SECTION A

*Attempt **all** questions.*

1. Candle wax is a mixture of hydrocarbon molecules that belong to the same homologous series.

(a) Explain what is meant by the term homologous series. (01marks)

Rej's; If not organic compounds ✓

is a group of organic compounds with same functional groups. 01

Accept; { Members differ from the next by addition of a $-CH_2-$ group and have the same general method of preperation

(b) An example of one hydrocarbon contained in candle wax is $C_{25}H_{52}$.

i) Name the homologous series to which this hydrocarbon belongs. (01mark)

Alkanes ✓ 01 Reject; Alkane

ii) Write the molecular formula for the molecule, containing 72 hydrogen atoms, that belongs to the same homologous series. (01mark)

$C_{35}H_{72}$ ✓ 01

(c) State the suitable method that can be used to separate the different hydrocarbons in candle wax and give a reason.

(i) Method (01mark)

Fractional distillation ✓ 01 check for spelling

(ii) Reason (01mark)

Different hydrocarbons in candle wax have different boiling points. ✓ 01

2. A student carried out the following experiment.

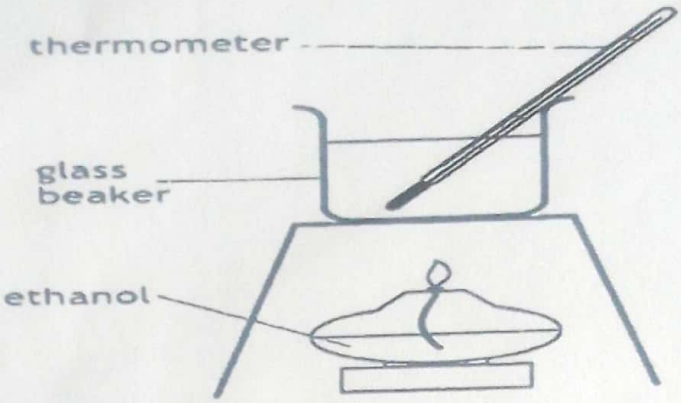


Fig 1.

(a) Write equation for complete combustion of ethanol (1½ marks)

$C_2H_5OH_{(l)} + \frac{7}{2}O_{2(g)} \longrightarrow 2CO_{2(g)} + 3H_2O_{(g)}$ or $_{(l)}$ + heat

Accept; $2C_2H_5OH_{(l)} + 7O_{2(g)} \longrightarrow 4CO_{2(g)} + 6H_2O_{(l)}$ + heat

(b) When 0·8 g of ethanol was burned, 8·36 kJ of energy was absorbed by the water. If the temperature of the water increased by 40 °C, calculate the mass, in grammes, of water used by the student in this experiment. (specific heat capacity of water is 4.2 J/g °C) (1½ marks)

Heat change $= mc\Delta\theta$

$= m \times 4.2 \times 40$

$= \left(\frac{168m}{1000}\right)$ KJ

0·8g of C_2H_5OH produce 8·36 KJ of heat

$\therefore 8.36 = \frac{168m}{1000}$

$m = 49.76$ g

∴ Mass of water used is 49.76g.

(c) The experiment was repeated, replacing the glass beaker with a copper can and using a draught shield. Explain why these changes resulted in more heat energy being absorbed by the water.

(i) Use of copper can (01mark)

Copper can is a good conductor of heat hence the resultant total heat absorbed by water increases.

(ii) Use of draught shield (01mark)

It minimises heat loss to the surroundings hence the resultant total heat absorbed water increases

3. A researcher investigated the conditions for producing ammonia at industrial scale

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

(a) Name the catalyst used in the industrial production of ammonia *(01mark)*

Finely divided Iron ✓ 01 Accept: Iron

(b) In her first experiment she measured how the percentage yield of ammonia varied with pressure at a constant temperature of 500 °C.

Pressure(atmospheres)	100	200	300	400	500
Percentage yield of ammonia (%)	10	18	26	34	42

Predict the percentage yield of ammonia at 700 atmospheres *(01mark)*

58% ✓ 01

(c) In a second experiment the researcher kept the pressure constant, at 200 atmospheres, and changed the temperature as shown.

Temperature (°C)	200	300	400	500
Percentage yield of ammonia (%)	89	67	39	18

Describe how the percentage yield of ammonia varies with temperature. *(01mark)*

Increase in temperature lowers the percentage yield of ammonia 01

(d) Using the information in both tables, deduce the suitable conditions that would produce the highest percentage yield of ammonia. *(02mark)*

Low temperature of 200°C ✓ 02

High pressures of 700 atm ✓ Accept: (500–700 atm) a value in range

4. Vitamin C is found in fruits and vegetables. In an experiment, 16.00 cm^3 of 0.005M of iodine solution reacted with exactly 25cm^3 of orange juice according to the equation below

$C_6H_8O_6(aq) + I_2(aq) \longrightarrow C_6H_6O_6(aq) + 2HI(aq)$

(Vitamin C)

Calculate the concentration, in grammes per litre of vitamin C in the orange juice (C=12, H=1 and O=16) (05marks)

Moles of Iodine that reacted

1000cm^3 of solution Contain 0.005moles

16.00cm^3 of solution Contain $\left(\frac{16.00 \times 0.005}{1000}\right)$

$= 8 \times 10^{-5}$ moles

Since 1mole of Iodine reacts with 1mole of Vitamin C

8×10^{-5} moles of Iodine react with $\left(\frac{8 \times 10^{-5} \times 1}{1}\right)$ moles

$= 8 \times 10^{-5}$ moles of vitamin C

25cm^3 of Orange juice contain 8×10^{-5} moles of Vitamin C

1000cm^3 of orange juice Contain $\left(\frac{1000 \times 8 \times 10^{-5}}{25}\right)$ moles

$= 3.2 \times 10^{-3} moll^{-1}$

Molar mass of $C_6H_8O_6 = (12\times6)+(1\times8)+(16\times6)$

$= 116g$.

1mole of Vitamin C contain 116g

3.2×10^{-3} moles of Vit.C Contain $\left(\frac{3.2\times10^{-3}\times116}{1}\right)$

$= 0.3712g$.

∴ The concentration of Vitamin C in Orange is 0.371g

check for dps

5. Oxygen is obtained on large scale by the fractional distillation of air as shown on the flow chart below.

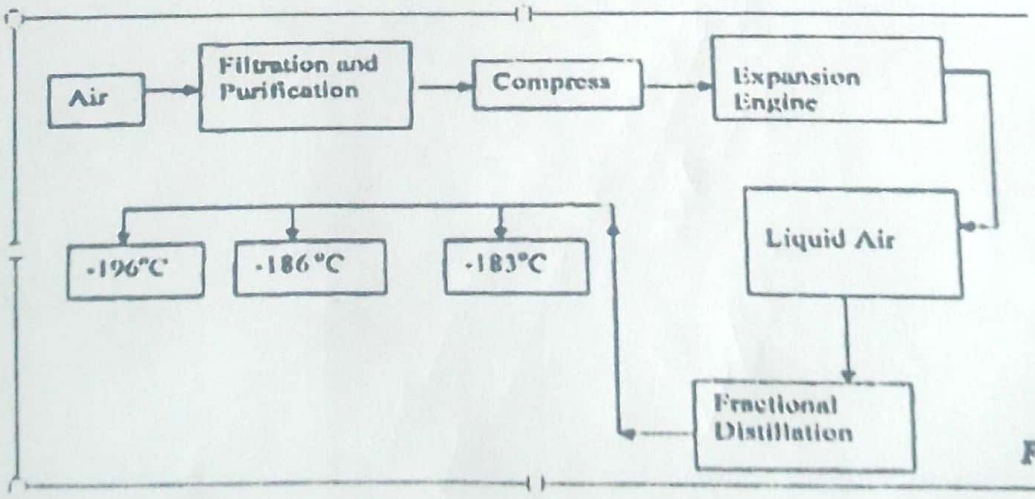


Fig 2.

(a) Name four components of air in the atmosphere. (02marks)

Nitrogen ✓ Carbon dioxide ✓

Oxygen ✓ Water Vapour ✓ 02

Rare gases.

(b) Identify the substance that is removed at the filtration stage. (01mark)

Dust particles. ✓ 01

(c) Explain why Carbon(IV) oxide and water are removed before liquefaction of air. (01mark)

At low temperatures, Carbon(IV) oxide ✓ and water condense and solidify in the pipes hence blocking the ✓ pathways in the pipes 01

(d) Identify the component that is collected at -186°C. (01mark)

~~Oxygen~~. Argon ✓ 01 Accept; Rare gases.

6. The set-up below is used to investigate the properties of hydrogen.

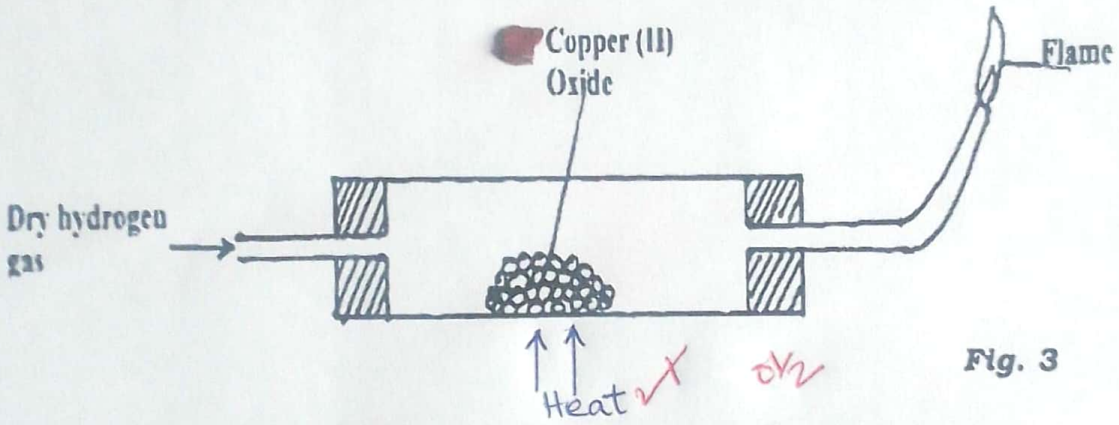


Fig. 3

(a) On the diagram, indicate what should be done for the reaction to occur. (0½ marks)

(b) Hydrogen gas is allowed to pass through the tube for some time before it is lit. Explain why. (01mark)

To allow Complete reaction between Copper(II) oxide ✓ 01 and dry hydrogen gas to Copper metal.

Accept; To allow complete reduction of Copper(II) oxide to Copper.

(c) Write an equation for the reaction that occurs in the combustion tube (1½ marks)

$CuO_{(s)} + H_{2(g)} \longrightarrow Cu_{(s)} + H_2O_{(l)}$ or (g) ... 01½

(d) When the reaction is complete, hydrogen gas is passed through the apparatus until they cool down. Explain why. (01mark)

Air (oxygen) may enter and oxidise the copper formed back to Copper (II) oxide ... 01

(e) What property of hydrogen is being investigated? (0½ mark)

Reducing property ... Rej; Reduction property

(f) What observation confirms the property stated in (e) above? (0½ mark)

All the Black solid turning to a brown residue ... 0½

7. The table below gives information about the ions T^+ and X^{2-}

Ions	T^+	X^{2-}
Electronic configuration	2:8:8	2:8:8
Number of neutrons	20	16

(a) How many protons are there in the nucleus of;

(i) Element T? (01mark)

19 ... 01

(ii) Element X? (01mark)

16 ... 01

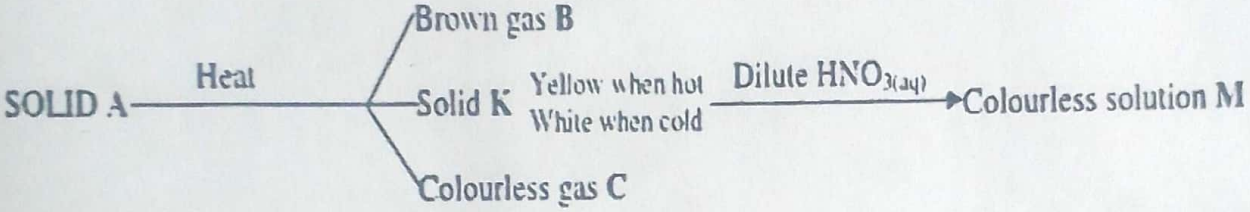
(b) Determine the molar mass of the compound formed between T and X
Mass number = P+N
(02marks)

Mass number of T = (19+20) = 39 ✓
Mass number of X = (16+16) = 32 ✓ 02
Molar mass of Compound formed T_2X = (39×2) + 32 ✓
= 110g ✓ -½ for missing units.

(c) State two conditions under which the compound would conduct electricity
(01mark)

When in molten state ✓
When in aqueous state ✓ 01

8. Study the flow chart below and answer the questions that follow



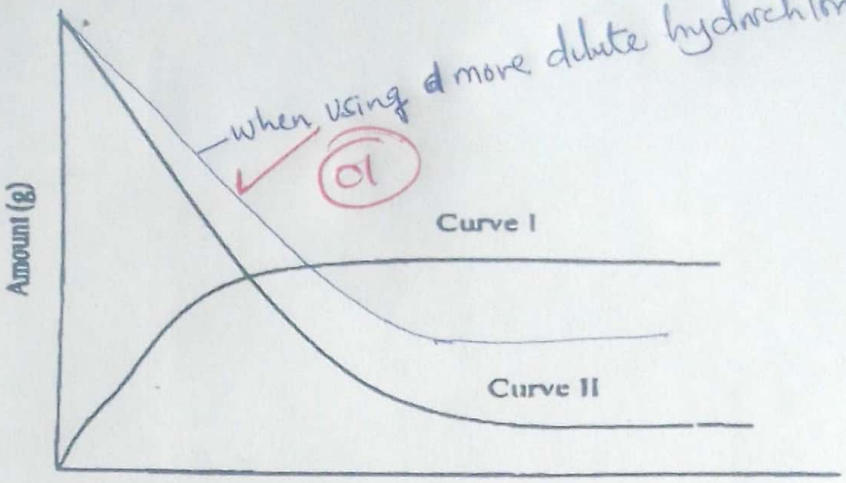
(a) Identify;
(01mark)
(i) gases C Oxygen ✓ Accept; O_2 and B Nitrogen dioxide ✓ Accept NO_2
Accept; Nitrogen (IV) oxide
(ii) Ions likely to be presented in solid A.
(01mark)
Zinc ion ✓ Rej; Zinc 01 Accept; Zn^{2+}
Nitrate ion ✓ Accept; NO_3^- Rej; Zinc(II) ion.

(b) Write chemical equation for reaction that
(i) led to formation of solid K
(1½ marks)
$2Zn(NO_3)_{2(s)} \xrightarrow{heat} 2ZnO_{(s)} + 4NO_{2(g)} + O_{2(g)}$ ✓✓ 01½

(ii) occurred between solid K and dilute nitric acid.
(1½ marks)
$ZnO_{(s)} + 2H^+_{(aq)} \longrightarrow Zn^{2+}_{(aq)} + H_2O_{(l)}$ ✓✓ 01½

Accept; $ZnO_{(s)} + 2HNO_{3(aq)} \longrightarrow Zn(NO_3)_{2(aq)} + H_2O_{(l)}$

9. The graph below shows the amount of calcium carbonate and calcium chloride varying with time in the reactions:



(a) What is meant by the term 'rate of reaction' *(01mark)*

The amount of products formed per unit time ✓ 01

Accept; Amount of reactants used up per unit time

(b) Write an equation for reaction between calcium carbonate and dilute hydrochloric acid. *(1½ marks)*

$CaCO_{3(s)} + 2HCl_{(aq)} \rightleftharpoons CaCl_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$

Accept; $CO_3^{2-}{}_{(s)} + 2H^+_{(aq)} \longrightarrow CO_{2(g)} + H_2O_{(l)}$

(i) Which curve shows the amount of calcium chloride varying with time? *(1½ marks)*

Curve I

(ii) Explain why the two curves become horizontal after a given period of time. *(01mark)*

The reaction has reached ✓ its end point. 01

Accept; No more reactants nor products formed

(iii) Sketch on the graph how curve II would appear if the experiment was repeated using a more dilute hydrochloric acid solution (01mark)

10. The setup below was used in the electrolysis of dilute copper (II) nitrate solution.

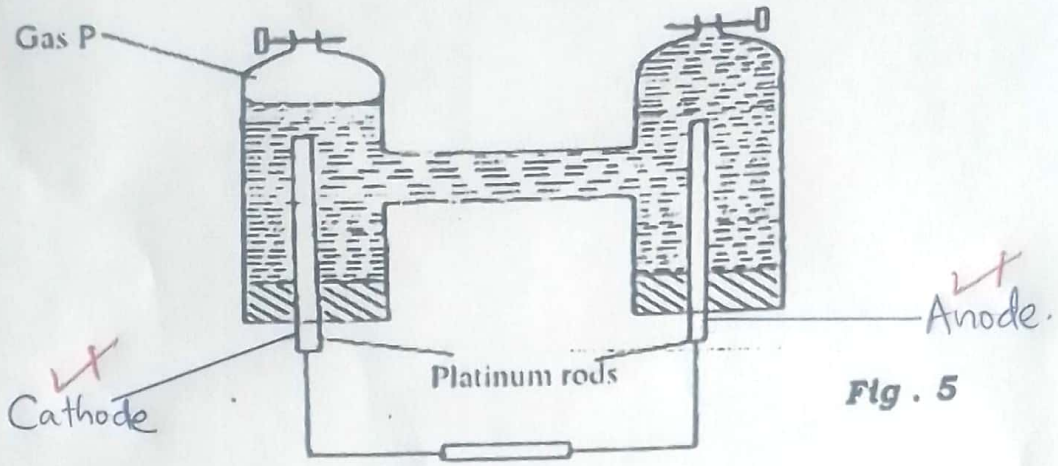


Fig . 5

01

(a) What is meant by the term electrolysis? (01mark)

The process by which a compound when in molten or aqueous state can conduct electricity and decomposes chemically by it. 01

(b) Show the anode and cathode on the diagram above. (01mark)

(c) Explain how you would confirm gas P (01mark)

By inserting a burning splint in a gas jar of P.
The burning splint is extinguished with a 'pop' sound 01

(d) Write the equation for the reaction occurring at

i) Anode (01mark)

$4OH^-_{(aq)} \longrightarrow 2H_2O_{(l)} + 4e + O_{2(g)}$ 01

ii) Cathode (01mark)

$2H^+_{(aq)} + 2e \longrightarrow H_{2(g)}$ 01

SECTION B

*Attempt any **two** questions.*

11. (a) Sodium metal is extracted by the electrolysis of molten sodium chloride to which calcium chloride is added before heating is done.

i) Give a reason for the addition of calcium chloride. *(01mark)*

ii) Name a material that can be used as the cathode and another that can be used as the anode. *(01mark)*

iii) Write equations for the reactions that take place at each electrode. *(02marks)*

iv) Describe how the product at the cathode is collected. *(01mark)*

v) Name one other metal that can be extracted by a similar method *(01mark)*

(b) Name a place in Uganda where a plant for the extraction of sodium could be constructed. Give a reason for your answer. *(02marks)*

(c) State what would be observed and write equation(s) for reaction(s), if a small piece of sodium metal is;

i) heated and quickly plunged into a gas jar of oxygen. *(03marks)*

ii) dropped in trough which is half filled with water *(04marks)*

12. (a) Chlorine can be prepared in the laboratory from an acid and an oxide.

i) Name the acid and the oxide used in the preparation of chlorine. *(01mark)*

ii) State the conditions for the reaction. *(01mark)*

iii) Write an equation for the reaction which takes place between the acid and the oxide you have named in (i). *(1½ marks)*

(b) (i) Draw a labelled diagram to show the preparation of anhydrous iron(III) chloride using chlorine. *(04 marks)*

(ii) State what would be observed during the preparation. *(1½ marks)*

(iii) Write an equation for reaction leading to the formation of iron(III) chloride. *(1½ marks)*