the ozone layer.

i. Name the main compound responsible for ozone depletion in the Earth's atmosphere.

_____ (1)

ii. Explain how the ozone layer helps to protect life on Earth.

_____ (1)

b. The increase in greenhouse gas emissions is a significant factor contributing to global warming.

i. Name **ONE** greenhouse gas.

_____ (1)

ii. Explain how the greenhouse effect is brought about.

_____ (1)

c. Acid rain is a form of environmental pollution caused by the release of sulfur dioxide (SO_2) and nitrogen oxides (NO_x) into the atmosphere.

i. Name a major source of the nitrogen oxides in air.

_____ (1)

ii. Describe **ONE** detrimental consequence of acid rain on our environment.

_____ (1)

(Total: 6 marks)

6

Please turn the page.

Section B: Answer TWO questions from this section.

11. Two groups of students wanted to investigate the energy change in a neutralisation reaction between:

- 20 cm³ of 2 mol dm⁻³ hydrochloric acid;
- 20 cm³ of 2 mol dm⁻³ sodium hydroxide.

The two groups did **not** use the same apparatus.

	Group A	Group B
Apparatus	Glass beaker Thermometer Stirrer	Polystyrene cup Thermometer Stirrer

- State the apparatus that should be used to measure the exact volumes of the acid and of the alkali. Give **ONE** reason for your answer. (2)
- From the set of apparatus listed in the table above, choose the most appropriate set for this experiment. Give a reason for your answer. (2)
- Using the set of apparatus chosen in part 11.b., draw a labelled diagram showing how the apparatus is set up. (2)
- The initial temperature of the acid and the alkali was 15.2 °C. The maximum final temperature during the experiment was 28.2 °C. Calculate the change in temperature. (1)
- Calculate the energy change of the reaction taking place. (2)
- The students wanted to calculate the heat of neutralisation.
 - Define heat of neutralisation. (2)
 - Write a balanced equation for the reaction between the acid and the base. (2)
 - Calculate the number of moles of water produced. (3)
 - Find the standard heat of neutralisation. (3)
- A different group of students reacted ethanoic acid and sodium hydroxide. The heat of neutralisation was less exothermic. Give **ONE** reason for this observation. (1)

(Total: 20 marks)

12. Chlorine, bromine and iodine all belong to Group 7 of the Periodic Table.

- Give the name given to the Group 7 elements. (1)
- Write the physical state at room temperature of the three elements listed above. (3)
- Astatine is the next member in the group below iodine. Predict the state of astatine at room temperature and pressure. (1)
- What happens to the reactivity of the elements on going down the group? Give **ONE** reason for your answer. (2)
- Use chemicals from the word bank below to describe a simple experiment to show the reactivity of chlorine, bromine, and iodine. (3)

chlorine solution	bromine solution	iodine solution
potassium chloride	potassium bromide	potassium iodide

- Chlorine can be prepared by reacting manganese(IV) oxide and concentrated hydrochloric acid.
 - Draw a well-labelled diagram of the apparatus used to prepare pure, dry chlorine in the laboratory. (6)
 - Give a balanced equation, including state symbols, for the reaction taking place to prepare chlorine. (3)
 - Identify the oxidising agent in the reaction in part 12.f.ii. (1)

(Total: 20 marks)

13. This question is about Avogadro's Law.

- a. Avogadro's Law states that equal volumes of different gases, measured under certain conditions contain an equal number of particles. Name the **TWO** conditions that must remain constant for Avogadro's Law to hold true. (2)
- b. The following Table shows information about six different gases.

Molecule	RMM	Volume occupied by 1 g of gas at STP in cm ³
HF	20	1178
N ₂	28	800
O ₂		700
C ₃ H ₄	40	560
CO ₂		509
SO ₂	64	350

- i. Calculate the RMM of O₂ and CO₂ to complete the Table. Show your working. (2)
- ii. Plot a graph of relative molecular mass (y-axis) against volume (x-axis) on the graph paper provided. Both axes do not need to start from the origin (0,0). Draw the best curve. (7)
- iii. Calculate the RMM of ethyne (C₂H₂) and from the graph find the volume of 1 g of ethyne at STP. (2)
- iv. Find the formula of a gas which contains only nitrogen and oxygen if the volume of 1 g of this gas occupies 750 cm³ at STP. (2)
- v. Boron, an element in group 3 of the Periodic Table, readily combines with hydrogen to create multiple compounds. From the graph find the RMM of the gaseous hydride when 1 g of it occupies a volume of 800 cm³ at STP. Hence find the molecular formula of the compound. Show your reasoning. (3)
- vi. Calculate the volume occupied by the hydride in part b.v. if the temperature is raised to 373 K. (2)

(Total: 20 marks)

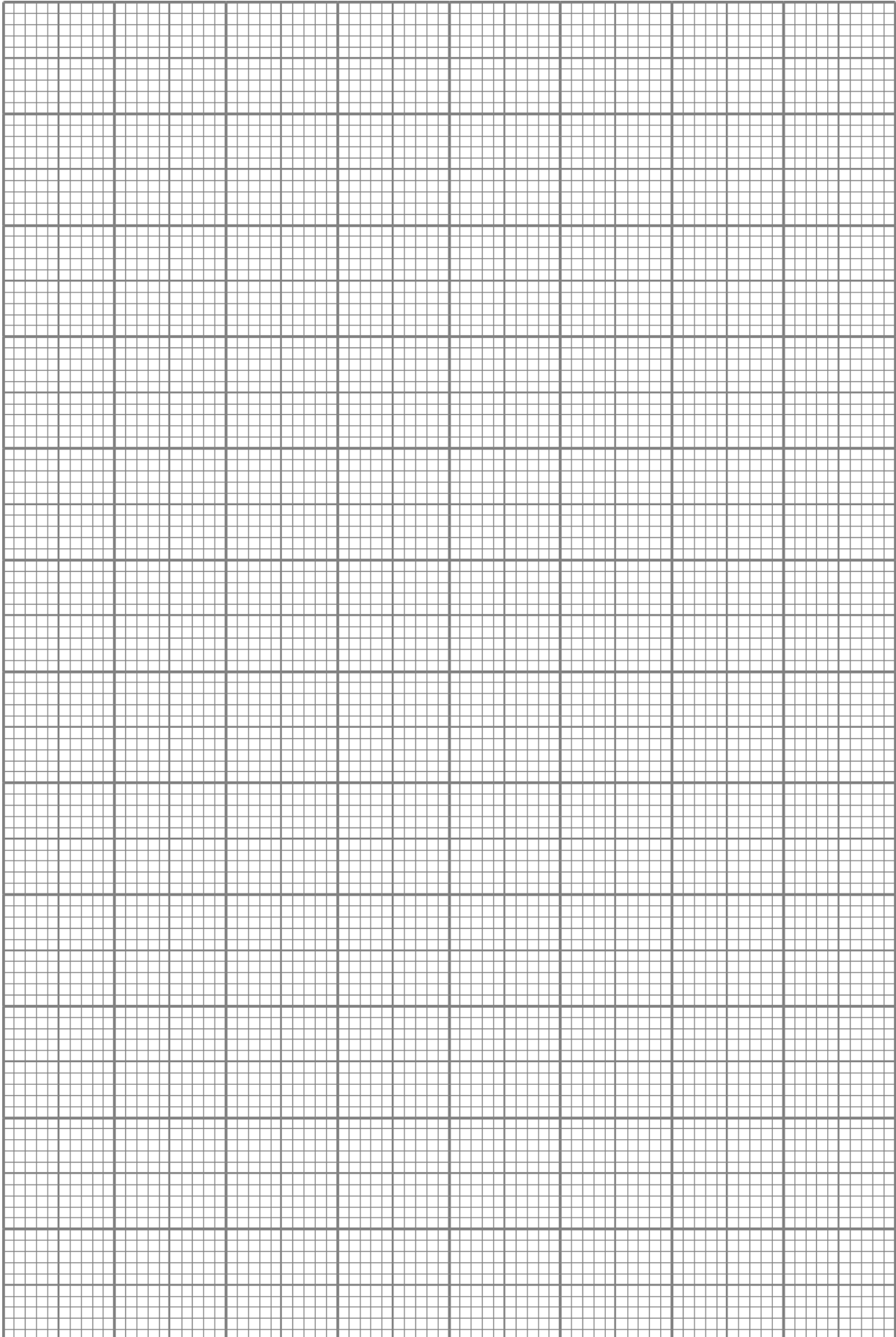
14. Redox reactions involve the transfer of electrons. These reactions can be analysed in terms of changes in the oxidation states of elements, as well as the gain or loss of hydrogen and oxygen.

- a. Explain 'oxidation' in terms of electrons. (1)
- b. When zinc is added to a solution of copper(II) sulfate, a colour change occurs.
- Write an ionic equation for the reaction which occurs. (3)
 - Identify the reducing agent. (1)
 - Describe what happens to the reducing agent in terms of electrons. (1)
 - State the colour change that is observed in the solution. (1)
- c. During the electrolysis of molten lithium chloride, LiCl, lithium metal is formed at the cathode, and chlorine gas is produced at the anode.
- Write the half equations for the reactions that occur at the cathode and the anode. (4)
 - Draw a fully labelled diagram of the apparatus required for this reaction. (5)
 - In a particular experiment, a current of 10 A was applied for a duration of three hours. Determine the mass of pure lithium generated during this period. (4)

(Total: 20 marks)

Please turn the page.

DO NOT WRITE ABOVE THIS LINE





SUBJECT:	Chemistry
PAPER NUMBER:	IIB
DATE:	24 th May 2024
TIME:	9:00 a.m. to 11:05 a.m.

Useful data:

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Section A: Answer ALL questions.

1. Most elements in the Periodic Table have isotopes.

a. Fill in the blanks with the correct terms.

Isotopes are _____ of the same element with the same number of _____ but a different number of _____.

(3)

b. Lithium has two isotopes ${}^6\text{Li}$ and ${}^7\text{Li}$. Use the Periodic Table to fill in the table below with the appropriate numbers.

(3)

	Isotope ${}^6\text{Li}$	Isotope ${}^7\text{Li}$
Protons		
Neutrons		
Electrons		

(Total: 6 marks)

6

2. PTFE (polytetrafluoroethene) is a polymer commonly known by its trade name as Teflon[®].

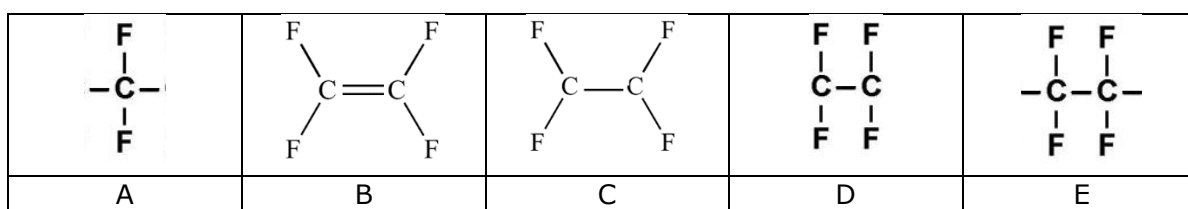
a. Underline the correct term:

PTFE is considered to be a (natural / synthetic) polymer.

(1)

b. Draw a circle around the monomer of PTFE.

(1)



c. Draw the repeating unit of the PTFE polymer.

d. State **ONE** use of PTFE in everyday life.

(3)

(1)

(Total: 6 marks)

6

3. This question is about nitrogen. Fill in the blanks choosing a term from the word bank below. Some words can be used once, more than once, or not at all.

- | | | | |
|------------|-------------------------------|----------|--------|
| monoatomic | double | 450 | weak |
| 100 | V ₂ O ₅ | diatomic | iron |
| strong | 250 | 200 | triple |

Nitrogen exists as a _____ molecule. It is highly unreactive as it has a _____ bond between its atoms which makes the attraction very _____. Nitrogen reacts with hydrogen at a temperature of _____ °C and a pressure of _____ atm using finely divided _____ as a catalyst.

(Total: 6 marks)

6

4. State whether these statements are True or False. Write T or F in the space provided.

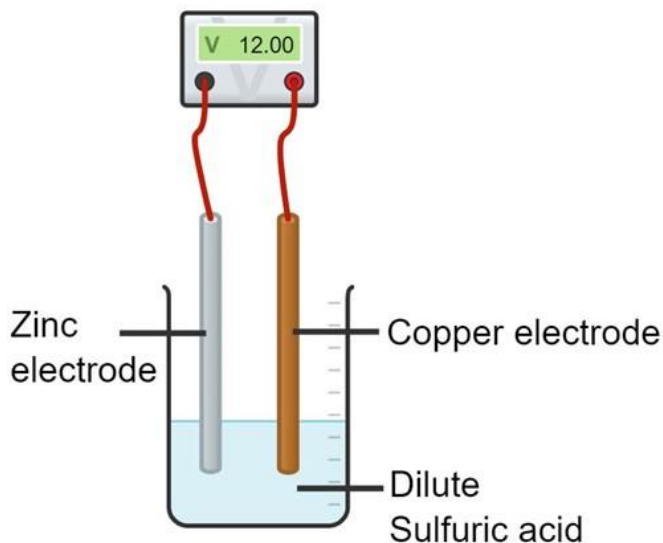
		True or False
a.	Butane is used as domestic LPG gas.	
b.	Ethyl ethanoate is used to make casts.	
c.	Calcium stearate is found in soaps.	
d.	Milk of Magnesia is used to increase pH in soil.	
e.	Washing soda is used to soften hard water.	
f.	Quicklime is used to reduce stomach acidity.	

(Total: 6 marks)

6

Please turn the page.

5. A simple cell changes chemical energy into electrical energy. The cell contains two metallic electrodes in an electrolyte as shown in the diagram below.



a. The more reactive metal reacts with the acid and goes into solution as ions. Which is the more reactive metal in the cell?

_____ (1)

b. Complete the half ionic equation below.



c. Underline the best term:

i. (Ions / Electron) move from the most reactive to the less reactive metal through the external circuit.

ii. The simple cell is the basic structure found in (batteries / electrolysis).

iii. Dilute sulfuric acid is acting as an electrolyte as it has free (ions / electrons). (3)

(Total: 6 marks)

6

6. a. Give the definition of the rate of a chemical reaction.

 _____ (1)

b. Give typical units for the rate of a reaction.

 _____ (2)

- c. Name **THREE** factors that can influence the rate of a chemical reaction.

_____ (3)

(Total: 6 marks)

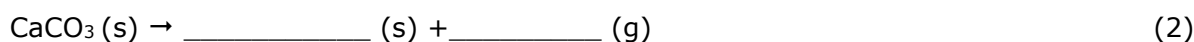
6

7. Complete and balance the following equations. Include state symbols.

- a. When magnesium is burnt in air white ash is produced.



- b. Calcium carbonate decomposes upon heating to produce a gas which turns limewater milky.



- c. Reddish brown copper filings turn black when they are heated in air.



(Total: 6 marks)

6

8. Answer the following questions.

- a. State the number of protons and neutrons in an atom of hydrogen ^1H .

_____ (1)

- b. What type of bond exists between the atoms in a hydrogen molecule?

_____ (1)

- c. Describe a simple chemical test for hydrogen.

_____ (1)

- d. When hydrogen burns in air a colourless odourless gas is formed. Write a balanced chemical equation for this reaction. Include state symbols.

_____ (3)

(Total: 6 marks)

6

Please turn the page.

9. Answer the following questions. Equations are **not** required.

a. Give the formula of the alkaline compound which forms when sodium metal reacts with water.

_____ (1)

b. State the colour produced when phenolphthalein indicator is added to potassium hydroxide solution.

_____ (1)

c. State why Group 2 metals are known as 'Alkaline Earth' metals.

 _____ (2)

d. Considering aluminium and iron, state which is the most reactive metal.

_____ (1)

e. Give the metal that is used to galvanize iron doors.

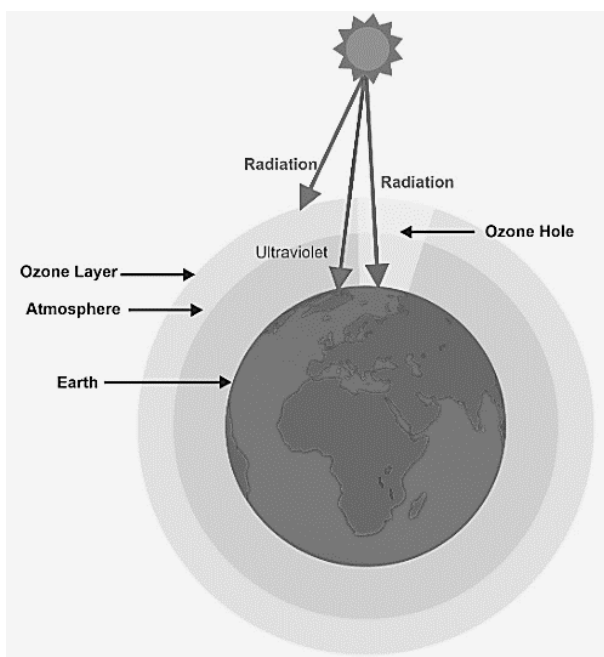
_____ (1)

(Total: 6 marks)

6

10. This question is about pollutant gases.

a. The ozone layer plays a crucial role in protecting life on Earth. However, human activities have led to the depletion of the ozone layer.



(Adapted from: <https://infinitylearn.com/surge/articles/ozone-depletion/>)

- i. Which of the following gases is causing ozone layer depletion? Underline the correct answer.

Oxygen / Nitrogen / Carbon dioxide / Chlorofluorocarbons / hydrogen. (1)

- ii. By referring to the above picture, explain how the ozone layer helps to protect life on earth.

_____ (1)

- b. Another effect caused by pollutant gases is global warming. The increase in greenhouse gas emissions is a significant factor contributing to global warming.

- i. Name **ONE** greenhouse gas. _____ (1)

- ii. Briefly explain how the greenhouse effect works.

_____ (1)

- c. Acid rain is another form of environmental pollution caused by the release of sulfur dioxide (SO₂) and nitrogen oxides (NO_x) into the atmosphere.

- i. Name **ONE** source of such gases in air. _____ (1)

- ii. Acid rain is known to corrode stone buildings besides other things. Name the chemical present in Maltese stone which reacts rapidly with acid rain to form a salt, water, and carbon dioxide.

_____ (1)

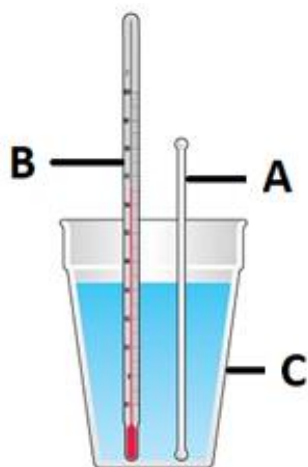
(Total: 6 marks)

6

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Section B: Answer TWO questions from this section.

11. Two groups of students wanted to investigate the energy change in a neutralisation reaction. The set up used by both groups is the following.

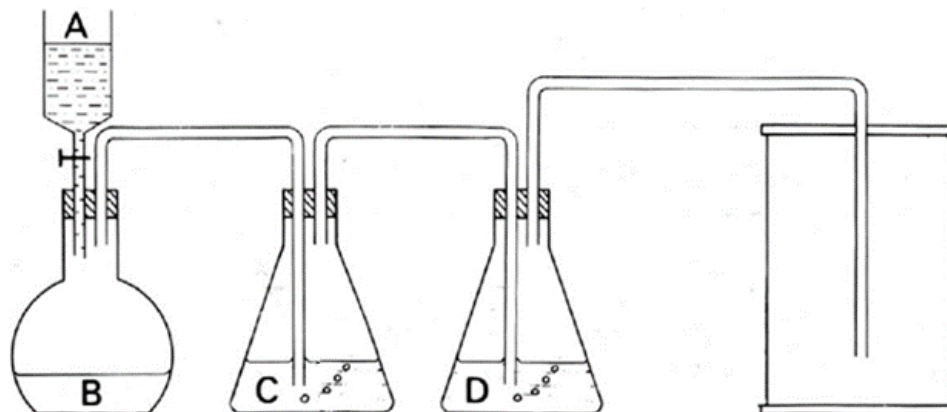


(Adapted from: <https://edu.rsc.org/resources/measure-enthalpy-changes/2395.article>)

- Give the name of apparatus A and B. (2)
- Students of group A used a glass beaker for apparatus C. Students of group B used a polystyrene cup. Which group made the correct choice? Give **ONE** reason for your answer? (2)
- Both groups used 20 cm^3 of 2 mol dm^{-3} hydrochloric acid and 20 cm^3 of 2 mol dm^{-3} sodium hydroxide during the experiment. They wanted to find out the enthalpy of neutralisation.
 - Define enthalpy of neutralisation. (2)
 - Write a balanced equation for the reaction including state symbols. (3)
 - The initial temperature of both the acid and alkali was $15.2 \text{ }^\circ\text{C}$ and the maximum final temperature during the experiment was $28.2 \text{ }^\circ\text{C}$. Is the reaction exothermic or endothermic? (1)
 - Calculate the change in temperature. (1)
 - Use the equation $\Delta H = mc\Delta\theta$ to calculate the energy change of the reaction taking place. (2)
 - Find the number of moles of hydrochloric acid used and hence the number of moles of water produced during the reaction. (3)
 - Calculate the standard enthalpy of neutralisation. (3)
- Another group reacted ethanoic acid instead of hydrochloric acid. State whether the heat of reaction would be less or more exothermic. (1)

(Total: 20 marks)

12. Chlorine, bromine, and iodine all belong to Group 7 of the Periodic Table.
- Give the name of Group 7. (1)
 - Give the physical state and the colour for chlorine, bromine and iodine. (6)
 - Do these elements exist as monoatomic or as diatomic particles? (1)
 - Which is the most reactive element of the three elements listed above? (1)
 - Pure, dry chlorine can be prepared in the lab by reacting manganese(IV) oxide and concentrated hydrochloric acid using the setup below. (1)



- State the substances placed in **A**, **B**, **C** and **D**. (4)
 - Copy the equation below and fill in the blanks accordingly. (3)
- $$\text{MnO}_2 (\text{s}) + \text{---} \text{HCl} (\text{---}) \rightarrow \text{MnCl}_2 (\text{aq}) + \text{---} (\text{l}) + \text{Cl}_2 (\text{g})$$
- Identify the oxidising agent in the reaction. (1)
 - Chlorine is collected by downward delivery. Give **ONE** reason for this. (1)
 - State why this experiment should be carried out in the fume cupboard. (1)
 - Give **ONE** use of chlorine. (1)

(Total: 20 marks)

13. Avogadro's Law states that equal volumes of different gases, measured under certain conditions which must remain constant contain an equal number of molecules.
- Name the **TWO** conditions that must remain constant for Avogadro's Law to hold true. (2)
 - The following table shows information about six different gases.

Molecule	Relative molecular mass	Volume occupied by 1 g of gas at STP in cm ³
HF	20	1178
N ₂	28	800
O ₂		700
Ar	40	560
CO ₂		509
SO ₂	64	350

- Calculate the RMM of O₂ and CO₂ to complete the table. Show your working. (2)

This question continues on next page.

- ii. Plot a graph of relative molecular mass (y -axis) against volume (x-axis). Both axes do not need to start from the origin (0,0). Draw the best curve on the graph paper provided. (6)
- iii. The RMM of HCl is 36.5 and that of C₂H₂ is 26. Use your graph to find the volume occupied by 1 g of:
- 1) hydrogen chloride (HCl) at STP; (2)
 - 2) ethyne (C₂H₂) at STP. (2)
- iv. The volume occupied by 1 g of gas X is 750 cm³ at STP.
- 1) From the graph find the RMM of gas X. (1)
 - 2) Work out the molecular formula given that gas X is made up of nitrogen and oxygen atoms only. (1)
- v. One mole of any gas occupies 22.4 dm³ at STP.
- 1) Calculate the volume occupied by 2.5 moles of oxygen gas at STP. (2)
 - 2) Use the following equation to find the volume occupied by 2.5 moles of oxygen gas at 300 K. (Take temperature T₁ as 273 K.)

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

(2)

(Total: 20 marks)

14. Redox reactions involve the transfer of electrons between reactants. These reactions can be analysed in terms of changes in the oxidation states of elements, as well as the gain or loss of hydrogen and oxygen atoms.
- a. Copy and complete the following sentence: Oxidation is the _____ of electrons while reduction is the _____ of electrons. (2)
- b. When chlorine gas is bubbled through a solution of potassium iodide, a colour change occurs.
- i. Copy and complete the ionic equation for the reaction which occurs.

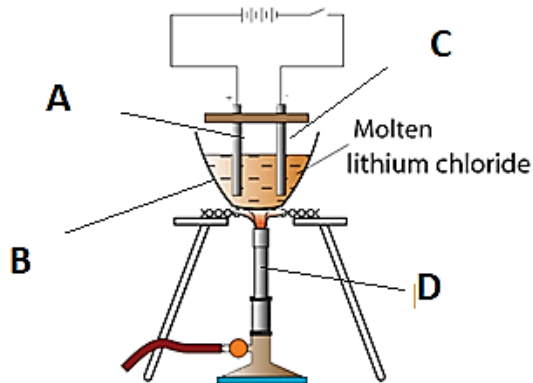
$$\text{Cl}_2 (\text{g}) + 2 \text{I}^- (\text{aq}) \rightarrow 2 \text{Cl}^- (\text{aq}) + \text{_____} (\text{aq})$$
 (1)
 - ii. Explain why potassium is **not** shown in the ionic equation. (1)
 - iii. State the oxidation state of chlorine gas. (1)
 - iv. State the oxidation state of the chloride ions. (1)
 - v. Explain the role of chlorine as an oxidizing agent in this reaction. (2)
 - vi. What is the colour change which occurs? (1)
- c. During the electrolysis of molten lithium chloride (LiCl), lithium metal and chlorine gas are produced.
- i. Consider the following diagram. Name labels A to D using the terms in the word bank below. Give your answers in the form of a list.

anode

cathode

Bunsen burner

crucible



(4)

(Adapted from: <https://nurhafizahzaidipijaja.wordpress.com/others/electrolysis-of-lead-ii-bromide/>)

- ii. Give the half ionic equation for the production of lithium metal and identify the electrode at which it is deposited. (3)
- iii. In a particular experiment, a current of 10 A was applied for a duration of 60 s.
 - 1) Use the equation $Q=It$ to calculate the charge produced during this time. (1)
 - 2) Given that 96500 C produce 1 mole of lithium, calculate the mass of lithium produced during this experiment. (3)

(Total: 20 marks)

DO NOT WRITE ABOVE THIS LINE

