

MARKING GUIDE

545/2

CHEMISTRY

Paper 2

2023.

COUHEA.

Uganda Certificate of Education

Chemistry Paper 2

DURATION: 2 HOURS

INSTRUCTIONS:

1. This paper consists of 10 structured questions in section A and 4 semi-structured questions in section B.
 2. Answer all the 10 questions in Section A in the spaces provided. Select only ~~two~~ questions from section B and answer on the separate answer sheets provided.
 3. In all cases show your working clearly.
 4. Where necessary use: (H = 1, C = 12, O = 16, Na = 23, P = 31.
1 mole of gas at S.t.p occupies 22.4dm³: 1 mole of gas occupies 24dm³ at room temperature)

For Examiners use only.

SECTION A (50MARKS)

1. a) State with a reason whether the following process is a physical or a chemical change.

i) Water electrolysis

Chemical change ✓

(½ mark)

1
2

Reason

Because hydrogen and oxygen are formed (1mark)
as new products. ✓

ii) Separating vinegar and water by distillation

(½ mark)

Physical change. ✓

1
2

Reason

No new substance is formed (1mark) ✓

1

b) Distillation method can be used to remove hardness from water.

State;

i) the property that is the basis for using distillation method. (1mark)

Water is volatile while the salts are non-volatile. ✓

1
2

ii) One advantage of the method

It can remove all hardness ✓

(½ mark)

1
2

iii) one disadvantage of the method

It is an expensive method ✓

(½ mark)

1
2

2. Below are some of the properties of elements P, Q, R, and T. Use them to answer

05

the questions that follow. The letters are not the actual symbols of the elements.

Element	Properties
P	Is the only non-metal that forms a neutral, liquid oxide at room temperature Burns with a pop sound in presence of a strong flame
Q	<ul style="list-style-type: none">Is in period 3, forms an amphoteric oxide of formula Q_2O_3Does not react with water but the heated element reacts with steam.
R	<ul style="list-style-type: none">Is in period 2, Forms two oxides, a neutral but very poisonous monoxide and an acidic dioxide that turns lime water milky.
T.	<ul style="list-style-type: none">Does not form compoundsIs in same period of the periodic table as P.

a) Write the electronic configuration of element.

Q: $2:8:3$ ✓ (½ mark)

R: $2:4$ ✓ (½ mark)

b) Identify which element:

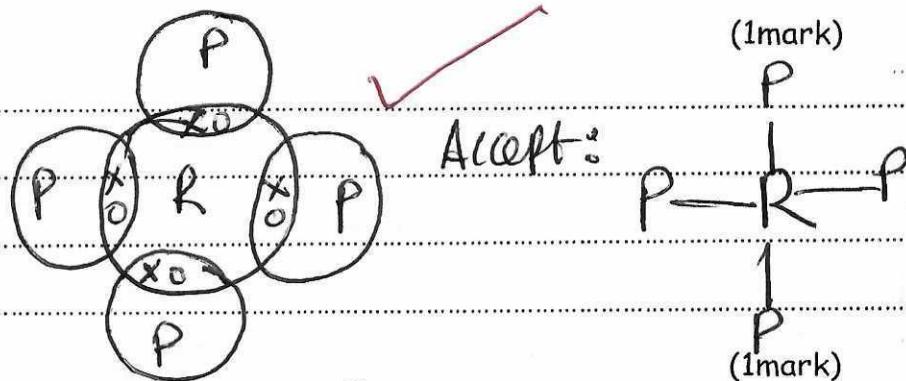
i) Is a noble gas T ✓ (½ mark)

ii) Is commonly used to make food containers. Q ✓ (½ mark)

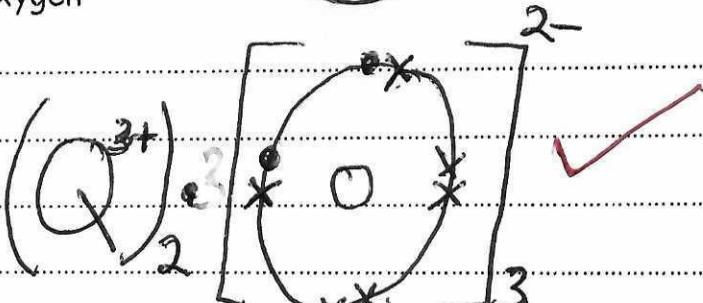
iii) Is a metal Q ✓ (½ mark)

C) Draw in the space below the structures of the compounds formed between

i) R and P



ii) Q and oxygen



d) State one property of the compound formed between Q and oxygen. (½ mark)

Conducts electricity in molten or aqueous state. ✓ ½

3. Aqueous Lead (II) nitrate reacts with aqueous potassium iodide as shown below: 05



a) Name a method:

i) that could be used to separate the products. (1mark)

Filtration ✓

ii) that could be used to obtain pure crystals of KNO_3 (1mark)

Crystallisation (or Evaporation to dryness) ✓

b) Suggest:

i) a reason for the choice of the method given in (a)(ii) above. (1mark)

Water can evaporate while KNO_3 cannot
(OR Water is volatile, KNO_3 is non-volatile.) ✓

ii) one practical application of the reaction above. (1mark)

Confirming Lead (II) ions in solution. ✓

c) State what would be observed when the pure dry crystals of KNO_3 are strongly heated in a dry test tube.

Melts to a colourless liquid liberating bubbles of gas and forms a pale yellow solid on cooling. ✓

4. Two different atoms of phosphorus are ^{31}P and ^{32}P and two the different forms of phosphorus are, white phosphorus and Red phosphorus. 0.5/2

a) What chemical term is used to describe:

i) the two different atoms of phosphorus? (½ mark)

Isotopes ✓

ii) the two different forms of phosphorus? (½ mark)

Allotropes ✓

b) State:

i) One difference between the two atoms. (½ mark)

Have different mass numbers ✓

OR Have different number of neutrons. ✓

ii) One similarity between the two atoms. (½ mark)

Have same atomic number. ✓

c) i) Identify the form of phosphorus that smolders when exposed to air. ($\frac{1}{2}$ mark)

White Phosphorus ✓

$\frac{1}{2}$

ii) Suggest any precaution taken to prevent the smoldering. ($\frac{1}{2}$ mark)

It is stored under water. ✓

$\frac{1}{2}$

d) Phosphorus forms simple molecules which have a relative molecular mass 124.

Suggest the molecular formula of the molecules. (1mark)

$$\text{Let } P_n = 124 \quad n = 4$$

$$31n = 124 \quad n = \frac{124}{31}$$

$$n = 4$$

Thus molecular formula is P₄ ✓

$\frac{1}{2}$

e) Phosphorus has a low melting point and does not conduct electricity. Suggest a reason why:

i) phosphorus has a low melting point.

Has weak intermolecular forces (or Van der waal's forces) ✓ $(\frac{1}{2} \text{ mark})$ weak

$\frac{1}{2}$

ii) Phosphorus does not conduct electricity.

Lack free mobile electrons, ✓ $(\frac{1}{2} \text{ mark})$

$\frac{1}{2}$

5. During the preparation of copper(II) sulphate crystals using copper metal and concentrated sulphuric acid, after effervescence has ceased a dark brown residue is left.

a) Name the two components present in the dark brown residue. (2 marks)

- Copper (II) Sulphide ✓

2

- Copper (II) Sulphate. ✓

b) Write equation for the reaction leading to formation of:

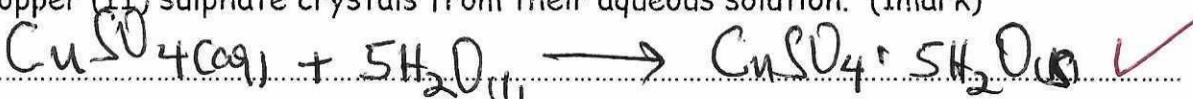
i) Copper (II) sulphate in solution.



✓ $(1\frac{1}{2} \text{ marks})$

$\frac{1}{2}$

ii) Copper (II) sulphate crystals from their aqueous solution. (1mark)



1

c) State what is observed when dry crystals of copper (II) sulphate are gently heated. 1
5

Blue crystals turn to white

6. a) Concentrated aqueous sodium chloride was electrolysed using graphite electrodes. Name the product(s) formed at :

i) the positive electrode. (1 mark)

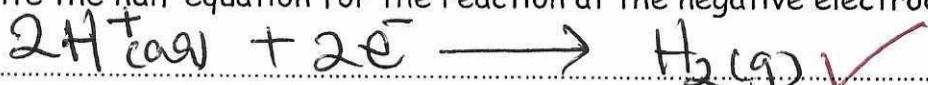
- Chlorine gas ✓

- Oxygen gas ✓

ii) the negative electrode. (½ mark)

Hydrogen gas ✓

b) Write the half equation for the reaction at the negative electrode. (1mark)



c) Chlorine gas can be prepared on a large scale by electrolysis of concentrated aqueous sodium chloride according to the overall equation below.



i) What common name is given to concentrated aqueous sodium chloride? (½ mark)

Brine ✓

ii) If 55dm^3 of 3.5mol/dm^3 of sodium chloride solution is completely electrolysed, what is the maximum volume of chlorine that can be formed and measured at room temperature and pressure? (2marks)

1000cm^3 of NaCl solution contain 3.5 moles.

1dm^3 of NaCl solution contains 3.5 moles
 dm^3 of NaCl solution contains (3.5×55) moles

2 moles of NaCl reacted to produce 1 mole of H_2
192.5 moles of NaCl produced $\frac{1}{2} \times 192.5$ ✓

= 96.25 moles of H_2

1 mole of H_2 occupies 24dm^3

96.25 moles of H_2 occupies

$$\underline{(24 \times 96.25)}$$

05

$$= \underline{\underline{2,310\text{dm}^3}}$$
 of hydrogen

7. Petroleum (Crude oil) is a mixture of hydrocarbons and the refinery gas fraction known as natural gas contains methane, ethane and propane

a) State what is meant by the term hydrocarbons. (1 mark)

This is a compound containing only carbon and hydrogen.

b) State:

i) the component with mole percentage 94.7% in natural gas. ($\frac{1}{2}$ mark)

Methane

ii) the homologous series to which the hydrocarbons in natural gas belong. ($\frac{1}{2}$ mark)

Alkanes

iii) the general formula of the homologous series that contains methane, ethane and propane. ($\frac{1}{2}$ mark)

C_nH_{2n+2}

iv) the common name of the homologous series containing natural gas. ($\frac{1}{2}$ mark)

Paraffins

c) Give one use of each of the following components of petroleum.

i) Kerosene

- used as a fuel for domestic cooking, lighting

ii) naphtha

- Making varnishes, used for making laundry soaps, washing cleaning fluids, used as a fuel in camp stoves.

d) Name

i) one non-energy component found in natural gas.

Hydrogen Sulphide (or Carbon dioxide, nitrogen, water)

ii) the process by which long chain hydrocarbons are broken down to simpler ones.

($\frac{1}{2}$ mark)

Cracking

(Allow: Catalytic cracking or thermal cracking.)

05

8. Ethanoic acid, CH_3COOH is a monobasic acid and is considered a weak acid.

a) State what is meant by the terms:

i) Monobasic acid

(1mark)

An acid that has only one hydrogen ion to donate to a base in an acid-base reaction.
(Accept equivalent definitions).

ii) Weak acid

(1mark)

This is an acid that does not completely dissociate in aqueous solution.
(Accept equivalent definitions).

b) The melting point of ethanoic acid is 16.7°C and the boiling point is 118°C .

i) Deduce the physical state of ethanoic acid at 130.0°C .

($\frac{1}{2}$ mark)

Gas ✓

$\frac{1}{2}$

ii) Suggest a reason for your deduction.

($\frac{1}{2}$ mark)

Because 130.0°C is above the boiling point 118°C .

$\frac{1}{2}$

c) Ethanoic acid reacts with sodium carbonate according to the equation below.



A student added 3.18g of sodium carbonate to 224cm^3 of 0.250 M ethanoic acid.

Determine which of the two reagents was added in excess. (2marks)

$$\text{RMM of } \text{Na}_2\text{CO}_3 = 23 \times 2 + 12 + 16 \times 3$$

$$= 106$$

From ratio of $\text{CH}_3\text{COOH} : \text{Na}_2\text{CO}_3 = 2 : 1$

$$\text{Moles of } \text{CH}_3\text{COOH} = 2 \times 0.250$$

$$= 0.50 \text{ moles}$$

106g of Na_2CO_3 contain 1 mole

3.18g of Na_2CO_3 contain $\frac{1 \times 3.18}{106}$

$$= 0.03 \text{ moles}$$

Since 0.06 moles is greater than 0.03 moles, then

Sodium carbonate was in excess.

Moles of CH_3COOH

1000cm^3 of solution contain 0.250 moles

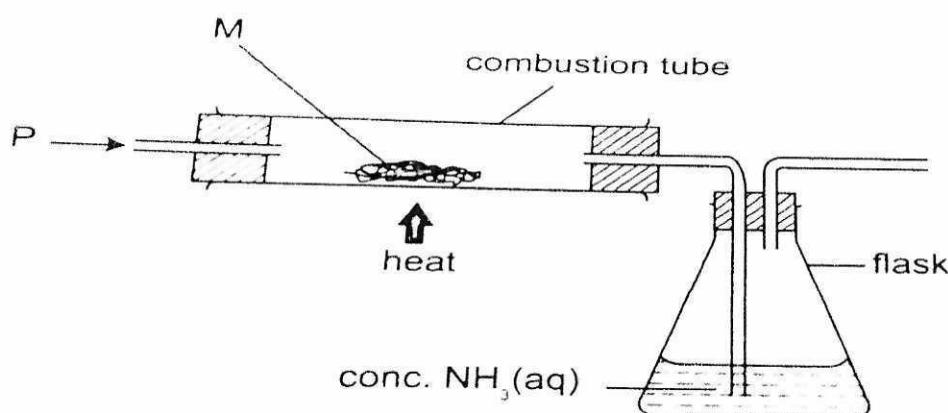
224cm^3 of solution contains

$$\frac{0.250 \times 224}{1000} \text{ moles}$$

$$= 0.056 \text{ moles of } \text{CH}_3\text{COOH}$$

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Q. The diagram below represents a set-up for the reaction between chlorine and aluminium.



a) Identify:

P: Chlorine ✓ (½ mark)

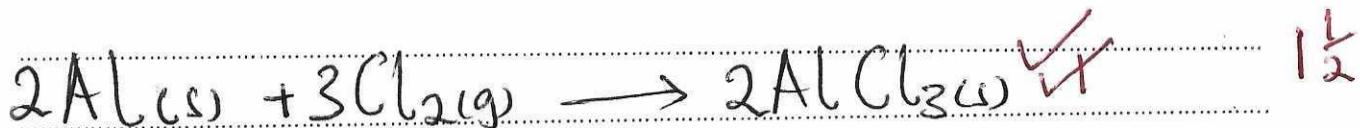
M: Aluminium ✓ (½ mark)

b) Name the substance dissolved in concentrated ammonia solution. (½ mark)

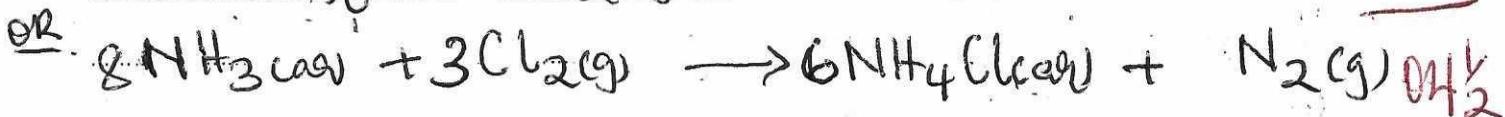
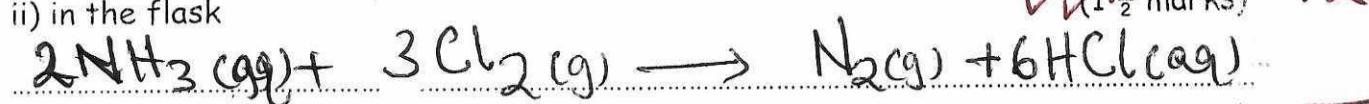
Excess chlorine. ✓

c) Write the equations for the reactions taking place in:

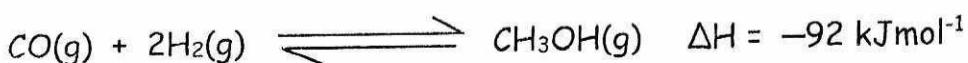
i) in the combustion tube. (1 ½ marks)



ii) in the flask



10. The formation of methanol from carbon(II) oxide and hydrogen gas can be represented by:



a) Determine;

i) the mass of carbon (II) oxide would react to give 16g of methanol? (2marks)

1mole of CH_3OH was produced by 1mole of CO.
 $(12+1\times 4+16)$ g of CH_3OH was produced by $(12+16)$ g of CO.
32g of CH_3OH was produced by 28g of CO.
16g of CH_3OH was produced by $\frac{(28 \times 16)}{32}$ g of CO
 $= 14$ g of CO.
Thus mass of Carbon(II)oxide = 14g ✓

ii) the amount of heat that would be evolved to produce 16g of methanol. ($1\frac{1}{2}$ marks)

1mole of CO produces 92 kJ
 (28) g of CO produces 92 kJ
 $\therefore 14$ g of CO produces $\frac{(92 \times 14)}{28}$ kJ
 $= 46$ kJ ✓

b) State what would happen to the amount of methanol if temperature is increased. Give a reason to support your answer.

Amount of methanol would increase ✓ 15
This is because increase in temperature increases kinetic energy of the reactants such that they collide faster ✓ 05

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(To be fastened together with other answers to paper)

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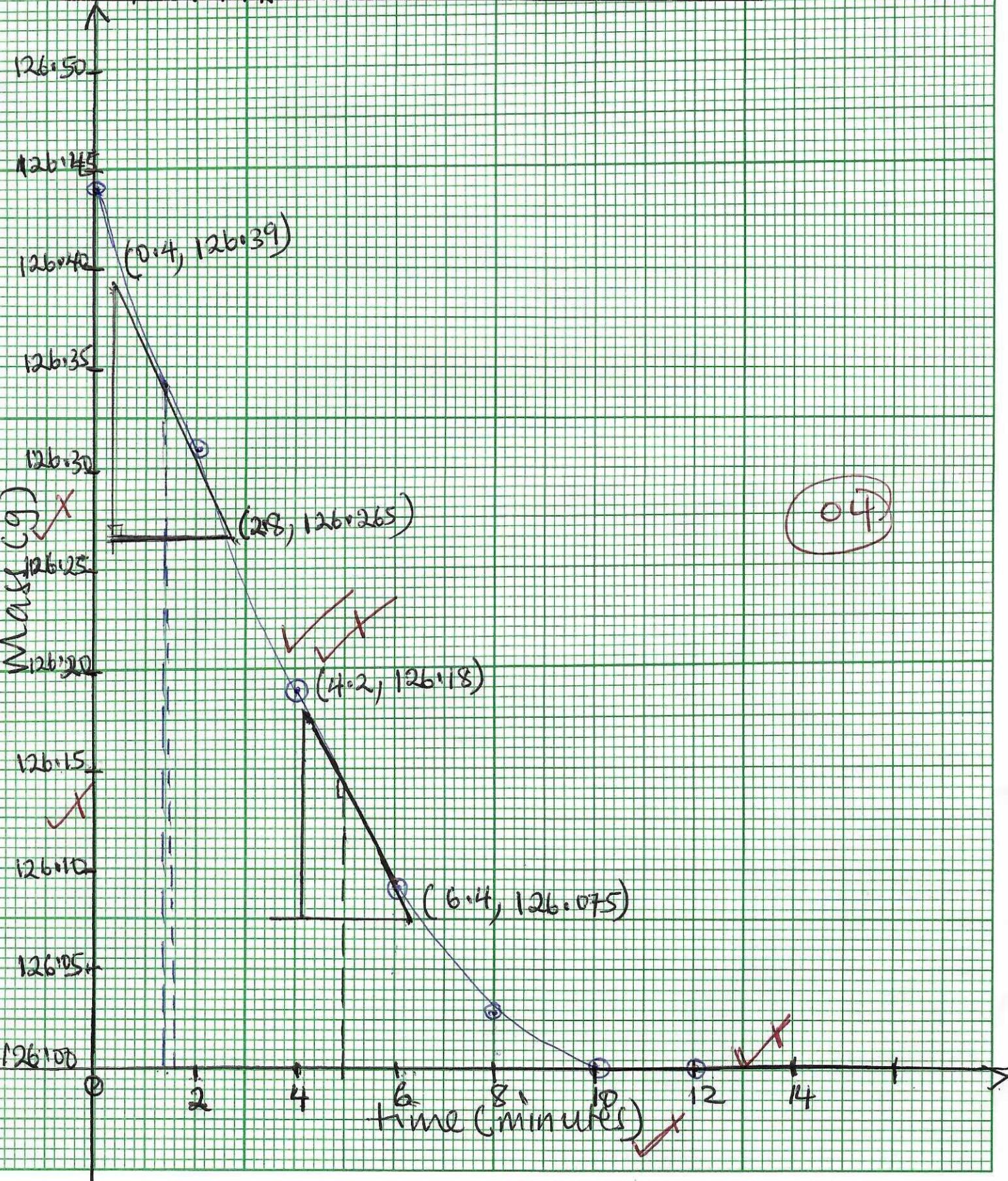
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A GRAPH MASS AGAINST TIME ✓



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QUESTION 11

- a) i) Solvay process. ✓ 1
- ii) Concentrated sodium chloride solution (or Brine). ✓ 1½
- Ammonia ✓
 - Carbon dioxide. ✓
- iii) Anhydrous : soda ash ✓
 Hydrated : washing soda ✓ crystals. ✓ 1
- b) i) $\text{NaCl(aq)} + \text{NH}_4\text{OH(aq)} + \text{CO}_2(\text{g}) \rightarrow \text{NaHCO}_3(\text{s}) + \text{NH}_4\text{Cl(aq)}$
 ✓ 4½
- $2\text{NaHCO}_3(\text{s}) \rightarrow \text{Na}_2\text{CO}_3(\text{s}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O(l)}$ ✓
- ii) $\text{Na}_2\text{CO}_3(\text{s}) + 10\text{H}_2\text{O(l)} \rightarrow \text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O(s)}$ ✓ 1½
- c) i) Ammonia. ✓ ½
 ii) Calcium chloride. ✓ ½
- d) $2\text{NH}_4\text{Cl(aq)} + \text{Ca(OH)}_2(\text{s}) \rightarrow \text{CaCl}_2(\text{aq}) + 2\text{H}_2\text{O(l)} + 2\text{NH}_3(\text{g})$ ✓ 1½
- e) i) Uses of anhydrous sodium carbonate.
 - used in atom manufacture of glass.
 - used in water treatment plants to balance pH.
 - Manufacture water glass. ✓ 1½



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ii) uses of washing soda

- used as a cleaning agent in abattoirs, and cosmetic industries.
- used in the manufacture of soap.
- used in textiles and petroleum refinery
- used to remove permanent hardness from water.

d) 1mole of Na_2CO_3 weighs $(23 \times 2 + 12 + 16 \times 3)$
 $= 106 \text{ g.}$

$$\text{RMM of H}_2\text{O} = 1 \times 2 + 16 = 18$$

$$\text{mass of water lost} = 20.1 - 8.1 = 12 \text{ g.}$$

$$\text{Moles of Na}_2\text{CO}_3 = \frac{8.1}{106} = 0.0764 \text{ moles}$$

$$\text{moles of H}_2\text{O} = \frac{12}{18} = 0.667 \text{ moles.}$$

	$\text{Na}_2\text{CO}_3 :$	H_2O	$2\frac{1}{2}$
moles	0.0764	0.667	
molar ratio	0.0764	0.667	$0\frac{3}{2}$
	$\frac{0.0764}{0.0764}$	$\frac{0.667}{0.667}$	

Formula $\text{Na}_2\text{CO}_3 \cdot 9\text{H}_2\text{O}$

Thus $n = 9$

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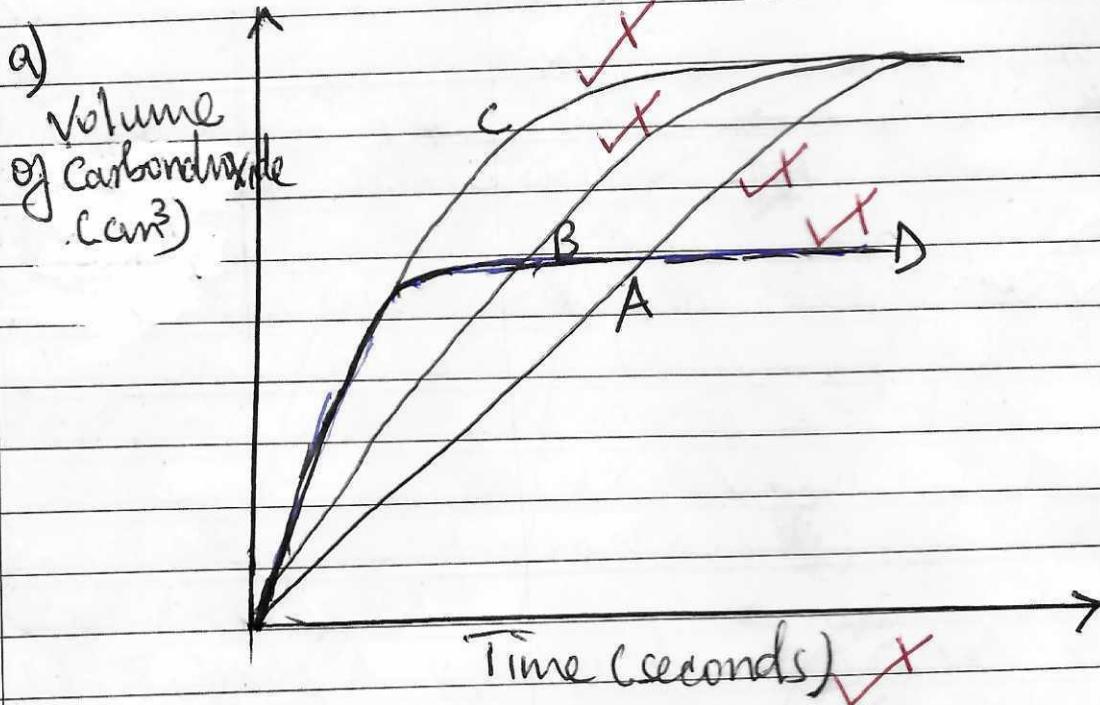
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QUESTION 12

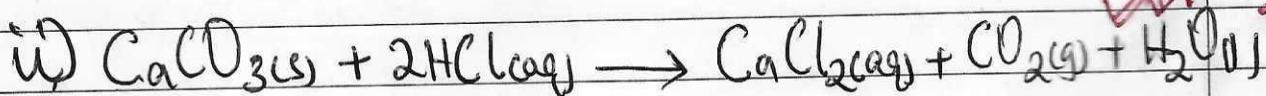


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b) i) On graph paper.

Title ✓
Labelled Axes ✓
Correct scale ✓
Plotting ✓
Correct shape ✓

4



iii) Rate at 1.4 minutes

$$\text{Rate} = \frac{126.265 - 126.39}{2.8 - 0.4} \quad \checkmark$$

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$$\frac{= -0.125}{2.4}$$

$$\text{Rate} = -0.0521 \text{ g minute}^{-1} \quad (\text{Ignore sign})$$

Rate at 5.0 minutes

$$\text{Rate} = \frac{126.075 - 126.18}{6.4 - 4.2} \quad \checkmark \quad 2$$

$$\frac{= -0.105}{2.2} \quad \checkmark$$

$$\text{Rate} = -0.04773 \text{ g minute}^{-1}$$

iv) Rate at 5 minutes is lower than rate at 1.4 minutes. ~~This is because at 1.4 minutes, the number of particles of Calcium Carbonate was still high but at 5 minutes the number of particles was getting used up.~~ 1½

- v) - By increasing concentration of the acid
 - by using powdered calcium carbonate.
 - by heating the reaction mixture.



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vi) This is because the residue absorbed water moisture from the atmosphere to form hydrated calcium chloride.
ignore equation increase in mass from 97.63 to 98.63g2

The process is deliquescence.
(Accept: Hygroscopy).

15

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QUESTION 13

a) i) An ore is a naturally occurring solid material from which a metal or mineral can be extracted profitably. ✓ 1

ii) Sodium is extracted by electrolysis because it is a very reactive metal ~~and~~ and cannot be obtained by reduction of its oxide since it is far above carbon ~~in~~ in the activity series. 2

Iron is obtained by carbon reduction method because carbon is more reactive and therefore displaces iron from its oxide ores. ✓

iii) Name: Rock salt (sodium chloride) 1

Formula: NaCl. ✓

iv) - Calcium chloride is added to lower the melting point of sodium chloride during electrolysis. ✓ 2

- Calcium chloride also helps to protect the sodium metal formed from getting oxidized by oxygen at high-temperature conditions of the cell reaction.



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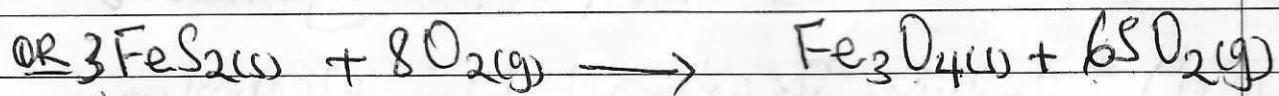
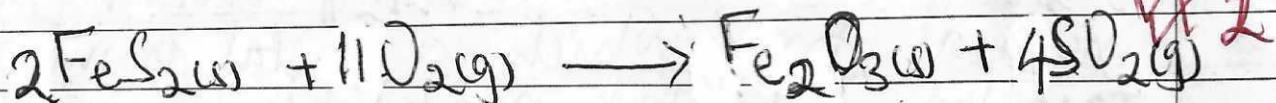
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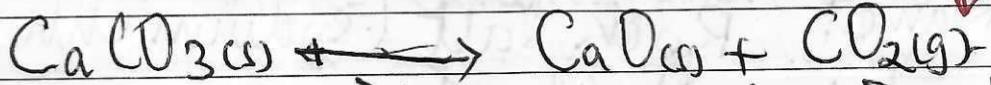
b) Roasting. ✓



c) i) Limestone

Limestone is added to remove impurities of silicon (IV) oxide (or sand) from the iron ore.

In this case, the limestone is decomposed by heat to calcium oxide (or quicklime) and carbon dioxide. ✓



The calcium oxide then reacts with the silicon (IV) oxide to form a molten slag of calcium silicate. ✓



The molten calcium silicate being less dense than molten iron, floats on top of the molten iron and helps to prevent oxygen from oxidizing iron at the high temperatures. ✓



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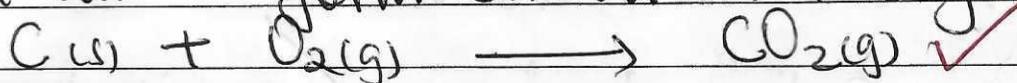
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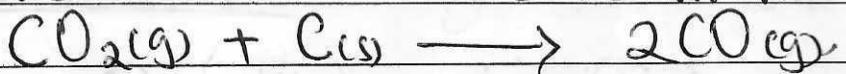
ii) COKE

COKE acts as a reducing agent.
In this case the COKE reacts with
hot air to form carbon dioxide gas.



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As the Carbon dioxide formed rises
up the blast furnace and it is reduced
by more COKE to carbon monoxide
which is the actual reducing agent that
reduces the iron ore to molten iron.



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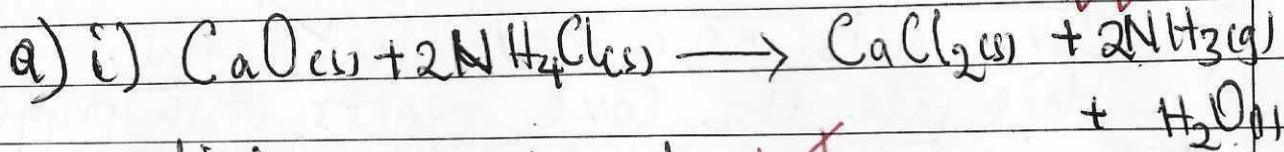
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QUESTION 14

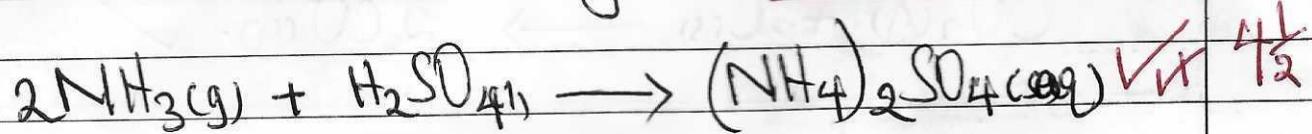


Conditions. — heat ✓

ii) — Calcium hydroxide ✓ (sodium hydroxide) 1/2

b) i) Calcium oxide ✓ 1/2

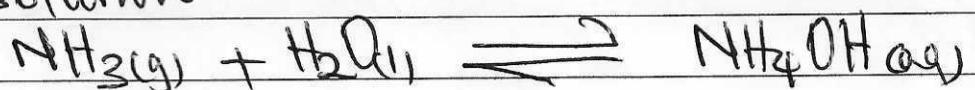
ii) The concentrated sulphuric reacts ✓ with ammonia to form ammonium sulphate



Anhydrous calcium chloride also reacts with ammonia to form a complex compound



c) This is because ammonia is very soluble in water form ammonium hydroxide solution ✓ 2



(095)



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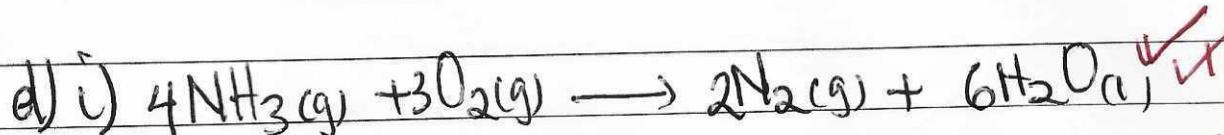
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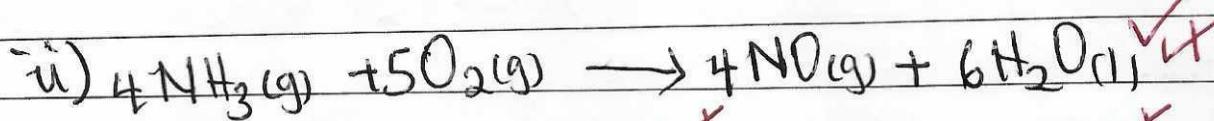
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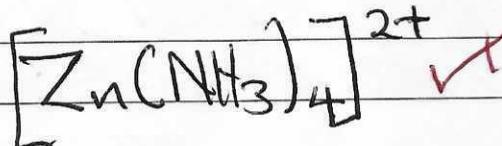
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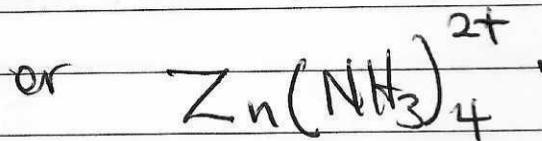
e) i) A white precipitate which dissolves in an excess of bubbling to form a colourless solution. ✓✓✓

ii) Name: Tetraamminezinc ion ✓✓✓

Formula:



0.5



1.5

TOTAL 80 MARKS

