

DRAFT MARKING SCHEME

Candidate's Name : JOSEPH JOBS KAYURA

Signature : 

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(Do not write your School /Centre Name or Number anywhere on this booklet.)

545/2

CHEMISTRY

Paper 2

Oct./Nov. 2022

2 hours



UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Certificate of Education

CHEMISTRY

Paper 2

2 hours

INSTRUCTIONS TO CANDIDATES:

Section A consists of 10 structured questions. Answer all the questions in this section.

Answers to these questions must be written in the spaces provided.

Section B consists of 4 semi-structured questions. Answer any two questions from this section. Answers to the questions must be written in the answer booklet(s) provided.

In both sections all working must be clearly shown and must be in blue or black ink.

Any work done in pencil will not be marked except drawings.

Mathematical tables and silent non-programmable calculators may be used.

Where necessary use:

$$[H=1, C=12, O=16, Mg=24]$$

1 mole of gas occupies 24 l at room temperature.

1 mole of gas occupies 22.4 l at s.t.p.

For Examiners' Use Only

1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
5	5	5	5	5	5	5	5	5	5	15	15	15	15	100

SECTION A: (50 MARKS)

Answer all questions in this section.

1. Carbon exists in different forms.

(a) Giving a reason in each case, name the form of carbon which is used (02 marks)

(i) to make glass cutters.

Name:

Diamond ✓

Reason:

Diamond is very hard ✓

(ii) as electrodes.

Name:

Graphite ✓

Reason:

Graphite has free mobile electrons to conduct electricity ✓

(b) Name two elements other than carbon that exist in different forms. (01 mark)

Sulphur ✓

Phosphorus ✓

2. The atomic numbers of elements Q, T, X, Y and Z are 2, 7, 11, 13 and 16 respectively.

(a) Write a formula for the compound formed if: (01 mark)

(i) Y reacts with Z.

Y_2Z_3

reject Z_3Y_2

(ii) X reacts with T.

X_3T

reject TX_3

(b) State the element(s) that:

(i) exist(s) as diatomic gas(es).

(ii) is/are inert.

(iii) is/are metals.

(c) Which one of the elements belongs to group I in the Periodic Table?

3. Zinc reacts with steam to give a solid Y and a gas Z.

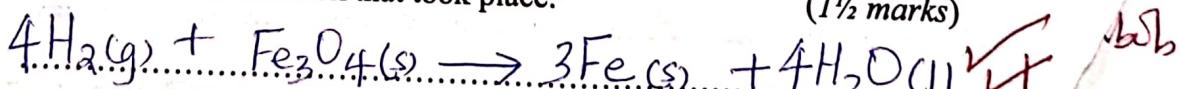
(a) Identify;

(i) solid Y.

(ii) gas Z.

(b) State how gas Z can be tested in the laboratory.

(c) Z was passed over heated triiron tetraoxide (Fe_3O_4). Write an equation for the reaction that took place.



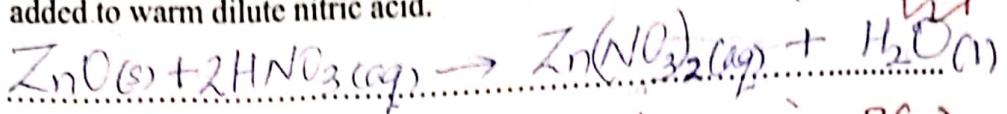
reject wrong symbols.

- $\frac{1}{2}$ for wrong states.

Award 0 for unbalanced eqn.

Turn Over

- (d) Write an equation for the reaction that would take place if solid Y was added to warm dilute nitric acid. (1½ marks)



Accept ionic eqn. Mark as in 3(c)

1½

4. A hydrocarbon Q consists of 85.7% carbon by mass.

- (a) Determine the simplest formula of Q. (02 marks)

$$\% \text{ of Hydrogen} = 100 - 85.7 = 14.3$$

Elements	C	H	Award 1 mark for $(100 - 85.7)$
moles	85.7	14	Simplest formula
	7.1417	1	

Simplest ratio $\frac{7.1417}{7.1417} : \frac{1}{7.1417}$ is CH_2 .

$$1 : 1.9622$$

1 : 2

- (b) 0.224 g of Q occupies 96 cm³ at room temperature.

- (i) Determine the molecular formula of Q. (03 marks)

96 cm³ of Q contain 0.224 g

24000 cm³ contain $\left(\frac{24000 \times 0.224}{96} \right)$ g

Accept other logical approach $= 56$ g

$$(\text{CH}_2)_n = 56$$

$$(12+2)n = 56$$

accordingly

$$14n = 56$$

3

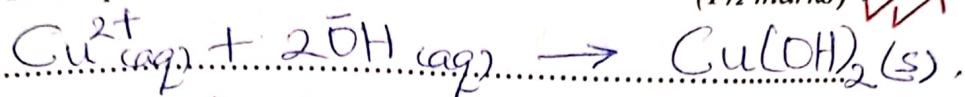
$$n = 4$$

Molecular formula is C_4H_8 .

5. (a) State what is observed and write an ionic equation for the reaction that takes place when excess dilute sodium hydroxide solution is added to copper(II) chloride solution.
- (i) Observation

(Pale) blue precipitate insoluble ✓ Block mark (½ mark)

- (ii) Ionic equation



Mark as in 3(c)
reject molecular eqn

- (b) (i) Name the reagent that can be used to identify the anion in copper(II) chloride.

B Silver nitrate solution ✓
Accept dilute nitric acid followed by
Silver nitrate solution

- (ii) State what would be observed if the anion was treated with the reagent you have named.

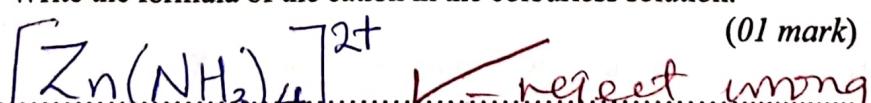
White precipitate ✓

- (c) When aqueous ammonia was added dropwise until in excess to a solution containing zinc ions, a white precipitate was formed which dissolved afterwards into a colourless solution.

- (i) Give a reason why the precipitate dissolved.

The Zinc hydroxide formed dissolves
to form a complex soluble in water
~~reject amphoteric~~
~~Accept Accept~~ complex ion

- (ii) Write the formula of the cation in the colourless solution.



✓ reject wrong symbols
- charge missing

6. (a) State what is meant by the term heat of combustion. (01 mark)

.....Heat of combustion is the heat evolved given out when one mole of a substance is completely burnt in oxygen. ✓ Accept heat change emphasize one mole

- (b) When 0.4 g of an alcohol X was burnt completely, it raised the temperature of 100 g of water by 21.5°C . Calculate the heat of combustion of X.

(Formula mass of X = 32, specific heat capacity of water = $4.2 \text{ J g}^{-1} \text{ }^{\circ}\text{C}^{-1}$). (2½ marks)

$$\begin{aligned}\text{Heat evolved} &= \frac{\text{mass of H}_2\text{O} \times \text{specific heat}}{\text{Capacity} \times \text{temperature rise}} \\ &= (100 \times 4.2 \times 21.5) \checkmark \\ &= 9030 \text{ Joules.}\end{aligned}$$

$$\begin{aligned}\text{Moles of X burnt} &= \frac{0.4}{32} \checkmark \\ \frac{0.4}{32} \text{ moles of X} &\text{ evolve } 9030 \text{ J.} \checkmark\end{aligned}$$

$$\begin{aligned}1 \text{ mole of X evolves} & \left(\frac{1 \times 9030 \times 32}{0.4} \right) \checkmark \\ &= 722400 \text{ J mol}^{-1} \checkmark\end{aligned}$$

Heat of combustion of X is $-722400 \text{ J mol}^{-1}$
or $-722.400 \text{ kJ mol}^{-1}$ (Q2)

reject answer if no charge shown, or units missing or wrong.

- (c) (i) State how the heat of combustion of X that you have calculated in (b) would compare with the theoretical value. (01 mark)

It would be less than the theoretical value (Q)

- (ii) Give a reason for your answer in (c) (i). (½ mark)

Some heat is lost to the surroundings. $\frac{1}{2}$

7. Impure copper is purified by electrolysis.

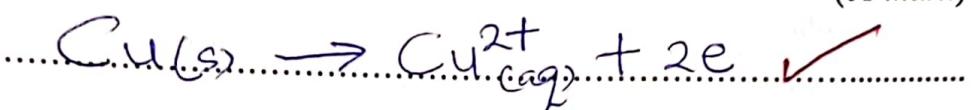
- (a) Name the electrolyte used during the purification of copper. (01 mark)

Copper(II) sulphate solution ✓

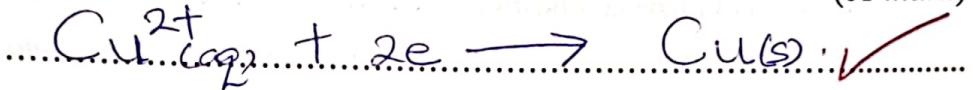
Accept acidified copper(II) sulphate solution

- (b) Write an equation for the reaction at the:

- (i) anode. (01 mark)



- (ii) cathode. (01 mark)



- (c) State what is observed at the end of the process. (01 mark)

A brown solid is deposited at the cathode. ✓

The electrolyte remains a blue solution.

- (d) State what would be observed if a clean iron-nail was placed into the electrolyte you have named in (a). (01 mark)

Grey solid dissolves. Blue solution turns green ✓ A brown solid formed. reject brown precipitate

8. Fermentation of glucose produces ethanol which is about 10% by volume.

- (a) (i) Name the process by which the percentage of ethanol could be increased. (01 mark)

Fractional distillation ✓ reject distillation

- (ii) State the principle on which the process you have named in (a) (i) works. (01 mark)

Water and ethanol have different boiling points ✓

- (b) Ethanol undergoes complete combustion in oxygen according to the following equation.



- (i) Calculate the heat evolved when 21.6 g of ethanol undergoes complete combustion. (02 marks)

(The enthalpy of combustion of ethanol = $1370.0 \text{ kJ mol}^{-1}$)

Molar mass of $C_2H_5OH = (2 \times 12) + (6 \times 1) + (16 \times 1)$
= 46 g

46 g of C_2H_5OH evolve 1370.0 kJ .
21.6 g will evolve $\left(\frac{21.6 \times 1370}{46} \right)$

= 643.30 kJ

-½ if units missing

- (ii) State the practical application of combustion of ethanol. (01 mark)

Mixed with petrol to make fuel for car engines

9. (a) A clean piece of calcium was dropped into water in a beaker.

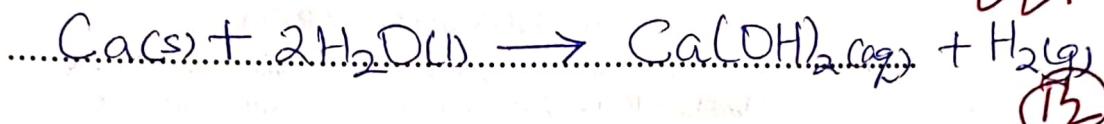
- (i) State what was observed.

(2½ marks)

Grey solid sinks with effervescence
(bubbles) of a colourless gas gradually disappears to form
a (white) (milky) suspension.

2½

- (ii) Write an equation for the reaction. (1½ marks)



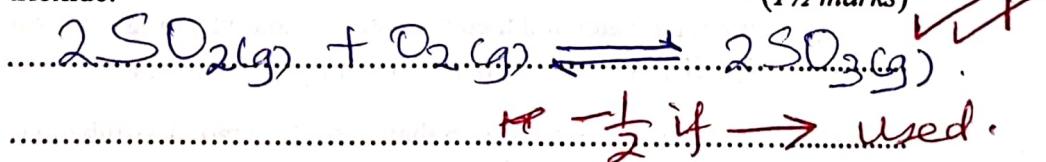
12

- (b) Blue litmus paper was dipped into the resultant solution in (a). State what was observed. (01 mark)

Blue litmus paper (remains blue)

10. In the manufacture of sulphuric acid by the contact process, sulphur dioxide reacts reversibly with excess oxygen in the presence of vanadium(V) oxide at a relatively low temperature to form sulphur trioxide.

- (a) Write an equation for the reaction leading to the formation of sulphur trioxide. (1½ marks)



H → if → used.

- (b) Suggest a reason for the use of:

- (i) excess oxygen. (01 mark)

To make ~~sure~~ all the ~~expensive~~
Sulphur dioxide reacts! (Used up)

(1½ marks)

- (ii) low temperature.

To make the equilibrium yield of sulphur dioxide high. Since reaction is exothermic, high temperatures are not required.

- (c) State one reason why vanadium(V) oxide is preferred as a catalyst in the manufacture of sulphuric acid. (01 mark)

It is cheaper.
Not easily poisoned by impurities.
Accept any one.

SECTION B: (30 MARKS)

Answer any two questions from this section.
Additional question(s) answered will not be marked.

11. During laboratory preparation of chlorine from hydrochloric acid, the gas is first passed through water, then through concentrated sulphuric acid before it is collected.

- (a) (i) Name a substance that is reacted with hydrochloric acid to produce chlorine. (01 mark)

- (ii) State the conditions and write an equation for the reaction leading to the formation of chlorine. (2½ marks)

- (iii) Give reasons why chlorine is passed through water and then concentrated sulphuric acid before it is collected. (02 marks)

- (b) A long glass tube filled with chlorine was inverted in a beaker containing water and then allowed to stand in sunlight for sometime. State what was observed and explain your observations. (06 marks)

- (c) To a sample of the solution that was left in the glass tube in (b), silver nitrate solution was added.

State what was observed and write an ionic equation for the reaction that took place. (2½ marks)

- (d) State one use of chlorine. (01 mark)

12. (a) Describe how a dry sample of zinc sulphate crystals can be prepared from zinc. (Your description should include equation(s) for the reaction(s) that take(s) place.) (7½ marks)
- (b) To a mixture of zinc sulphate crystals and sufficient sodium carbonate, water was added and the mixture shaken then filtered.
- State what would be observed if acidified barium chloride solution was added to the filtrate. (01 mark)
 - Write an ionic equation for the reaction in (b) (i). (1½ marks)
- (c) The residue in (b) was dried and heated until no further change then allowed to cool.
- State what was observed. (1½ marks)
 - Write an equation for the reaction that took place. (1½ marks)
- (d) To the cooled product in (c) was added dilute sulphuric acid. State what was observed and write the equation for the reaction. (02 marks)
13. (a) State what is meant by the term **rate of reaction**. (01 mark)
- (b) Table 1 shows volumes of hydrogen gas liberated when 2.0 g of magnesium separately reacted with different volumes of hydrochloric acid of a uniform concentration.
- Table 1**
- | Volume of hydrochloric acid (cm^3) | 0 | 5 | 15 | 20 | 25 | 35 | 45 |
|---|---|-----|-----|-----|-----|-----|-----|
| Volume of hydrogen gas (cm^3) | 0 | 120 | 360 | 500 | 600 | 600 | 600 |
- Plot a graph of volume of hydrogen gas formed against volume of hydrochloric acid used. (04 marks)
 - Determine the volume of hydrochloric acid needed to react exactly with the 2.0 g of magnesium. (01 mark)
 - (i) Write an equation for the reaction in (b). (1½ marks)
(ii) Determine the number of moles of magnesium that reacted. (1½ marks)
(iii) Calculate the concentration of hydrochloric acid in moles dm^{-3} . (2½ marks)
 - Explain the effect of the following on the rate of reaction:
 - Concentration. (02 marks)
 - Surface area. (1½ marks)

- 14.** (a) Sodium metal is extracted by the electrolysis of molten sodium chloride to which calcium chloride has been added.
- (i) Give a reason for adding calcium chloride. (01 mark)
- (ii) Name **one** substance that is used as the cathode and another as the anode. (01 mark)
- (b) (i) Write equations for the reactions that take place at the cathode and anode. (03 marks)
- (ii) State how the product at the cathode is collected and give a reason. (1½ marks)
- (iii) Name **two** other elements that can be extracted by a similar method. (01 mark)
- (c) A small piece of sodium metal was lit and lowered into a gas jar of oxygen. State what was observed and write an equation for the reaction that took place. (03 marks)
- (d) The product in (c) was dissolved in water and the solution tested with litmus. State what was observed and write an equation for the reaction that took place. (2½ marks)
- (e) Name **one** place in Uganda where a plant for extraction of sodium could be constructed and give a reason for your answer. (02 marks)

QN 11

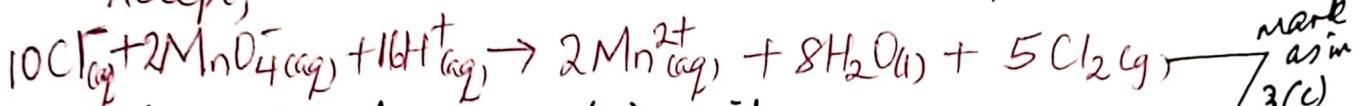
(i) (ii) Potassium manganate(VII) ✓ Accept potassium permanganate
 Emphasize spelling
 Accept if crystals present
 Reject formula

(iii) Room temperature ✓

Concentrated acid. ✓



Accept;



mark as in
3(c)

Acc a(i) Manganese (IV) oxide.

(iv) Heat required, concentrated acid. ✓



Accept Bleaching powder, etc and corresponding entries

(v) Passed through water to remove traces of hydrogen chloride gas and then through concentrated sulphuric acid to be dried. ✓

ignore explanations.

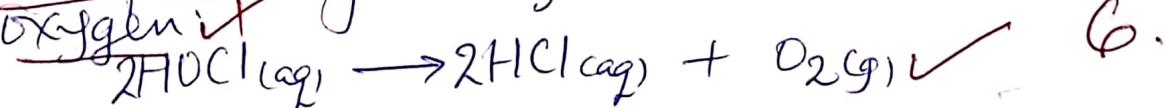
(b) Observation: The greenish-yellow gas dissolved forming a yellow-green/greenish-yellow/yellowish solution which then changes colourless and bubbles of a colourless gas which collects in the tube. ✓ reject effervescence

Chlorine

Explanation: Chlorine dissolved in water to form chlorine water (a mixture of hydrochloric acid and hypochlorous acid) ✓ Accept reacts with water

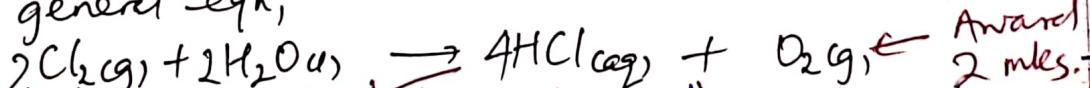


The hypochlorous acid (chloric (I) acid) slowly decomposes to form hydrochloric acid and oxygen. ✓



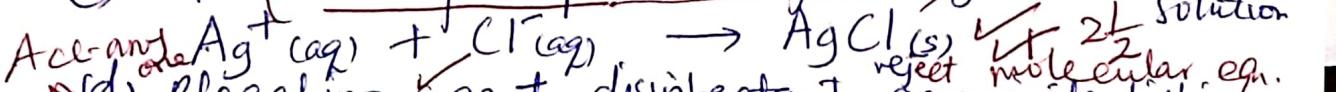
6.

Accept general eqn;



Award 2 mks.

(c) A white precipitate is formed from the solution



reject molecular eqn.

(d) Bleaching agent, disinfectant, germicide, killing germs, water treatment, making hypochlorite acid, etc.

Deny^t for only sulphuric acid
 Add dilute sulphuric acid to an excess of zinc powder/granules in a beaker.
 Add a little copper(II) sulphate solution/crystals and was gently.
 Bubbles of a colourless gas are observed.
 Filter off the excess zinc and any other solid impurities.
 A colourless filtrate is obtained.
 The filtrate is placed in an evaporating dish and heated/evaporated to dryness.
 It's then cooled under tap water.
 Crystals then are formed and more form as $\frac{1}{2}$.
 the solution is cooled further.
 The crystals are filtered off, washed (2 or 3 times) with cold distilled water and dried between filter papers or in sunshine.

- $Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$
- (b) i) White colourless filtrate formed a $\textcircled{1}$
 (white precipitate)
 $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s) \textcircled{1/2}$
- ii) White residue turned to a yellow residue when hot and white when cooled $\textcircled{1/2}$
 $ZnCO_3(s) \rightarrow ZnO(s) + CO_2(g) \textcircled{1/2}$
- (c) Observation: White residue dissolved to form a colourless solution at
 $ZnO(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2O(l) \textcircled{2}$

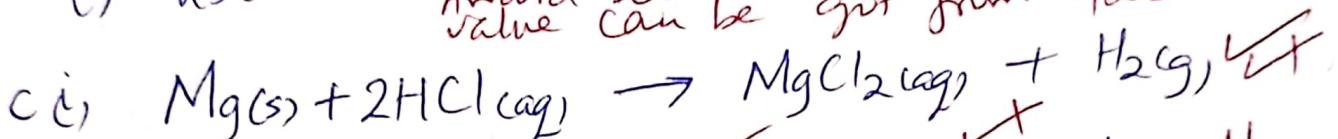
QN 13

(a) Amount of product formed per unit time (in a chemical reaction)

or
Amount of reactant used up per unit time (in a chemical reaction)

(b) in check graph paper.

(ii) 25 cm^3 ✓ Award whether graph used or not.
Award even when graph is wrong but value can be got from table.



$$\text{iii) moles of Mg} = \frac{2.0}{24} = 0.08333 \text{ moles. } \frac{1}{2} \text{ L}$$

$$\text{iv) } \text{Mole ratio of Mg : HCl} = 1:2 \text{ ✓. } \\ \text{moles of HCl} = (2 \times 0.08333) \cancel{\text{is}} = \underline{0.1667} \text{ ✓. } \\ \text{Acc } 2 \times \frac{2.0}{24}$$

$$\text{Molar concentration of HCl} = \left(\frac{1000 \times 0.1667}{25} \right) \cancel{\text{is}} = \underline{6.668 \text{ mol/dm}^{-3}}$$

(d) i) The higher the concentration of reacting particles, the higher the frequency of collisions, and the higher the rate of reaction.

(2)

ii) The larger the surface area of reacting particles, the greater the rate of reaction due to increased collision frequency.

(1½)

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(To be fastened together with other answers to paper)

UCE

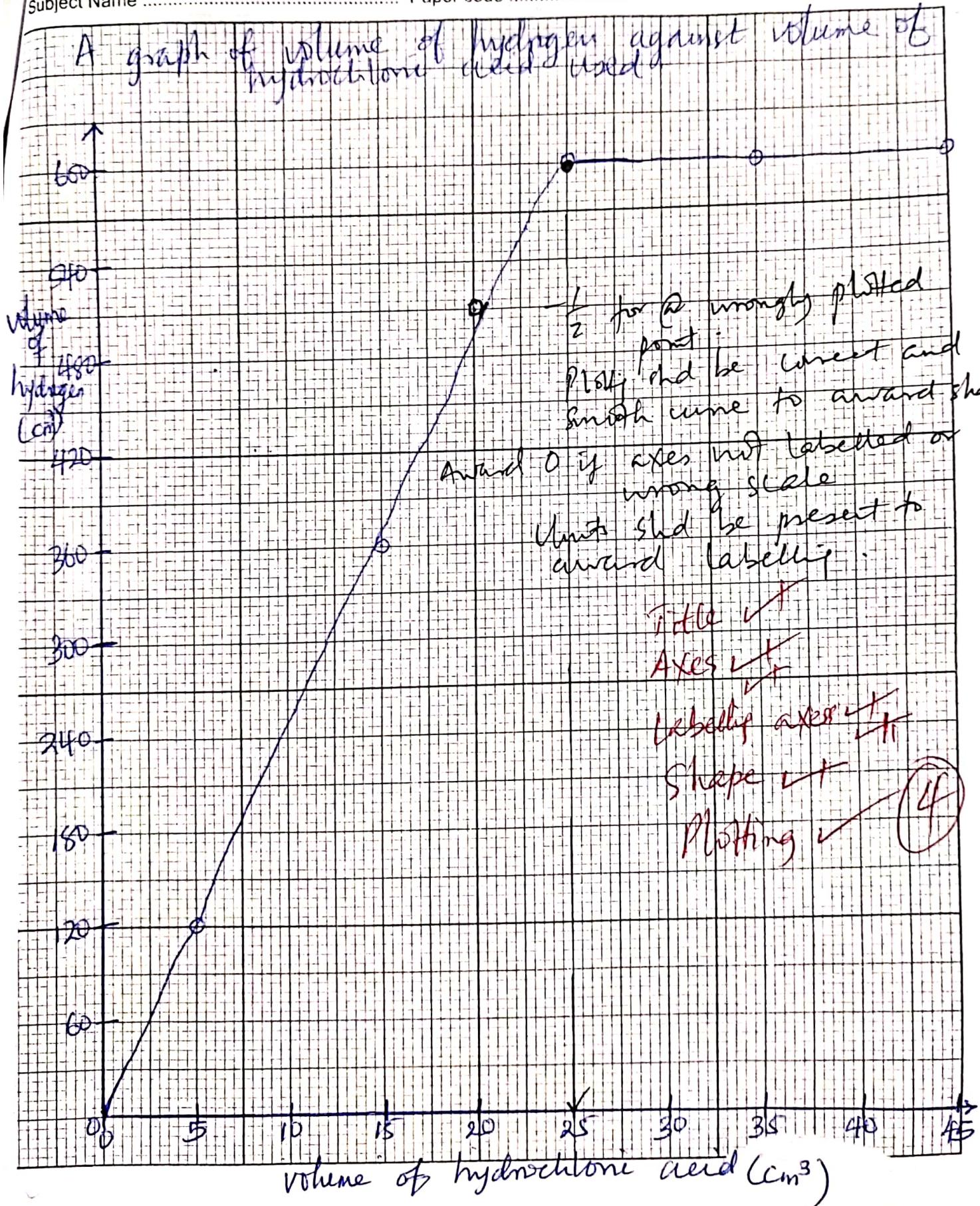
Candidate's Name

Random No.

Signature

Personal Number

Subject Name Paper code /



Title ✓

Axes ✓

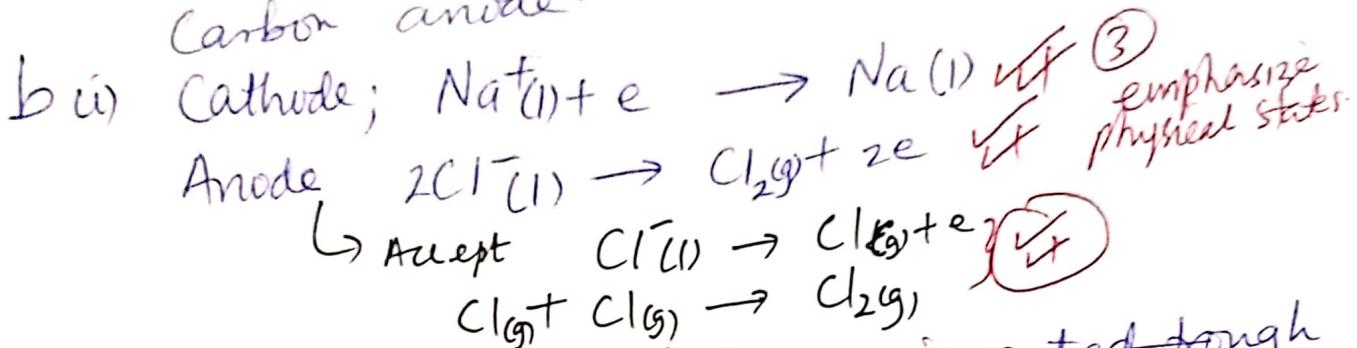
Labelling axes ✓

Shape ✓

Plotting ✓

(i) To lower the melting point of sodium chloride
 (from 800°C to ~~600°C~~ below 600°C)

(ii) Iron cathode ✓
 Carbon anode ✗



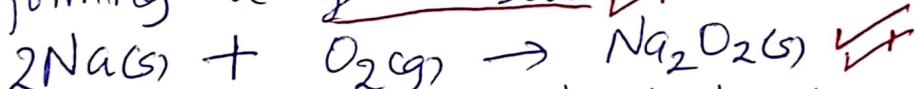
(ii) Sodium is collected in an inverted trough over the iron cathode, rise up a pipe into

(iii) Sodium is collected under ^{dry} nitrogen dry ^{reject if miss} because it is a highly reactive element and nitrogen is relatively inert. Accept liquid paraffin or kerosene

(iv) Potassium and magnesium ✓
 → emphasise spelling

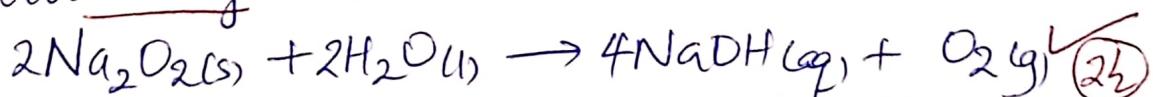
reject any other element apart from calcium or aluminium

(v) Sodium burns ✓ forming a yellow solid ✓ a (bright) yellow flame



③

(vi) yellow solid dissolved to form a colourless solution ✓ and bubbles of a colourless gas ✓ The solution turns litmus blue.



②

(vii) Near Lake Katwe ✓ Reject Lake Katwe.
 Accept any place near the lake
 There are deposits of sodium chloride in Lake Katwe.

—END—