KAPSABET HIGH SCHOOL

Name ……MARKING SCHEME……..……Index No…………..……

School…………….....…..……………..   Date…………………………………

Kenya Certificate of Secondary Education
CHEMISTRY
Paper 2
THEORY
2 hours

Instructions

Write your name, Index number and class in the spaces provided above.
*Answer **ALL** the questions in the spaces provided.*
Mathematical tables and silent electronic calculators may be used.
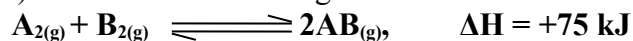*All working **MUST** be clearly shown where necessary.*

For Examiner's use only

Question	Maximum Score	Candidate's Score
1	**11**	
2	**12**	
3	**12**	
4	**12**	
5	**11**	
6	**11**	
7	**11**	
Total	**80**	

*This question paper has **10** printed pages.*
Confirm that all the pages are printed as indicated and
***No** questions are missing.*

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1. a) Consider the following reaction:

$$A_{2(g)} + B_{2(g)} \rightleftharpoons 2AB_{(g)}, \qquad \Delta H = +75 \text{ kJ}$$

Sketch an energy level diagram showing the relative activation energies for the catalysed and uncatalysed reactions using the axes below.   (2mks)

Uncatalysed

Catalysed

Energy (kJ)

Reaction path
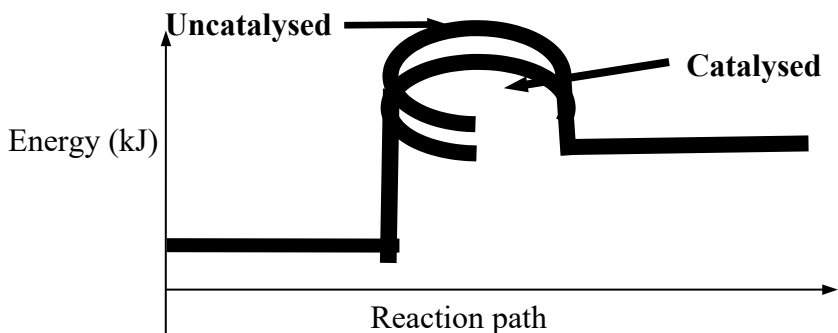
b) Given that; $\Delta H_f (Al_2O_3) = -1590$ kJmol^{-1}

$\Delta H_f(Cr_2O_3) = -1134$kJmol^{-1}

Calculate the heat of reaction for; $2Al_{(s)} + Cr_2O_{3(s)} \rightarrow Al_2O_3 + 2Cr_{(s)}$ **(2mks)**

c) The following data was obtained during an experiment

Mass of ethanol burnt	=	0.2g
Mass of water in the calorimeter	=	200g
Specific heat capacity of water	=	4.2 jg^{-1}k^{-1}
Initial temperature of water	=	23.5 ^{0}C
Final temperature of water	=	28.0 ^{0}C

i) **How** was the mass of ethanol that burnt determined? (1mk)
By sybtracting the mass of the burner and ethanol before igniting and the mass of the burner and ethanol after the burning

ii) **How** much heat was required to raise the temperature of water from 23.5 ^{0}C to 28.0^{0}C? (2mks)
Heat produced ΔH = mass of water(m) x specific heat capacity (c)xΔT
=> 200 x 4.2 x 4.5 = 3780 Joules = 3.78 kJ

iii) Two assumptions were made in calculating the enthalpy of combustion for ethanol. **State them.** (1mk)
No heat loss to the environment
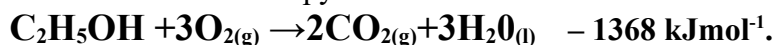
The calorimeter did not absorb any heat

iv) **Determine** the molar enthalpy of combustion of ethanol.(C= 12,H=1, O=16) (2mks)
Moles of ethanol used = **0.2/46**
=0.0043 moles $\longrightarrow$ 3.78kJ

$$1 \text{ Mole} \longrightarrow ?$$
$$= 3.78 \times 1/0.0043$$
$$= -879.069 \text{kJ/mol}$$

v) **Write** a thermochemical equation for the combustion of ethanol given the accurate value for enthalpy of combustion is – 1368 kJmol⁻¹. (1mk)

$$C_2H_5OH + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(l)} \quad – 1368 \text{ kJmol}^{-1}.$$

2. Two half cells were connected as shown to form a voltaic cell. The reduction potentials are given.

$$Pb^{2+}_{(aq)} + 2e \longrightarrow Pb_{(s)} \ E^{\ominus} = – 0.13V$$
$$Fe^{2+}_{(aq)} + 2e \longrightarrow Fe_{(s)} \ E^{\ominus} = – 0.44V$$
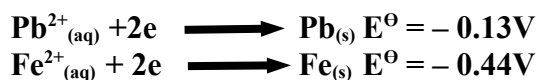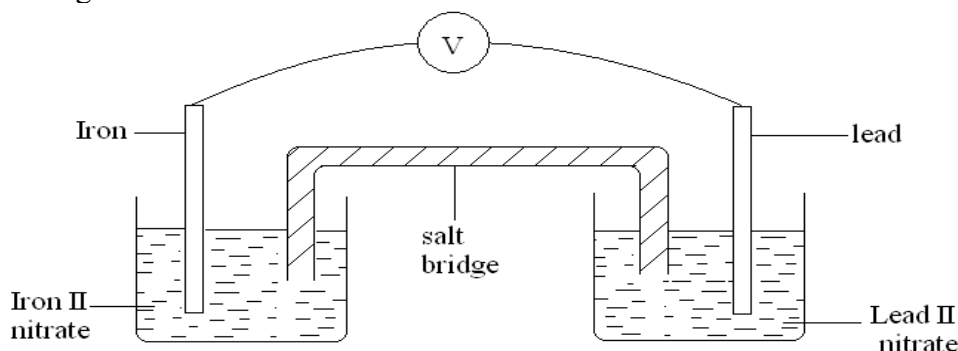
a) **Calculate** the e.m.f of the cell. (1mk)

$$E_{REDOX} = E_{RED} - E_{OX} = -0.13 - -0.44$$

$$= +0.31V$$

b) Sodium Chloride is used as the salt bridge. **State the** two functions of the salt bridge. (2mks)

complete the circuit

maintain balance of charges /ions on both half cells.

c) **Show** the direction of the electron flow in the external circuit. (1mk)

d) The e.m.f of the cell will reduce with time. Give a reason for this. (1mk)
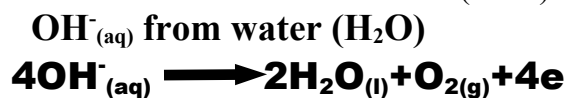
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e) During electrolysis of water acidified with Sulphuric acid, two gases were produced at the electrodes:

i) **State** which ions are preferentially discharged at the electrodes. **Explain** with aid of half ionic equations.
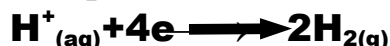Anode. (2mks)

$$OH^-_{(aq)} \text{ from water } (H_2O)$$
$$4OH^-_{(aq)} \longrightarrow 2H_2O_{(l)} + O_{2(g)} + 4e$$

OH⁻ ions selectively discharged instead of SO₄²⁻ ions at the anode

Cathode. (2mks)

$H^+_{(aq)}$ from either sulphuric(VI) acid ($H_2 SO_4$) or water (H_2O)
$H^+_{(aq)} + 4e \longrightarrow 2H_{2(g)}$

ii) **Calculate** the volume of the gases at s.t.p produced when a current of 0.025A is passed for 4 hours. (1 Faraday=96500C) (3mks)

Quantity of electricity (in Coulombs) =Current(I)xtime(t)
Substituting /converting time to second = 0.025x (4x60x 60)
= 360 C

ANODE; 4 moles of electrons = 4 Faradays = 96500x4 C $\longrightarrow$ 22400cm^3

$$360C \rightarrow \frac{360 \times 22400}{96500 \times 4}$$

$$= 20.89cm^3$$

CATHODE; ratio 1;2
20.89x2=41.78cm^3

3. a) The fermentation of glucose is catalysed by enzymes from yeast. Yeast is added to aqueous glucose, the solution starts to bubble and becomes cloudy as more yeast cells are formed.

$$C_6H_{12}O_{6(aq)} \longrightarrow 2C_2H_5OH_{(aq)} + 2CO_{2(g)}$$

The reaction is exothermic. Eventually the fermentation stops when the concentration of ethanol is about 12%.

(i) On a large scale, the reaction mixture is cooled. Suggest a reason why this is

necessary. (1mk)

-kil yeast or denature enzymes (due to increase in temperature)

(ii) Why does the fermentation stop? Suggest one reasons. (1mk)

-All glucose used up

-yeast killed or denatured or damaged by ethanol/alcohol

(iii) What technique is used to concentrate the aqueous ethanol? (1mk)

Fractional distillation

b) A compound X contains carbon, hydrogen and oxygen only. X contains **54.54**% of carbon by mass, **9.09**% of hydrogen by mass and **36.37**% of oxygen by mass. (C=12, O=16, H=1)

(i) Determine the empirical formula of compound X. (2mks)

Element	C	H	O
Mass	**54.54**	**9.09**	**36.37**
R.A.M	**12**	**1**	**16**
Moles	**54.54/12** **= 4.545**	**9.09/1** **= 9.09**	**36.37/16** **= 2.273**
Mole ratio	**4.545/2.273** **2**	**9.09/2.273** **3.999>>4**	**2.273/2.273** **1**

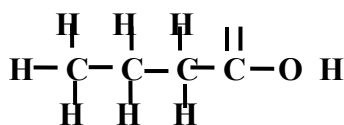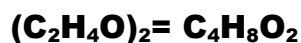|	C_2H_4O

(ii) Compound X has a relative molecular mass of 88. Draw the structural formula of compound X. (2mks)

$(C_2H_4O)_n = 88$

$(12 \times 2 + 1 \times 4 + 16)n = 88$

$44n = 88$

$N = 2$

$(C_2H_4O)_2 = C_4H_8O_2$

$$H-\overset{\overset{\displaystyle H}{|}}{\underset{\underset{\displaystyle H}{|}}{C}}-\overset{\overset{\displaystyle H}{|}}{\underset{\underset{\displaystyle H}{|}}{C}}-\overset{\overset{\displaystyle H}{|}}{\underset{\underset{\displaystyle H}{|}}{C}}-\overset{\overset{\displaystyle ||}{}}{C}-O\,H$$

c) The table below gives formulae of three organic compounds A, B and C**H**

Compound	Formulae
A	$C_2H_4O_2$
B	C_2H_6O
C	C_2H_6

Giving a reason in each case, select the letter(s) which represent a compound that

   i) Decolourises acidified potassium manganate (VII). (1mk)
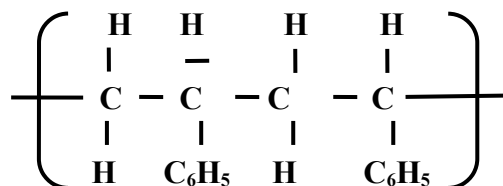
B Its an alkanol hence oxidized to alkanoic acid

   ii) .Gives effervescence with sodium hydrogen carbonate. (1mk)
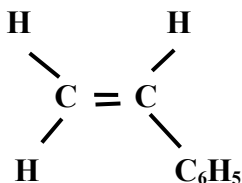
A Reacts to produce CO_2

   iii) Undergoes substitution reaction with chlorine gas. (1mk)

C its saturated

d) The following is a small reaction of polystyrene polymer. Study it and answer the questions that follow.

$$\left(\begin{array}{c} \overset{\overset{\displaystyle H}{|}}{\underset{\underset{\displaystyle H}{|}}{C}}-\overset{\overset{\displaystyle H}{-}}{\underset{\underset{\displaystyle C_6H_5}{|}}{C}}-\overset{\overset{\displaystyle H}{|}}{\underset{\underset{\displaystyle H}{|}}{C}}-\overset{\overset{\displaystyle H}{|}}{\underset{\underset{\displaystyle C_6H_5}{|}}{C}} \end{array}\right)$$

(i) Draw the structure of the monomer unit of polystyrene. (1mk)

$$\overset{\displaystyle H}{\diagdown}\,C = C\,\overset{\displaystyle H}{\diagup}$$
$$\underset{\displaystyle H}{\diagup}\qquad\underset{\displaystyle C_6H_5}{\diagdown}$$

(ii) Calculate the number of monomers used to form the polystyrene of relative molecular mass of 18096. (H = 1, C = 12) (1mk)

18096/104

**= 174 monomers**

4. An experiment was carried out using magnesium ribbon and dilute hydrochloric acid of different concentrations. The time needed to produce $50cm^3$ of the gas for every experiment was recorded in a table.

Concentration of HCl (moles per litre)	2.0	1.75	1.50	1.25	1.00	0.75	0.50	0.25
Time (seconds)	8.8	10.0	11.7	14.0	17.5	18.7	35.0	70.0

$\dfrac{1}{time}$ (Sec^{-1})	0.1140	0.1000	0.0854	0.0714	0.0571	0.0534	0.0286	0.0143
$\dfrac{1}{t} \times 10^{-2}$	11.4	10.0	8.54	7.14	5.71	5.34	2.86	1.43

a) Complete the table above for $^1/_{time}$. (4mks)

b) Plot a graph of rate i.e $^1/_{time}$ against concentration. (3mks)
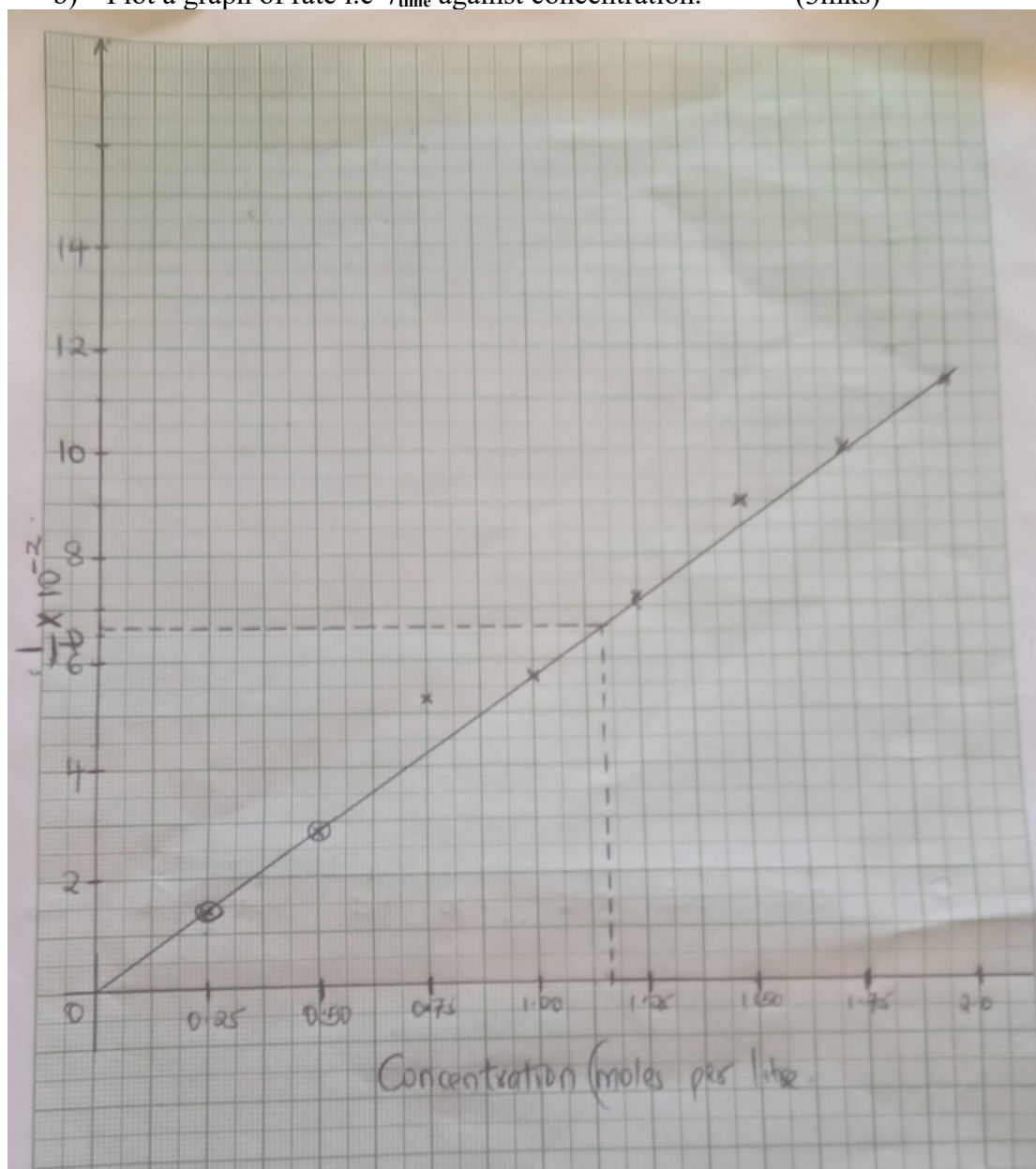
c) From your graph determine the concentration needed to produce 50cm^3 of hydrogen gas when time is 15.0 seconds (1mks)
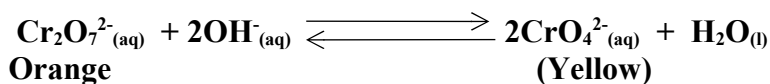
T=15

$\dfrac{1}{15} = 0.0667$

= **1.1625**

d) From your graph state the relationship between the rate of reaction and concentration. Give a reason. (1mks)

Rate of reaction increases with increase in concentration

e) A state of equilibrium between dichromate (vi) and chromate ions is established as shown below

$$Cr_2O_7^{2-}{}_{(aq)} + 2OH^-{}_{(aq)} \rightleftharpoons 2CrO_4^{2-}{}_{(aq)} + H_2O_{(l)}$$

Orange   **(Yellow)**

i) What is meant by dynamic equilibrium? (1 mk)

a reaction in which the rate of forward reaction is equal to the rate of backward reaction
balance of the rate of formation of products and reactants.

State and explain observation made, when a few pellets of Hydrochloric acid are added to equilibrium mixture (2 mks)

solution mixture makes it to be more Orange in colour.
Hydrochloric acid/ H+ (aq) is added to the equilibrium mixture a stress is created on the reactant side on the OH⁻ (aq). H+ ions react with OH⁻ (aq) to form water.
The equilibrium shift backward to the left to add/replace the 2OH- (aq) that have reacted with the H+ (aq) ions .More Cr₂O₇ (aq)ions formed in the

5. I) The table below shows properties of some elements represented by symbols W,X,Y and Z. Study the information in the table and answer the questions that follows

Element	No. Of protons	Atomic radius(nm)	Boiling point ^{0}C
W	2	0.93	-269
X	10	1.31	-246
Y	18	1.54	-186
Z	36	1.89	-152

a) Write down the electron arrangement for elements W and X (1mk)

        W 2
        X 2:8

b) In which group of the periodic table are the elements in the table above?Give the name of the group (2 mk)

        Group VII
        Halogens

c) Explain why the atomic radius of W is smaller than that of X (1mks)

X has more/2 energy levels than W (1 energy levels).

d) state one use of element X (1mk)

Use in making neon advertising coloured signs
Used to make high voltage indicators
Neon and helium are used in making gas lasers
Liquid helium is an economical refrigerant

II. The section below represents part of the periodic table. Study it and answer the questions that follow. The letters are not the actual symbol of the elements.

Q

X				B	H		M	T	
Y		A						V	
Z								S	

a) **Select** the most reactive non-metal. (1mk)

M

b) **Which** of the elements has the greatest tendency of forming covalent compounds in nature? **Explain** your choice. (1mk)

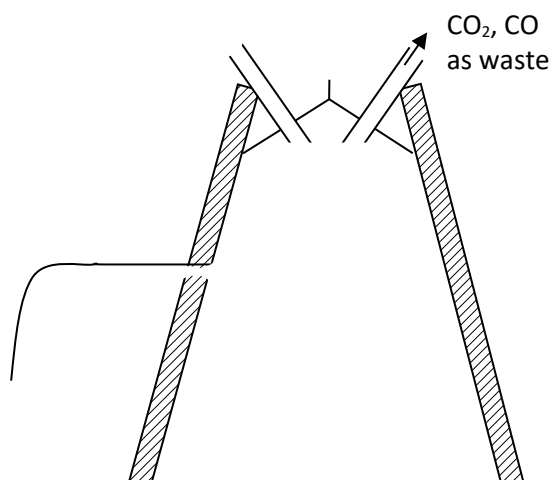**Q or H,group IV ,have a valency of 4 hence can share its 4 pairs of electrons**

c) **Explain** why the atomic radius of **T** is smaller than that of **M**. (2mks)
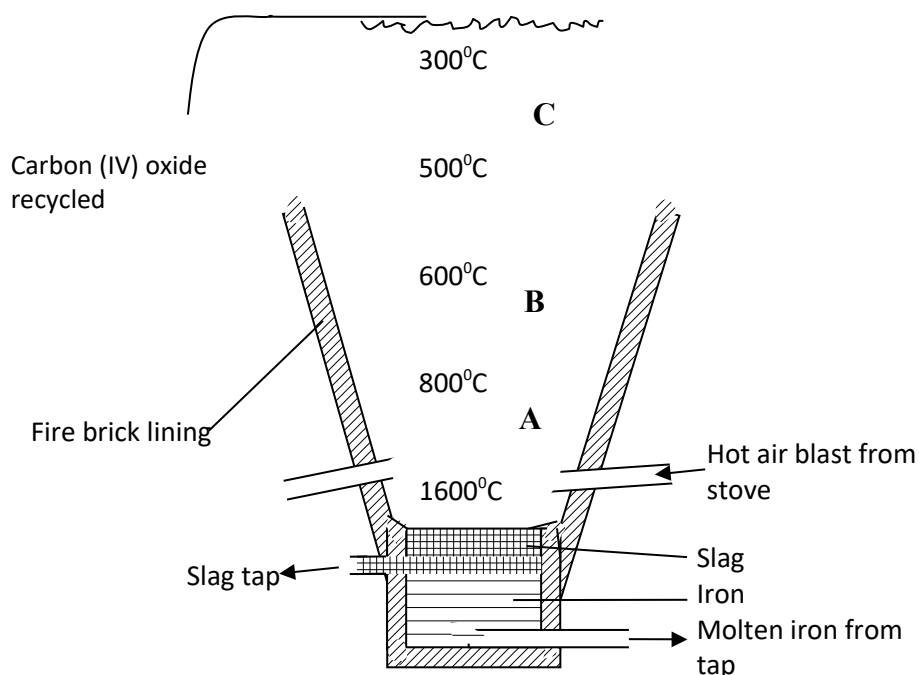
T has more protons(18) hence higher nuclear charge than M (17 protons) attracting outermost electrons closer to the nucleaus reducing the atomic radius

d) Compare the electrical conductivity of element X and B. (2mks)

B has higher conductivity,it has 3 delocalised electrons X has 1 delocalised electrons

6. Extraction of iron involves two main processes, smelting and refining. Below is the blast furnace which is used to smelt iron from its ore.

CO_2, CO as waste

300°C

C

Carbon (IV) oxide recycled

500°C

600°C

B

800°C

A

Fire brick lining

Hot air blast from stove

1600°C

Slag tap

Slag

Iron

Molten iron from tap

(a) (i) The chief ore is Haematite. Name one other ore used in extraction of iron (1 mark)

Magnetite / Siderite

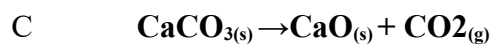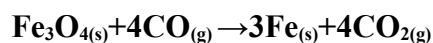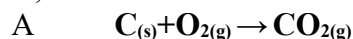(ii) Name the reducing agent in the process. **(1 mk)**

Carbon(II)oxide

(iii) What is the role of the hot air blast in the process?**(2 mks)**

**Reacts with coke/charcoal/carbon to form carbon(IV)oxide gas**

raises the temperature at the bottom of the furnace to about 2000K(1650ºC).

(b) Write equations for the reactions that take place at the region marked A, B and C. **(3 mks)**

A $C_{(s)}+O_{2(g)} \rightarrow CO_{2(g)}$

B $Fe_2O_{3(s)}+3CO_{(g)} \rightarrow 2Fe_{(s)}+CO_{2(g)}$

$Fe_3O_{4(s)}+4CO_{(g)} \rightarrow 3Fe_{(s)}+4CO_{2(g)}$

C $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO2_{(g)}$

(c) What is the purpose of limestone in the extraction process? **(1 mk)**
decomposes to quicklime /calcium oxide which reacts to remove impurities and produce more carbon(IV)oxide gas.

(d) Write equations to show how impurities are removed from the ore.**(2 mks)**
$CaO_{(s)} + SiO_{2(s)} \rightarrow CaSiO_{3(l)}$

$CaO_{(s)} + Al_2O_{3(s)} \rightarrow CaAl_2O_{4(l)}$
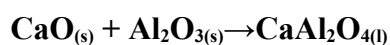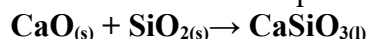
(e) State one environmental effect of the process. (1mk)
✓ **Carbon(IV)oxide(CO2) gas is a green house gas that causes/increases global warming if allowed to escape/leak from the furnace.**

✓ **Carbon(II)oxide(CO)gas is a highly poisonous/toxic odourless gas that can kill on leakage. It is preferentially absorbed by the haemoglobin in mammals instead of Oxygen to form a stable compound that reduce free hemoglobin in the blood.**

✓ **Haematite (Fe2O3), Magnetite(Fe3O4) and Siderite (FeCO3) are extracted through quarrying /open cast mining that cause soil / environmental degradation .**

7. a) Read the following passage and answer the questions.

A salt K was heated with slaked lime (calcium hydroxide). A colourless gas L with a characteristic smell and turns red litmus paper blue was evolved. A large quantity of this gas was passed through an inverted filter funnel into Copper(II)sulphate solution, and a deep blue solution M was obtained.

a) Identify gas L   (1 mk)
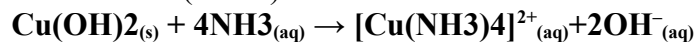
   Ammonia

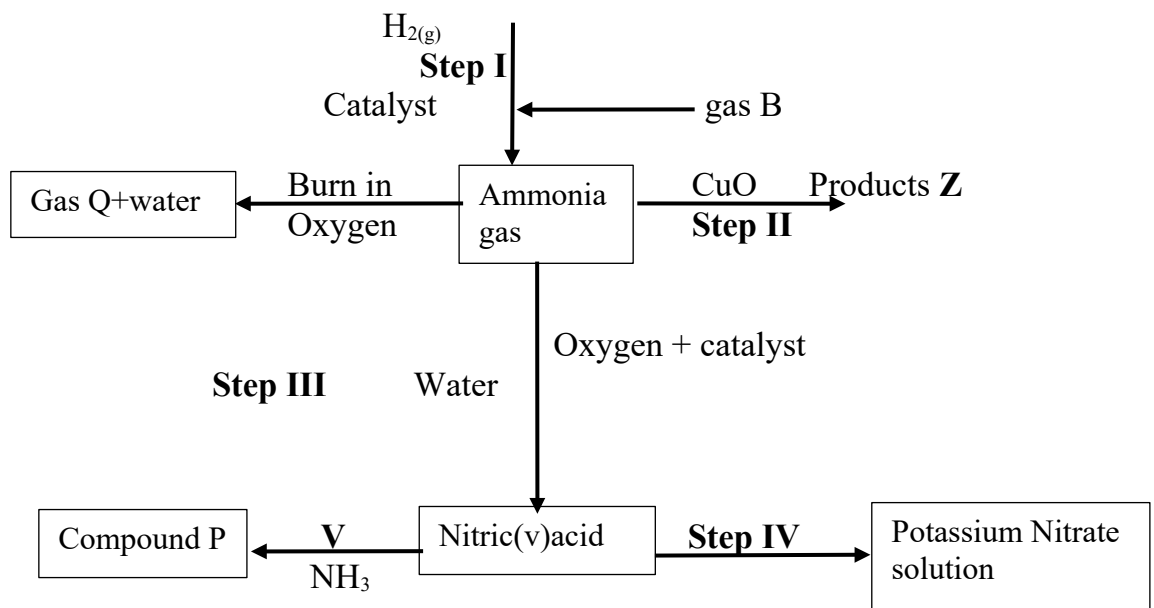b) What is K most likely to be?   (1 mk)

   Ammonium chloride

c) Write an equation for the reaction between K and slaked lime   (1 mk)

   $Ca(OH)2(s)+NH4Cl(s){\rightarrow}CaCl2(aq)+H2O(l)+2NH3(g)$

d) Write an ionic equation for the reaction with copper(II)sulphate forming the deep blue solution (1 mks)

   $Cu(OH)2_{(s)} + 4NH3_{(aq)} \rightarrow [Cu(NH3)4]^{2+}{}_{(aq)}+2OH^-{}_{(aq)}$

b) Study the flow chart below and answer questions that follow:

$H_{2(g)}$

Step I
Catalyst ← gas B

Gas Q+water ← Burn in Oxygen — Ammonia gas — CuO **Step II** → Products **Z**

Oxygen + catalyst

Step III Water

Compound P ← **V** NH₃ — Nitric(v)acid — **Step IV** → Potassium Nitrate solution

(i)   State **one** source of gas B   (1 mk)

   Fractional distillation of liquid air

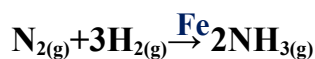(ii)   Name the catalysts used in;   (1 mk)
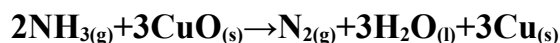
   a) Step I

   Finely divided Iron

   b) Step III

   Platinum or platinum rhodium
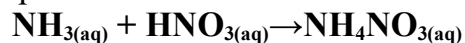
(iii)   Write chemical equations for reactions in;   (3 mks)
      a) Step I

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

      b) Step II

$$2NH_{3(g)} + 3CuO_{(s)} \rightarrow N_{2(g)} + 3H_2O_{(l)} + 3Cu_{(s)}$$

      c) Step V

$$NH_{3(aq)} + HNO_{3(aq)} \rightarrow NH_4NO_{3(aq)}$$

(iv)   Identify any other gas that can be used instead of Ammonia in step II   (1 mk)

Hydrogen/Carbon(II)oxide

(v)   State one use of gas Q   (1mk)

- ✓ **Used in the Haber process in the manufacture of ammonia.**
- ✓ **Due to its inert nature, it is mixed with argon to fill electric bulbs (to avoid soot formation).**
- ✓ **In liquid state it is used as an inert refrigerant e.g. storage of semen for artificial insemination.**
- ✓ **Due to its inert nature, it is used in food preservation particularly for canned products i.e. it prevents combination of oxygen and oil which tends to enhance rusting.**
- ✓ **It is used in oil field operation called enhanced oil recovery where it helps to force oil from subterranean deposits.**