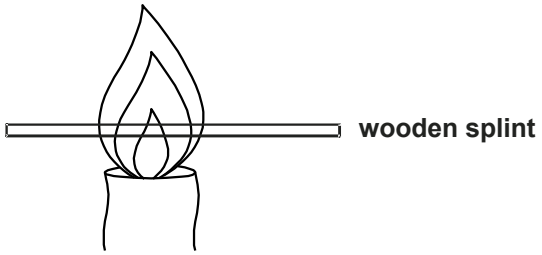
KCSE PREDICTION 1 2022
CHEMISTRY PAPER 1

1. Study the diagram below then use it to answer the questions that follow.



a) Draw the wooden splint at the end of the experiment. If it was slipped then removed. (1 mark)
b) Explain the appearance of the wooden splint in (a) above. (2 marks)

2. Use the bond energies given below to calculate the heat of reaction for; (3 marks)

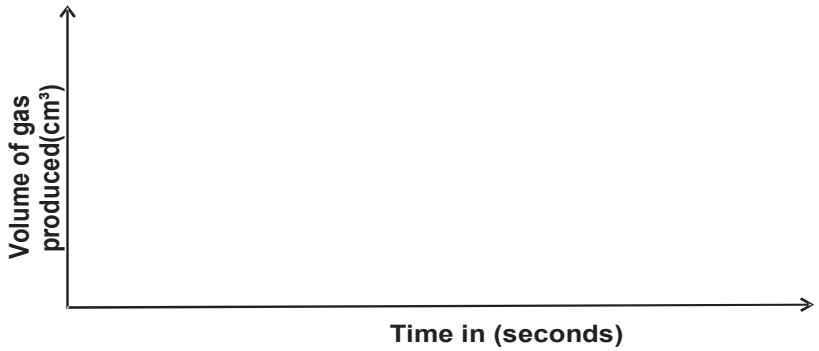
$$H_{2(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)}$$

Bond	Energy (Kj/Mol)
H - H	435
Cl - Cl	243
H - Cl	431

3. The table below gives three experiments on the reaction of excess sulphuric (VI) acid and 0.5g Zinc done under different conditions. In each case the volume of gas liberated was recorded at different time intervals.

Experiment	Form of Zinc	Sulphuric (VI) acid
I	Powder	0.8M
II	Powder	1.0M
III	Granules	0.8M

On the axes below, draw and label the three curves that would be obtained from the results above. (3 marks)



4. a) Explain why it is not advisable to use wood ash for cleaning aluminium utensils. (2 marks)
b) Give two reasons why duralumin is preferred to aluminium in making aeroplane parts. (1 mark)

5. The table below gives some properties of gases X and Y. Study it and answer the questions that follow.

Gas	**Density**	**Effect of $H_2SO_{4(aq)}$**	**Effect of $NaOH_{(aq)}$**
X	Lighter than air	React to form a salt	Dissolves without reacting
Y	Denser than air	Not affected	Not affected

a) Describe how you would obtain a sample of gas Y from a mixture of gases X and Y. (2 marks)
b) Suggest a possible identity of gas X. Give a reason for your answer. (1 mark)

6. In an experiment, soap solution was added to three separate samples of water. The table below shows the volumes of soap

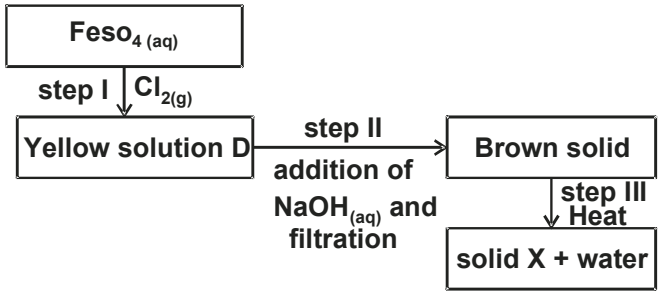
solution required to form lather. with 100cm³ of each sample of water before and after heating / boiling.

	SAMPLE		
	A	B	C
Volume of soap before water is boiled (cm³)	30	4	12
Volume of soap after water is boiled (cm³)	30	4	4

a) Which water sample is likely to be soft? Explain. (2 marks)
b) Explain the change in the volume of soap solution used in sample C. (1 mark)

7. a) Name one natural fibre. (1 mark)
b) Give two advantages of synthetic fibres over natural fibres (2 marks)

8. Study the scheme below and answer the questions that follow.



a) Write the formular of the cation present in solution D. (1 mark)
b) What property of chlorine is shown in step 1. (1 mark)
c) Write an equation for the reaction which occurred in step III. (1 mark)

9. x grammes of a radioactive isotope decayed to 5 grammes in 100 days. The half-life of the isotope is 25 days.
a) Define half life. (1 mark)
b) Calculate the initial mass **x** of the radioactive isotope. (2 marks)

10. 0.63g of lead powder were dissolved in excess nitric (V) acid to form lead (II) nitrate solution. All the lead (II) nitrate was then reacted with sodium sulphate solution.
a) Write an ionic equation for the reaction between sodium sulphate solution and lead (II) nitrate solution. (1 mark)
b) Determine the mass of the lead salt formed in the reaction in (a) above (2 marks)
(Pb = 207, S = 32, O = 16)

11. Use the cell representation below to answer the questions that follow.

$$Cr_{(s)} / Cr^{3+}_{(aq)} // Fe^{2+}_{(aq)} / Fe_{(s)}$$

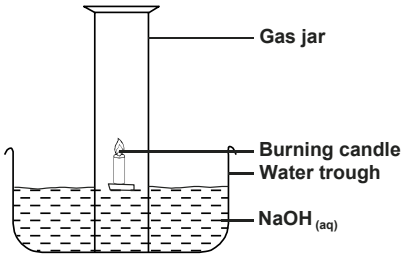
a) Write an equation for the cell reaction. (1 mark)
b) If the emf of the cell is 0.30G and the E value for $F^{2+} / Fe_{(S)}$ is -0.44V. Calculate the E value for $Cr_{(s)} / Cr^{3+}_{(aq)}$ (2 marks)

12. In an attempt to prepare sulphur (IV) oxide gas, dilute sulphuric (VI) acid was reacted with barium sulphite. The yield of sulphur (IV) oxide was found to be negligible. Explain. (3 marks)

13. Concentrated nitric (V) acid was added to iron (II) sulphate solution acidified with sulphuric (VI) acid and the mixture heated. The solution turned from pale green to yellow with evolution of a brown gas. Explain these observations. (3 marks)

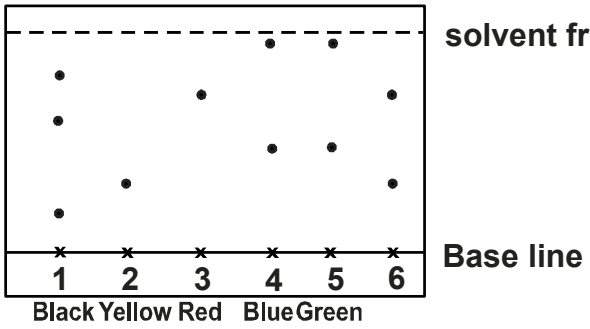
14. Draw and name two isomers of the 3rd members of the alkyne homologous series. (2 marks)

15. Use the diagram below to answer the questions that follow.



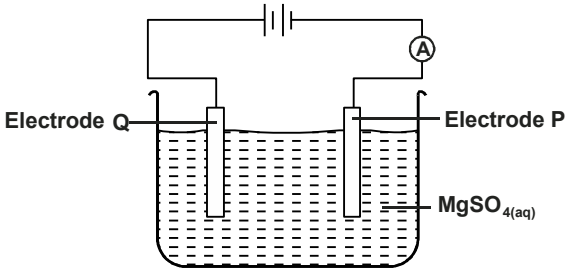
a) Why is sodium hydroxide solution preferred to water in the above set-up. (1 mark)
b) What modification should be made to the above set-up if percentage of oxygen used in air should be determined (1 mark)
c) Name the main component of air not used in the above set-up. (1 mark)

16. A piece of chromatography paper was spotted with coloured inks obtained from pens labelled 1 to 6. The diagram below shows the spots after the chromatogram was developed.



a) Which two pens contained the same pigment? (1 mark)
b) Which pens contained only one pigment? (1 mark)
c) According to the chromatogram, which pigments are present in the ink of pen number 6. (1 mark)

17. The diagram below was used to electrolyse magnesium sulphate solution



a) Write half equation at electrode. P,Q (2 marks)
b) State what happens to the concentration of the electrolyte after electrolysis process. (1 mark)

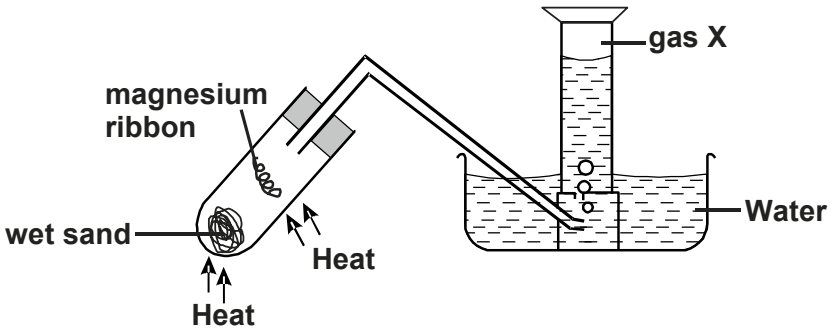
18. a) Starting with red roses, describe how a solution containing the red pigments may be prepared? (2 marks)
b) The solution can be shown to be an indicator. (1 mark)

19. The table below provides data on the successive ionisation energies of carbon.

Ionisation numbers	1st	2nd	3rd	4th	5th	6th
Ionisation energy (kJ/mol)	1090	2350	4610	6220	37800	47300

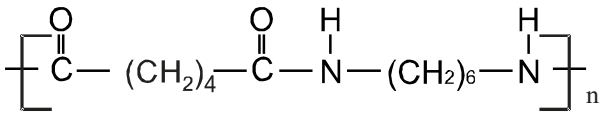
a) Explain why each ionisation energy increase in nature. (2 marks)
b) Write an equation for the 5th ionisation energy of carbon. (1 mark)

20. Magnesium reacts as shown below.



a) Identify gas X. (1 mark)
b) Between wet sand and magnesium ribbon, which one should be heated first? Explain. (2 marks)

21. Nylon 6, 6 is a condensation polymer whose structure is as follows.



a) Draw the structures of the monomers in nylon 6, 6 (2 marks)
b) Give one economic importance of perspex. (1 mark)

22. Calculate the number of molecules of water of crystallization in oxalic acid crystals, $H_2C_2O_4.nH_2O$ given that 5g of the crystals were made upto 250cm³ of this solution. 25.0cm³ of this solution required 15.9cm³ of 0.5M sodium hydroxide to neutralise it (H=1, C=12, O=16). (3 marks)

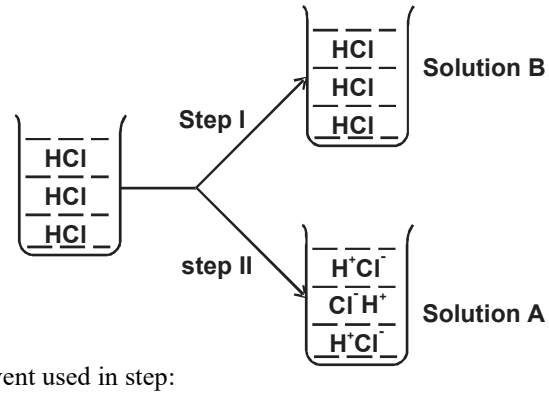
23. A dynamic equilibrium between chromate (VI) and Chromium (III) ions is as shown below.

$$Cr_2O^{2-}_{7(aq)} + 14H^{+}_{(aq)} \rightleftharpoons 2Cr^{3+}_{(aq)} + 7H_2O_{(l)}$$

(orange) (Green)

State and explain the observation made when solution hydroxide solution is added to the above equilibrium mixture. (3 marks)

24. Study the diagram below then use it to answer the questions that follow.



a) Identify the solvent used in step:
I. .....
II .....

b) What observation was made when, solid sodium carbonate was added to solution A and B separately. (1 mark)

25. Use dots (•) and cross (×) diagrams to draw bond in: (3 marks)
a) Al_2Cl_6 (Al = 13, Cl=17)
b) Al_2O_3 (Al = 13, O = 8)

26. Starting with lead metal and any other reagent, describe how crystals of lead (II) chloride can be prepared. (3 marks)

27. When sulphur is heated in a boiling tube in the absence of air, the yellow crystals melts into a golden yellow mobile liquid at 113°C. The liquid changes at 180°C into a dark brown liquid that is very viscous. More heating at 400°C produces a brown less viscous liquid.

a) Draw the molecular structure of sulphur in the yellow liquid. (1 mark)
b) Explain why the molten liquid becomes viscous. (2 marks)

233/2
CHEMISTRY
Paper 2

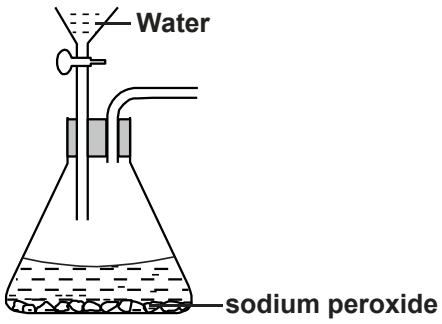
1. Rusting is a destructive process in which iron is converted to hydrated iron (III) oxide.

a) State
i) Two conditions necessary for rusting to occur. (2 marks)
ii) two methods used to protect iron from rusting other than galvanizing. (1 mark)

b) Explain why it is not advisable to wash vehicles using sea water. (2 marks)

c) Explain why galvanized iron objects are better protected even when scratched. (1 mark)

d) The set-up below was used to prepare oxygen gas. Complete the diagram to show how a sample of the gas can be collected.



i) Write an equation for the reaction producing oxygen gas. (1 mark)
ii) How can the rate of production of gas be increased using the set-up above? (1 mark)

2.a) The grid below represents part of the periodic table. Study it and answer the questions that follow. The letters do not represent the actual symbols of the elements.

C				F	G		I	
						H		K
D	E							
							J	

i) Identify the most reactive non-metal. Explain. (2 marks)

ii) What is the name given to the family of elements of which I and J belong? (1 mark)

iii) Using dots (•) and crosses (×) to represent electrons, show bonding in the compound formed between C and H. (2 marks)

iv) How does the atomic radius of F compare with that of I ? Explain. (2 marks)

b) Study the table below and answer the questions that follow.

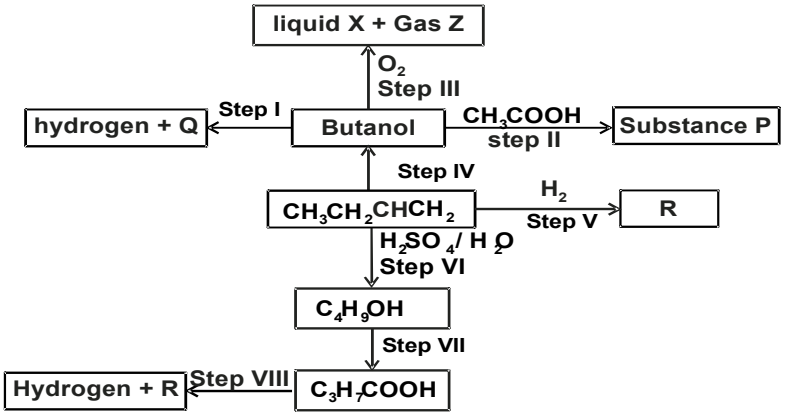
Substance	M	N	O	P	Q	R
M.P. °C	801	1356	-101	26	-39	113
B.P °C	1410	2850	-36	154	457	445
Electrical conductivity in solid state	Poor	Poor	Poor	Poor	Good	Poor
Electrical conductivity in molten state	Good	Poor	Poor	Poor	Good	Poor

i) Explain why substance M is a good conductor in molten state and not in solid state. (2 marks)

ii) What is the most likely structure of substance N? Explain. (2 marks)

iii) Identify, with reasons, a substance that exists as a liquid at room temperature. (2 marks)

3. Study the flow chart below and use it to answer the questions that follow.



a) i) What is the distinguishing physical property of substance P? (1 mark)

ii) Identify a suitable reagent that can be used for both steps I and VIII. (1 mark)

iii) Describe how C_3H_7COOH can be distinguished from C_4H_9OH (2 marks)

iv) Write an equation for the reaction that takes place in step III. (1 mark)

v) Name the type of reaction that occurs in steps II and VII. (2 marks)

Step II

Step VII

vi) If 7.4g of butanol completely underwent step III, determine the volume of gas Z produced at STP (MGV = 22.4l , C= 12.0, H=1.0 O=16.0) (3 marks)

vii) Write an equation for the reaction between R and one mole of fluorine. (1 mark)

viii) Describe a chemical test for liquid X. (2 marks)

4. a) Define redox reactions. (1 mark)

b) Use the standard electrode potentials given below to answer the questions that follow.

Half reaction	E^q (V)
Zn^{2+} + 2e$^-$® Zn	-0.76
Pb^{2+} + 2e$^-$® Pb	-0.13
Ag^+ + e$^-$® Ag	+0.80
Cu^{2+} + 2e$^-$® Cu	+0.34

i) Identify the strongest reducing agent. (1 mark)

ii) Choose a pair that will form a cell with the lowest E value. (1 mark)

iii) Write a notation to represent the cell in (ii) above. (1 mark)

c) Use a well-labelled diagram to show how an iron spoon can be electroplated with silver. (2 marks)

d) 1.21g of metal R were deposited when a current of 2.0A was passed through a molten salt of R for 30 minutes. (RAM of R = 65, 1Faraday = 96500C).
Calculate the quantity of charge in coulomb;
i) Used to deposit 1.21g of metal R. (1 mark)
ii) Needed to deposit one mole of R. (2 marks)
iii) Hence deduce the charge on the ion of R. (2 marks)

5. A stick of lithium was removed from a bottle of oil in which it was stored. A piece was cut from it and found to have a mass of 0.1g. The piece was transferred to an apparatus containing an excess of water. After the reaction had started, the volume of hydrogen gas produced was measured at intervals and the results tabulated as below.

Time (minutes)	Volume of hydrogen (cm^3)
1	8
2	24
3	72
4	138
5	172
6	172

a) Draw a diagram of a suitable arrangement of apparatus for the experiment in which hydrogen gas could be collected and its volume measured at the same time. (2 marks)
b) On the grid provided, draw a graph of volume (x-axis) against time. (4 marks)
c) From the graph, determine the rate of reaction in volume per minute between 3 and 4 minutes. (1 mark)
d) Give a reason for the changes in reaction rate between 4 and 5 minutes. (1 mark)
e) Explain the shape of the graph at minutes 5 and 6. (1 mark)
f) It was thought that the rate of reaction was affected by oil on the lithium so the experiment was repeated with 0.1g of lithium from which oil had been removed. Draw a doted graph on the axes to show the results you would expect from this second experiment. (1 mark)
g) Write equation for the reaction between lithium and water. (1 mark)
h) When one mole of lithium has completely reacted what volume of hydrogen would be produced at room temperature? (MGV = $24dm^3$, Li=7) (2 marks)

6. Sulphuric (VI) acid is manufactured by the contact process which makes use of the equilibrium reaction.

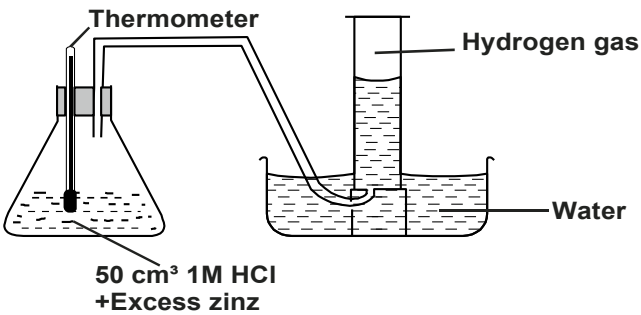
$$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$$

Heat is given out in the formation of sulphur (VI) oxide.
a) Explain what effect there would be on the equilibrium concentration of sulphuric (VI) oxide; if;
i) Pressure was increased. (1 mark)
ii) Temperature was raised. (1 mark)
b) The actual conditions used in the process vary somehow, but a rough average appears to be :
i) An excess air.
ii) A temperature of about 450°C
iii) A pressure slightly in excess of one atmosphere
iv) A catalyst
Explain why each condition (i) to (iv) is necessary. (4 marks)
c) Presence of nitrogen (IV) oxide and sulphur (IV) oxide in the atmosphere cause environmental pollution. Nitrogen (IV) oxide reacts with sulphur (IV) oxide according to the equation.

$$SO_{2(g)} + NO_{2(g)} \rightarrow SO_{3(g)} + NO_{(g)}$$

i) Identify the reducing agent in the above reaction. Explain your choice. (2 marks)
ii) State two effects of acid rain. (1 mark)
iii) Explain the term scrubbing of sulphur (IV) oxide. (1 mark)

7. Below is a set-up is a set-up used to prepare hydrogen gas in the laboratory.



a) Give a reason why the gas is collected as shown in the set-up. (1 mark)
b) Write an ionic equation for the reaction that takes place. (1 mark)
c) Given that the reaction was carried out at 25°C and that the highest temperature reached was 37°C.
   i) Calculate the enthalpy change for the reaction (Specific heat capacity = $4.2kJkg^{-1}k^{-1}$, density of solution = $1g / cm^3$) (2 marks)
   ii) Calculate the molar enthalpy of reaction. (2 marks)
d) The value obtained in c(ii) above is much lower than expected. State two possible reasons. (2 marks)
e) State two uses of hydrogen which are also uses of carbon (II) oxide. (2 marks)
f) Draw a set-up showing how hydrogen obtained from the reaction above can be dried and collected. (2 marks)

Kenya Certificate of Secondary Education
233/3
CHEMISTRY
Paper 3

1. You are provided with:
- 2.0g of impure sodium carbonate, Solid H
- 2M hydrochloric acid, solution A
- 0.1M sodium hydroxide, solution B

You are required to determine:
i) The number of moles of sodium carbonate in the impure solid H.
ii) The molar heat of reaction between sodium carbonate and hydrochloric acid.

PROCEDURE I

a) Using a burette, place $30.0cm^3$ of 2M hydrochloric acid (Solution A) in a $250cm^3$ beaker.
b) Stir gently with a thermometer and take the temperature of the acid after every half a minute for 1½ minutes. Record your readings in Table 1
c) At exactly 2 minutes, add **ALL** of solid H to the acid, stir gently with the thermometer.
d) Continue stirring and taking the temperature of the solution every after half a minute up to the 4th minute. Record your readings in Table 1.

Table 1

Time (min)	0	½	1	1½	2	2½	3	3½	4
Temperature (°C)									

(4 marks)

i) On the grid provided, plot a graph of temperature (y-axis) against time (x - axis) (3 marks)
ii) (1 mark)

PROCEDURE II

a) Transfer **ALL** the solution obtained in procedure I into a 250ml volumetric flask. Rinse both the beaker and thermometer with distilled water and add the rinsing to the volumetric flask.
b) Add more distilled water to the volumetric flask upto the mark. Label this as solution C.
c) Empty the burette and rinse with distilled water. Fill the burette with solution C.
d) Pipette $25cm^3$ of solution B into a 250ml conical flask and add 2 - 3 drops of phenolphthalein indicator.
e) Titrate solution B with solution C and record the results in Table 2. Repeat the titration two more times and complete the Table.

B. TABLE 2

Titration	I	II	III
Final burette reading (cm^3)			
Initial burette reading (cm^3)			
Volume of solution C used (cm^3)			

(4 marks)

i) Calculate the average volume of solution C used. (1 mark)
ii) Calculate the number of moles of sodium hydroxide in $25cm^3$ of solution B. (1 mark)
iii) Calculate the number of moles of solution C used. (2 marks)

c) Calculate the number of moles of hydrochloric acid in :
   i) $250cm^3$ of solution C. (1 mark)
   ii) $30cm^3$ of solution A. (1 mark)
d) Calculate:
   i) The number of moles of hydrochloric acid used in the reaction with sodium carbonate in solid H. (1 mark)
   ii) The moles of sodium carbonate in solid H. (2 marks)
   iii) The molar heat of reaction between sodium carbonate and hydrochloric acid in kJ mol^{-1} . Take the specific heat capacity

of the solution as $4.2Jg^{-1}k^{-1}$ and density of solution as $1.0g/cm^3$. (3 marks)

2. You are provided with solid P. Carry out the following tests and write your observation and inferences in the spaces provided. Place all of the solid P in a boiling tube. Add about $10cm^3$ of distilled water and shake until all the solid dissolves. Use the solution for the following tests.

a) To about $1cm^3$ of solution in a test tube, add 2M sodium hydroxide solution dropwise until in excess.

observation	inferences

b) To another $1cm^3$ portion of the solution in a test tube, add 2M ammonia solution dropwise until in excess.

observation	inferences

c) To another $2cm^3$ portion of the solution in a test tube, add 2 - 3 drops of aqueous potassium iodide solution.

observation	inferences

d) To about $1cm^3$ of the solution in a test tube, add 2 - 3 drops of barium nitrate solution.

observation	inferences

e) To about $1cm^3$ of the solution in a test tube, add 2 - 3 drops of lead (II) nitrate solution.

observation	inferences

3. You are provided with solid Q. Carry out the tests below and write your observations and inferences in the spaces provided.

a) Place half of solid Q on a clean metallic spatula and heat directly on the non-luminous flame of the Bunsen burner.

observation	inferences

b) Place the remaining portion of solid Q in a boiling tube. Add about cm^3 of distilled water and shake well. Divide the solution into two portions, in separate test tubes.

i) To the first portion, add a small amount of solid sodium hydrogen carbonate.

observation	inferences

ii) To the second portion, add 2 - 3 drops of acidified potassium manganate (VII) solution.

observation	inferences

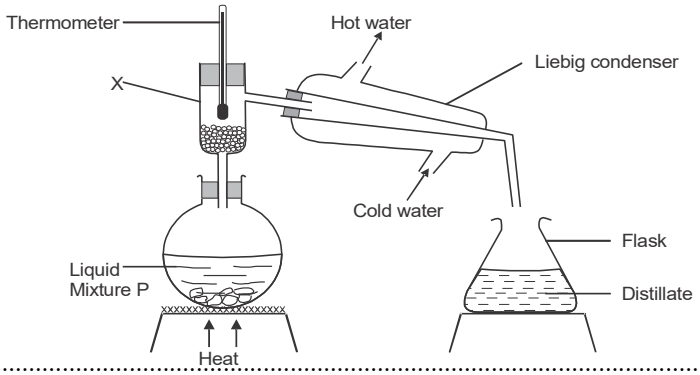
KCSE PREDICTION 2 2022
Kenya Certificate of Secondary Education
233/1
CHEMISTRY
Paper 1
(Theory)
July/August 2022

1. **a)** Name two commonly abused drugs in Kenya. (1 mark)
b) Differentiate between prescription drugs and over the counter drugs. (2 marks)

2. An organic compound with the formula $C_4H_{10}O$ reacts with sodium metal to give hydrogen gas and a white solid.
a) Give the formula of the white solid. (1 mark)
b) To which homologous series does the organic compound belong. (1 mark)
c) Write the equation for the reaction between the organic compound C_4H_{10} O and sodium metal. (1 mark)

3. Starting with sodium metal, describe how a sample of crystals of sodium hydrogen carbonate may be prepared. (3 marks)

4. Study the diagram below and answer the questions that follow. The diagram shows the method used to separate component of mixture P.



a) Name X ..... (½ mark)
b) What is the name given to the method used in separation of mixture P ? (½ mark)
c) What would happen if the inlet and outlet of water were interchanged ? (1 mark)
d) Which physical property is used to separate mixture P ? (1 mark)

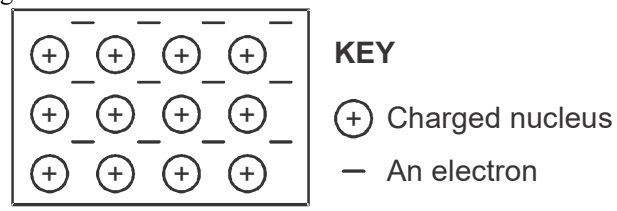
5. The following is a nuclear equation

$$^{233}_{91}Pa \longrightarrow {}^{x}_{y}Ac + \alpha$$

a) Calculate the value of x and y (1 mark)
b) State two differences between a nuclear reaction and a chemical reaction. (2 marks)

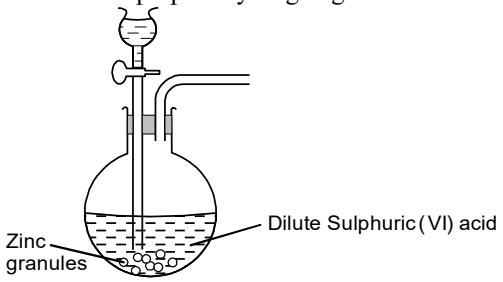
6. $20cm^3$ of an unknown gas Q takes 12.6 seconds to pass through small orifice. $10cm^3$ of oxygen gas takes 11.2 seconds to diffuse through the same orifice under the same conditions of temperature and pressure. Calculate the molecular mass of unknown gas. (O = 16) (3 marks)

7. The diagram below is a section of a model of the structure of element T.



a) State the type of bonding that exist in T. (1 mark)
b) In which group of the periodic table does element T belong ? Give a reason. (2 marks)

8. The set up below was used to prepare hydrogen gas.

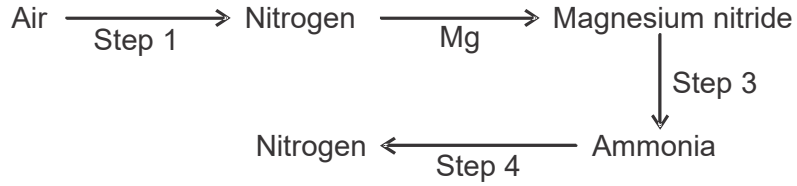


a) Complete the diagram to show how a dry sample of hydrogen gas can be collected. (2 marks)
b) Write an equation which takes place when hydrogen gas burns in air. (1 mark)

9. The chief ore of aluminium is bauxite which mainly contains $Al_2O_3.2H_2O$. The ore is initially purified before aluminium is extracted electrolytically.

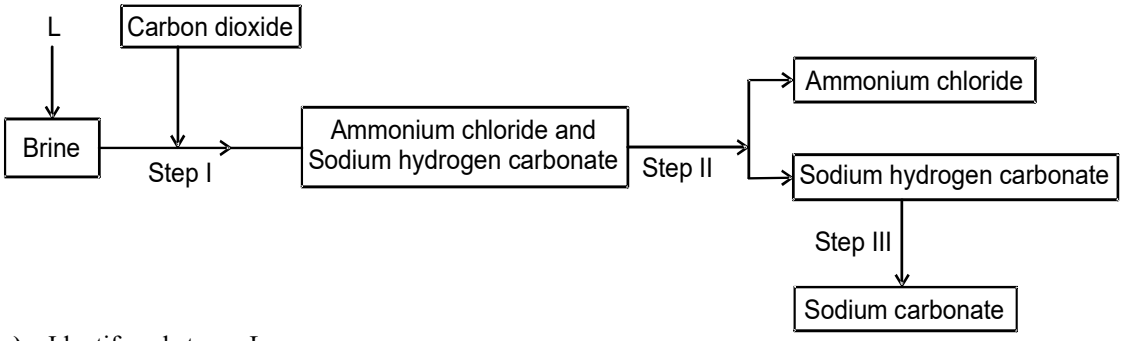
a) Identify the main impurity associated with this ore. (1 mark)
b) Sodium hydroxide solution is used in the purification process. State its role. (1 mark)
c) Give an equation for the reaction that forms aluminium oxide (Alumina) from aluminium hydroxide. (1 mark)

10. Study the sequence of reactions below and answer the questions that follow.



a) Name the process in step 4. (1 mark)
b) i) What reactant is used to achieve step 4 ? (1 mark)
ii) Write a balanced chemical equation for step 3. (1 mark)

11. The simplified flow chart below shows some of the steps in the manufacture of sodium carbonate by the Solvay process.



a) Identify substance L. (1 mark)
b) Name the process taking place in step II (1 mark)
c) Write an equation for the reaction which takes place in step III. (1 mark)

12. Below are PH values of some solutions.

Solution	Z	Y	X	W
PH	6.5	13.5	2.2	7.2

i) Which solution is likely to be
I. acidic rain ..... (½ mark)
II. Potassium hydroxide ..... (½ mark)
ii) A basic substance V reacted with both solutions Y and X. What is the nature of V. (1 mark)
iii) Identify two substances that show these characteristics in question (ii) above. (1 mark)

13. Copper (II) sulphate reacts with Barium chloride according to the equation below.
$CuSO_{4(aq)} + BaCl_{2(aq)} \rightarrow CuCl_{2(aq)} + BaSO_{4(s)}$ $\Delta H = -17.7KJmol^{-1}$
Calculate the temperature change when $900cm^3$ of 1M copper (II) sulphate were added to $600cm^3$ of 1M barium chloride.
(Heat capacity of solution = $4.2Jg^{-1}K^{-1}$, density of solution $1g/cm^3$) (3 marks)

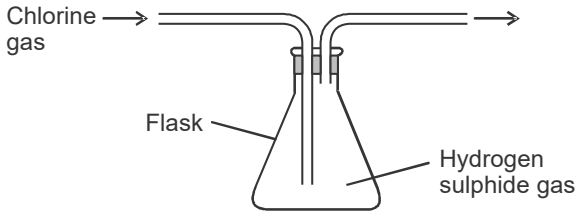
14. Metal S removes oxygen combined with P. Q reacts with an oxide of R and not with an oxide of P. P reacts with cold water but Q does not.
a) Which is the most reactive metal ? (1 mark)
b) Which is the least reactive metal ? (1 mark)
c) Arrange the metals in order of reactivity starting with most reactive to the least reactive. (1 mark)

15. Sequential removal of electrons was done in Y and energy required measured as follows.

Element Y	1st	2nd	3rd
Ionisation energy $KJmol^{-1}$	419	1146	5802

a) In which group is element Y. Explain. (1½ marks)
b) Element Z is next to Y and to its left in the same period. Which one between Z and Y has a bigger 1st ionisation energy. Explain. (1½ marks)

16. The figure below was set by a student to investigate the reaction between chlorine gas and hydrogen sulphide gas.



FOR MARKING SCHEMES INBOX 0724351706

a) Write an equation for the reaction that took place in the flask. (1 mark)
b) What observation was made in the flask ? (1 mark)
c) What precaution should be taken in carrying out the experiment ? (1 mark)

17. Some water samples A, B and C were tested with soap solution. The lathering produced was recorded as good or poor. The results are in the table below.

Test	A	B	C
1. Shaken with soap solution	Poor	Poor	Good
2. Na_2CO_3 added then shaken with soap solution	Good	Good	Good
3. Boiled then shaken with soap solution	Poor	Good	Good

a) Identify the anions present in sample of water A. (1 mark)
b) Give an advantage of hard water. (1 mark)
c) State one structural difference between a soapy and soapless detergent. (1 mark)

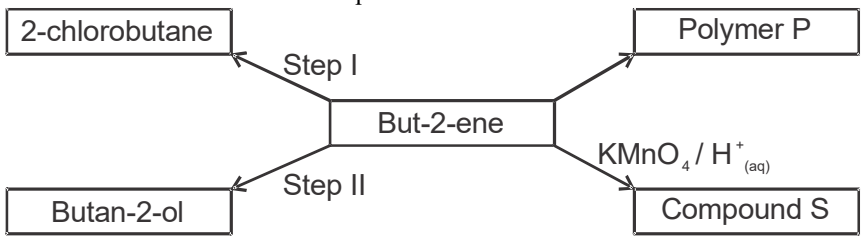
18. In an experiment, a student put equal volumes of mixture of ethanoic acid in water (tube A) and ethanoic acid in hexane (tube B). In each test tube, equal amounts of solid sodium hydrogen carbonate were added. State and explain the observations made. (3 marks)

19. The electronic structures for elements represented by letters A, B, C and D are
A - 2.8.6 B - 2.8.2 C - 2.8.1 D - 2.8.8
a) Select the element which forms :
i) a double charged cation (1 mark)
ii) a soluble carbonate (1 mark)
b) Which element has the shortest atomic radius ? (1 mark)

20. a) State Le Chatelier's principle. (1 mark)
b) According to the Le Chatelier's principle in (a) above, what two conditions should be adopted in the Haber process in order to obtain the maximum yield of ammonia. (2 marks)

21. An element Q has a relative atomic mass of 88. When a current of 0.5A was passed through the fused chloride of Q for 32 minutes and 10 seconds, 0.44g of Q were deposited at cathode. Determine the charge on the ion of Q. (1 Faraday = 9650 (3 marks)

22. Study the scheme below and answer the questions that follow.



a) Draw the structure of polymer P. (1 mark)
b) Identify compound S. (1 mark)
c) Give the reagents and conditions for step I and II (2 marks)
Step I:
Reagent .....
Condition .....
Step II:
Reagent .....
Condition .....

23. Bottle of sodium carbonate, sodium chloride and sugar have lost their labels. A student prepares and tests an aqueous solution of a sample of each bottle. The results obtained are as shown below.

Bottle	PH	Electrical conductivity	Correct label
1	7	conducts	
2	7	does not conducts	
3	10	conducts	

Complete the table by filling the correct label for each bottle. (3 marks)

24. A volume of $15cm^3$ of ethane gas was exploded with $50cm^3$ of oxygen. If both volumes were measured at the same temperature and pressure, calculate the volume of resulting gaseous mixture. (3 marks)

25. Below is a simple representation of a soap molecule



Using the structure above show how soap removes an oily smear from the fabric shown below.



(2 marks)

26. Study the information given in the table below and answer the questions below.

Bond	Bond energy KJmol-1
C —H	414
H —Cl	431
Cl— Cl	244
C — Cl	326

Calculate the enthalpy change for the reaction. (3 marks)

$CH_{4(g)} + Cl_{2(g)} \rightarrow CH_3Cl_{(g)} + HCl_{(g)}$

27. Hydrogen sulphide gas was bubbled into an aqueous solution of Iron (III) chloride.

a) State and explain the observations made. (2 marks)

b) Write the equation for the reaction that took place. (1 mark)

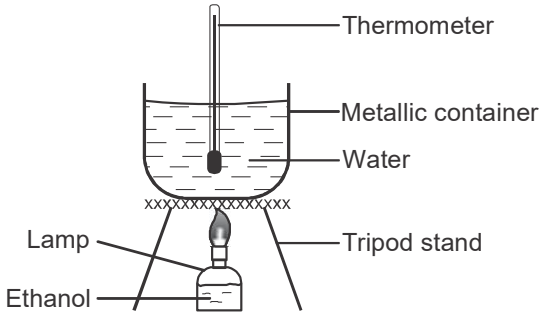
Kenya Certificate of Secondary Education
233/2
CHEMISTRY
Paper 2
(Theory)
July/August 2022

1. The grid below shows part of the periodic table. Study it and answer the questions that follows.

								Q
				S		R	K	
A	J		Y	U		P	L	
W							M	B

a) Give the name of the elements represented by the shaded region. (1 mark)
b) Identify an element which form ion with +2 charge. (1 mark)
c) Which non-metal is most reactive ? (1 mark)
d) Element V is in the second period and group V of the periodic table. Place it on the above grid of the periodic table. (1 mark)
e) State and explain how the atomic radius of U and J compare. (2 marks)
f) Write a chemical equation for the reaction between the oxide of A and water. (1 mark)
g) Explain how the electrical conductivity of A and Y compare. (2 marks)

2. a) State two reasons why wood charcoal is not a suitable fuel for cooking. (1 mark)
b) The diagram below represents a set up that was used to determine the molar heat of combustion of ethanol.



During the experiment the data given below was recorded :
Volume of water = 450cm^3
Initial temperature of water = 24.0^{o}C
Final temperature of water = 45.5^{o}C
Mass of ethanol + lamp before burning = 113.5g
Mass of ethanol + lamp after burning = 112.0g

I. Calculate the :
i) Heat evolved during the experiment (density of water = 1g/cm^3, specific heat capacity of water = 4.2Jg^{-1}K^{-1}) (2 marks)
ii) Molar heat of combustion of ethanol. (C = 12.0, O = 16.0, H = 1.0) (1½ marks)

II. Write the thermochemical equation for the complete combustion of ethanol. (1 mark)

III. The value of the molar heat of combustion of ethanol obtained in b(ii) above is lower than the theoretical value. State two reasons which lead to this. (2 marks)

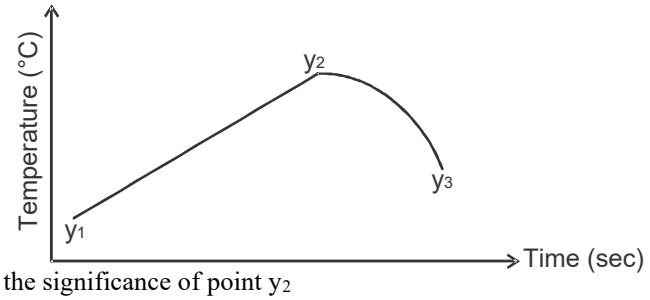
IV. On the axis below, draw an energy level diagram for combustion of ethanol. (1½ marks)



c) In order to determine the molar enthalpy of neutralization of sodium hydroxide, 50cm^3 of 2M sodium hydroxide and 50cm^3 of 2M hydrochloric acid both at the same initial temperature were mixed and stirred continuously with a thermometer. The temperature of the resulting solution was recorded after every 15 seconds until the highest temperature of the solution was attained. Thereafter the temperature of the solution was recorded for a further two minutes.

FOR MARKING SCHEMES INBOX 0724351706

The sketch below was obtained when the temperature of the mixture were plotted against time. Study and answer the questions that follow.

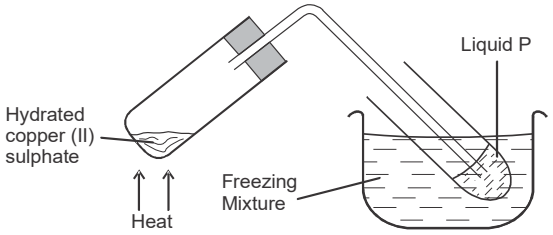


i) What is the significance of point y_2 (1 mark)

ii) Explain why there is a temperature change between points y_1 and y_2 (1 mark)

iii) Explain how the value of temperature rise obtained in this experiment would compare with the one that would be obtained if the experiment was repeated using $50cm^3$ of 2M methanoic acid instead of hydrochloric acid. (2 marks)

3. a) The diagram below shows a set up used to het hydrated copper (II) sulphate crystals.



i) State the colour change that occurred in the copper (II) sulphate crystals when heated. (1 mark)

ii) Identify liquid P (1 mark)

iii) Describe the chemical test that could be used to confirm liquid P. (2 marks)

b) Liquid P was heated for 8 minutes in a beaker. The results are given in the table below.

Time (minutes)	0	1	2	3	4	5	6	7	8
Temperature (°C)	-2	0	0	23.0	46.5	70	95	95	96

i) On the grid provided, plot a graph of temperature of liquid P (y-axis) against time (x-axis) (3 marks)

ii) On the graph, show the freezing point and boiling point of P. (2 marks)

iii) What is the effect of adding sodium chloride to the boiling point of liquid P ? Explain. (1 mark)

4. Use the standard electrode potentials for elements G, H, J, K and L given below to answer the questions that follow.

Half reactions	Electrode potential E^{θ} (volts)
$G^{2+}_{(aq)} + 2e^- \rightarrow G_{(s)}$	-2.90
$H^{2+}_{(aq)} + 2e^- \rightarrow H_{(s)}$	-2.38
$J^{+}_{(aq)} + e^- \rightarrow \frac{1}{2}J_{2(g)}$	0.00
$K^{2+}_{(aq)} + 2e^- \rightarrow K_{(s)}$	+0.34
$\frac{1}{2}L_{2(g)} + e^- \rightarrow L^-_{(aq)}$	+2.87

a) Which element could be hydrogen ? Explain. (1 mark)

b) Which two half cells would produce the highest potential difference (e.m.f) when combined ? (1 mark)

c) In the space provided below construct a well labelled electrochemical cell obtained when G^{2+}/G and K^{2+}/K half cells are combined. (3 marks)

d) Calculate the E^{θ} value of the electrochemical cell constructed in (c) above. (2 marks)

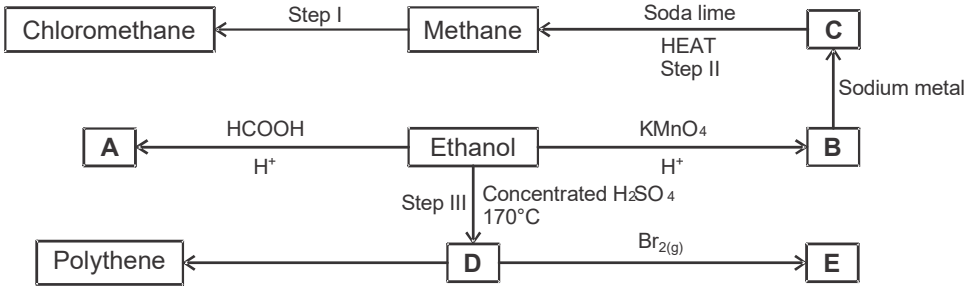
e) It is not advisable to store a nitrate solution of K in a container made of H. Explain. (2 marks)

II. During electrolysis of aqueous copper (II) sulphate using copper electrodes, a current of 0.4 amperes was passed through the cell for 5 hours.

i) Write an ionic equation of the reaction that occurred at the cathode. (1 mark)

ii) Determine the change in mass of the anode which occurred as a result of the electrolysis process. (Cu = 63.5, 1 Faraday = 96,500 coulombs) (3 marks)

5. I. The scheme below shows some reactions starting with ethanol. Study it and use it to answer the questions that follow.



a) Name substances A, B, C, D & E (2½ marks)

b) Name the reagent and condition required for the reaction in step I (1 mark)

Reagent .....

Condition

c) Write the equation for the reaction between :

i) sodium metal and B (1 mark)

ii) Bromine gas and compound D (1 mark)

d) Identify the process represented by step III. (1 mark)

e) Given that the relative molecular mass of polythene. $\left[CH_2-CH_2\right]_n$ is 42,000, calculate the value of n. (2 marks)

II. The structures below represent two cleansing agents

R - COONa

R - OSO_3Na

In the table below, give one advantage and one disadvantage of using each one of them. (2 marks)

	Advantage	Disadvantage
RCOONa		
R-OSO_3Na		

III. Complete the table below by inserting the missing information in the spaces provided. (2 marks)

Name of polymer	Monomer	Use
Polyvinylchloride		
	Styrene	

6. A piece of marble chip (calcium carbonate) is put in a beaker containing excess of dilute hydrochloric acid which is placed on a reading balance. The mass of the beaker and its contents is recorded every two minutes as shown in the table.

Time (min)	0	2	4	6	8	10	12
Mass (g)	126.4	126.3	126.2	126.1	126.0	126.0	126.0

a) Why is there a continuous loss of mass of the reaction mixture. (1 mark)

b) Write an equation for the reaction taking place. (1 mark)

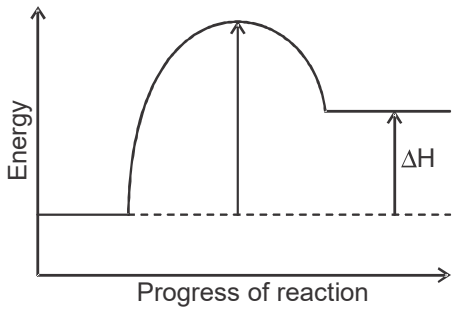
c) State two different ways by which the reaction could have been made more rapid. (2 marks)

d) Why does the mass remain constant after 8 minutes. (1 mark)

e) State the observations that would be made if a few drops of silver nitrate solution was added to 1cm^3 of the resulting solution followed by excess ammonia solution. (1 mark)

f) State one environmental effect that excess carbon (IV) oxide in the air causes. (1 mark)

g) The energy profile for the forward direction of a reversible reaction is shown.



Sketch on the diagram the path for a catalysed reaction. (1 mark)

h) What do you observe when you introduce the following substances in this equation

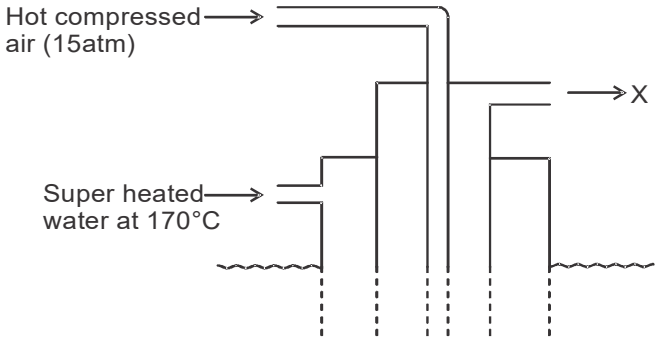
$$2CrO^{2-}_{4(aq)} + 2H^{+}_{(aq)} \rightleftharpoons Cr_2O^{2-}_{7(aq)} + H_2O_{(l)}$$

yellow orange

i) Sodium hydroxide solution (1 mark)

ii) Catalyst (1 mark)

7. a) The diagram below shows the Frasch process used for extraction of sulphur. Use it to answer the questions that follow.

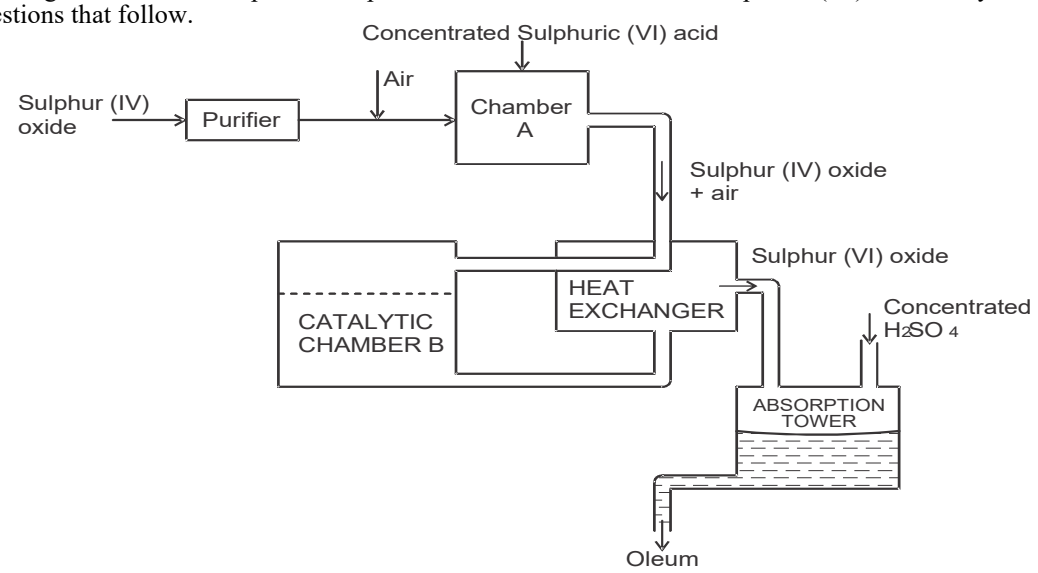


i) Identify X ..... (1 mark)

ii) Why is it necessary to use superheated water in this process. (1 mark)

iii) State two physical properties of sulphur that makes it possible for it to be extracted by this method. (2 marks)

b) The diagram below shows part of the processes in the manufacture of sulphuric (VI) acid. Study it and answer the questions that follow.



i) Write an equation for the formation of sulphur (IV) oxide from sulphur. (1 mark)

ii) What is the role of concentrated sulphuric (VI) acid in chamber A. (1 mark)

iii) Name two catalyst that can be used in the catalytic chamber B. (2 marks)

iv) State two roles of the heat exchanger. (2 marks)

c) Explain one way in which sulphur (IV) oxide is a pollutant. (1 mark)

d) What observation will be made when a few drops of concentrated sulphuric (VI) acid are added to crystals of sugar? Explain your answer. (2 marks)

Kenya Certificate of Secondary Education
233/3
CHEMISTRY
Paper 3
July/August 2022
Time : 2¼ Hours

1. You are provided with :
- 4.5g of solid M in a boiling tube
- solution N i.e. 0.06M acidified potassium manganate (VII)

You are required to determine :
i) The solubility of solid M at different temperatures
ii) The number of moles of water of crystallisation in solid M

Procedure
a) Using a burette, add 4cm^3 of distilled water to solid M in a boiling tube. Use the water bath to heat the mixture while stirring with the thermometer to about 70ºC When the entire solid has dissolved, allow the solution to cool while stirring with the thermometer until crystals first appear. Record this temperature in table 1.
b) Using the burette, add 2cm^3 of distilled water to the contents of the boiling tube. Warm the mixture while stirring with the thermometer until all the solid dissolves. Allow the mixture to cool while stirring. Note and record the temperature at which crystals of solid M first appear.
c) Repeat procedure (b) two more times and record the temperatures in table 1. Retain the contents of the boiling tube for use in procedure (e)
d) i) Complete table 1 by calculating the solubility of solid M at the different temperatures. The solubility of a substance is the mass of the substance that dissolves in 100g of water at a particular temperature

Table 1

Volume of water in the boiling tube (cm³)	Temperature at which crystals of solid M first appear (°C)	Solubility of solid M (g/100g of water)
4		
6		
8		
10		

(6 marks)

ii) On the grid provided plot a graph of the solubility of solid M (vertical axis) against temperature. (3 marks)
iii) Using your graph, determine the temperature at which 100g of solid M would dissolve in 100g of water. (1 mark)

e) i) Transfer the contents of the boiling tube into a 250ml volumetric flask. Rinse both the boiling tube and the thermometer with distilled water and add to the volumetric flask. Add more distilled water to make upto the mark. Label this solution as solution M. Shake the mixture thoroughly for uniformity of concentrations.
Fill the burette with solution N
Using a pipette and pipette filler place 25cm^3 of solution M into a conical flask. Warm the mixture to about 70ºC using the water bath provided. Titrate the hot solution M with solution N until a permanent pink colour persists. Record your readings in table 2. Repeat the titration two more times and complete table 2.

Burette readings	I	II	III
Final burette reading (cm³)			
Initial burette reading (cm³)			
Volume of solution N used (cm³)			

(4 marks)

ii) Calculate :
I. Average volume of solution used (1 mark)
II. Number of moles of potassium manganate (VII) used. (1 mark)
III. Number of moles of M in 25cm^3 of solution M given that 2 moles of potassium manganate (VII) react completely with 5 moles of M. (2 marks)

iii) The formula of M has the form D.nH_2O. Determine the value of n in the formula given that the relative formula mass of D is 90. (H = 1, O = 16) (2 marks)

2. **I.** You are provided with solid P, carry out the following tests and record your observations.
a) Transfer all of solid P into a boiling tube and add 20cm^3 of distilled water. Shake the mixture thoroughly then filter. Wash the residue with a little distilled water into the filtrate. Retain the filtrate and residue.

i) To the residue in a boiling tube, add dilute nitric (V) acid and retain the mixture.
Divide it into two portions.

Observations	Inference
(1mk)	(1mk)

ii) To the first portion of the mixture above, add $NaOH_{(aq)}$ dropwise until in excess.

Observations	Inferences
(1mk)	(1mk)

iii) To the second portion of the mixture add $NH_{3(aq)}$ dropwise till in excess.

Observations	Inferences
(1mk)	(1mk)

b) Divide the filtrate into four portions.

i) To the first portion, add $NaOH_{(aq)}$ dropwise till in excess.

Observations	Inferences
(1mk)	(1mk)

ii) To the second portion, add $NH_{3(aq)}$ dropwise till in excess.

Observations	Inferences
(1mk)	(1mk)

iii) To the third portion, add Barium chloride solution.

Observations	Inference
(1mk)	(1mk)

iv) To the fourth portion, add a few drops of Barium chloride solution followed by nitric (V) acid solution.

Observations	Inference
(1mk)	(1mk)

II. You are provided with solid Q. You are required to carry out the tests shown on solid Q in each case writing down your observations and inferences.

a) Take a half spatula endful of solid Q on a clean spatula. Ignite it over a Bunsen burner's non-luminous flame.

Observations	Inferences
(1mk)	(1mk)

b) Take another half spatula endful of solid Q in a clean test tube. Add just enough distilled water to dissolve it. Divide the resulting solution into two portions for tests (i) and (ii) below.

i) To the first portion, add 2 drops of bromine water.

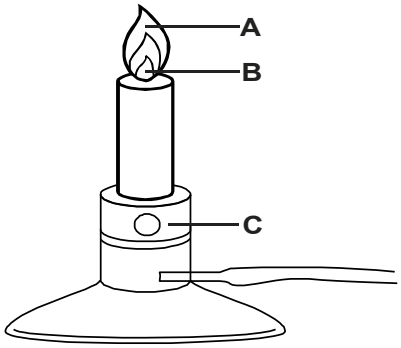
Observations	Inference
(1mk)	(1mk)

ii) To the second portion, add 2 drops of acidified potassium manganate (VII) solution.

Observations	Inferences
(1mk)	(1mk)

KCSE PREDICTION 3 2022
Kenya Certificate of Secondary Education
CHEMISTRY
233/1
CHEMISTRY
Paper 1

1. The diagram below shows a Bunsen burner when in use.



(a) Name the region labelled A and B (2 marks)
(b) State the function of the part labelled X (1 mark)

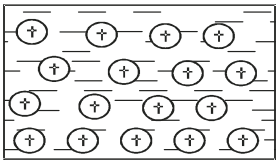
2. a) Complete the nuclear equation below. (1 mark)

$$^{210}_{83}X \rightarrow ^{210}_{84}Y +$$

b) The half-life of $^{210}_{83}$ X is 5 days.

Determine the mass remaining if 100g decayed in 20 days. (1 mark)
c) State one danger associated with exposure of human beings to radio isotopes. (1 mark)

3. The diagram below is a section of a model of the structure of element J.



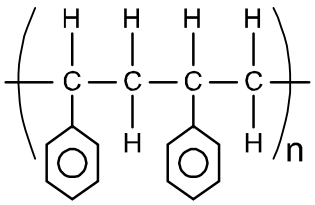
In which group of the periodic table does element J belong? Give a reason. (2 marks)

4. Study the standard reduction potentials given below and answer the questions that follow. (The letters are not the actual symbols of the elements). E (volts)

$$P^{2+}_{(aq)} + 2e \rightarrow P_{(S)} \qquad -0.14$$
$$Q^{2+}_{(aq)} + 2e \rightarrow Q_{(S)} \qquad -0.76$$
$$R^{2+}_{(aq)} + 2e \rightarrow R_{(S)} \qquad -2.37$$
$$S^{+}_{(aq)} + e \rightarrow S_{(S)} \qquad +0.86$$

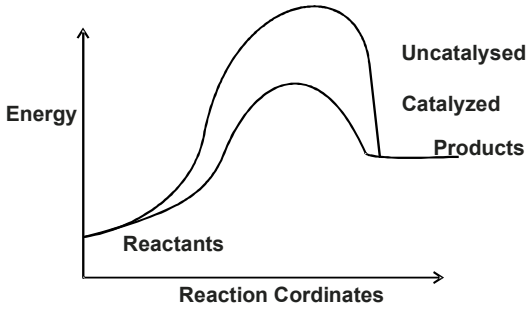
a) The standard reduction potential for $Fe^{2+}_{(aq)}$ is -0.44volts. Select the element which would best protect iron from rusting. (1 mark)
b) Calculate the E value for the cell represented as $P_{(S)} / P^{2+}_{(aq)} // S^{+}_{(aq)} / S_{(S)}$ (2 marks)

5. The formula given below represents a portion of a polymer.



a) What is the name of this polymer? (1 mark)
b) Draw the structure of the monomer used to manufacture the polymer. (1 mark)
c) Give one use to which the polymer given is put in real life. (1 mark)

6. The energy level diagram below shows the effect of a catalyst on the reaction path.



a) What does point P represent ? (1 mark)
b) With reference to the energy level diagram, explain how a catalyst increases the rate of a reaction. (2 marks)

7. Copper (II) sulphate reacts with barium chloride according to the equation below.
Calculate the temperature change when 900cm³ of 1M copper (II) sulphate were added to 600cm² of 1M barium (II) chloride.
(Assume heat capacity of solution is 4.2 $Jg^{-1}k^{-1}$ and density of solution is 1g/cm³) (3 marks)

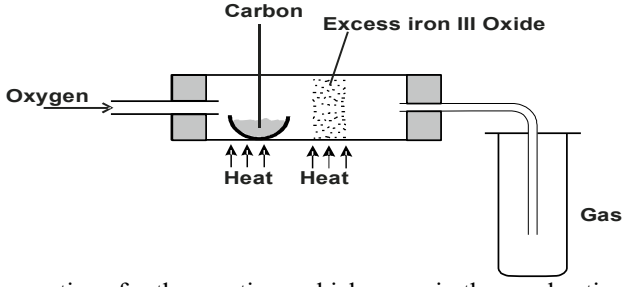
$$CuSO_{4(aq)} + BaCl_{2(aq)} \rightarrow CaCl_{2(aq)} + BaSO_{4(S)};\ \Delta H = -17.7kJ/mol$$

8. In an experiment, soap solution was added to three separate samples of water. The table below shows the volumes of soap solution required to form lather with 1000cm³ of each sample of water before and after boiling.

	Sample 1	Sample II	Sample III
Volume of soap before water is boiled (cm³)	25	2	8.5
Volume of soap after water is boiled (cm³)	25	2	2

a) Which water sample is likely to be soft? Explain. (2 marks)
b) Explain the change in the volume of soap solution used in sample III (1 mark)

9. The set-up below was used to obtain a sample of iron.



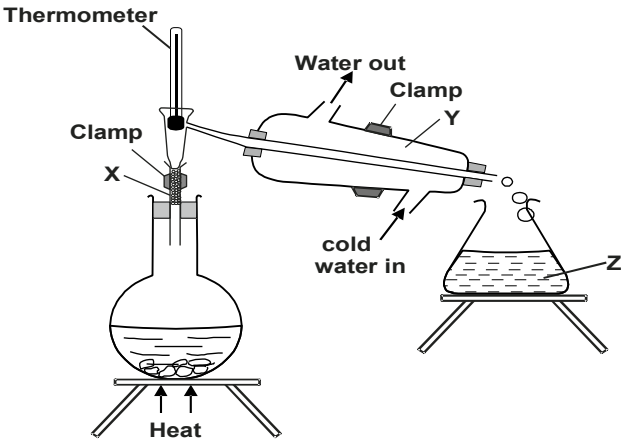
Write two equations for the reactions which occur in the combustion tube. (2 marks)

10. Complete the table below.

Isotope	Number of		
	Protons	Neutrons	Electrons
Cr			

(2 marks)

11. The diagram below shows the set-up of the apparatus used to separate methanol (boiling point 65°C) and water (boiling point 100°C)



Identify

(a) Apparatus X (1 mark)

(b) Apparatus Y (1 mark)

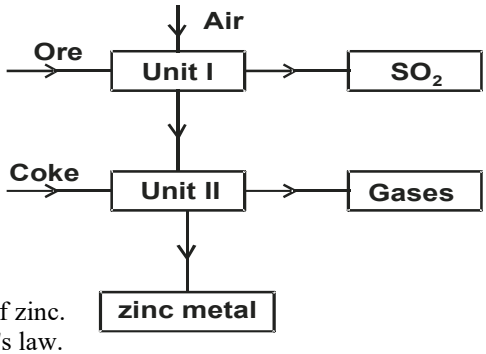
(c) Liquid Z (1 mark)

12. Determine the oxidation states of sulphur in the following compounds

(a) H_2S

(b) $Na_2S_2O_3$

13. The flow chart below shows some processes involved in the industrial extraction of zinc metal.



c) State two uses of zinc. (1 mark)

14. a) State the Charle's law. (1 mark)

b) The volume of a sample of nitrogen gas at a temperature of 291K and 1.0×10^5 Pascals was $3.5 \times 10^{-2}m^3$. Calculate the temperature at which the volume of the gas would be $2.8 \times 10^{-2}m^3$ at 1.0×10^5 pascals. (2 marks)

15. The general formula for a homologous series of organic compounds is $C_nH_{2n+1}OH$.

a) Give the name and structural formula of the third member of this series.

i) Name (1 mark)

ii) Structural formula. (1 mark)

b) Write an equation for the complete combustion of the third member of this series. (1 mark)

16. The diagram below represents part of the periodic table. Use it to answer the questions that follow.

N					W			
M	T		V					

a) Write the electronic arrangement for the stable ion formed by V. (1 mark)

b) Write an equation for the reaction between T and W. (1 mark)

c) How do the ionisation energies of the elements N and M compare? Explain. (1 mark)

17. Carbon (IV) oxide can be dissolved in water under pressure to make an acidic solution.

a) What is meant by an acidic solution. (1 mark)

b) Aqueous lead (II) nitrate reacts with the acidic solution to form a precipitate. Write an ionic equation for the reaction. (1 mark)

18. Name the process which takes place when

a) Iodine changes directly from solid to gas. (1 mark)

b) $Fe^{2+}_{(aq)}$ changes to $Fe^{3+}_{(aq)}$ (1 mark)

c) White sugar changes to black solid when mixed with excess concentrated sulphuric acid. (1 mark)

19. A certain carbonate, QCO_3, reacts with dilute hydrochloric acid according to the equation given below.

$$QCO_{3(S)} + 2HCl_{(aq)} \rightarrow QCl_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$$

If 1g of the carbonate reacts completely with 20cm³ of 1M hydrochloric acid. Calculate the relative atomic mass of Q. (3 marks)

(C = 12.0, O=16.0)

1. The table below gives some properties of three elements in group (VII) of the periodic table. Study it and answer the questions that follow.

Element	Atomic No.	Melting point (°C)	Boiling point (°C)
Chlorine	17	-101	-34.7
Bromine	35	-7	58.8
Iodine	53	114	184

(a) Which element is in liquid form at room temperature? Give a reason. (1 mark)

(b) Explain why the boiling point of iodine is much higher than that of chlorine. (2 marks)

21. Below are the bond dissociation energies of some elements.

Bond	Bond dissociation energy
C - C	343 kJ mol^{-1}
C - H	414 kJ mol^{-1}
H - H	435 kJ mol^{-1}
C = C	612 kJ mol^{-1}

Use this information to calculate the heat of reaction for (3 marks)

$$C_2H_{4(g)} + H_{2(g)} \rightarrow C_2H_{6(g)}$$

22. Sulphur (IV) oxide is oxidized catalytically to sulphur (VI) oxide in the reaction.

$$2SO_{2(g)} + O_{2(g)} \qquad 2SO_{3(g)} \quad \Delta H = -197kJ$$

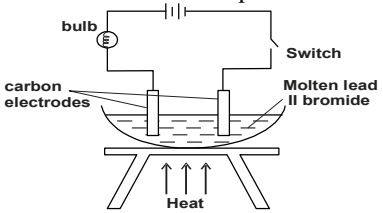
a) What information about the reaction is given by DH = -197kJ ? (1 mark)

b) Name one catalyst that can be used in this reaction. (1 mark)

23. Starting with solid magnesium oxide, describe how a solid sample of magnesium hydroxide can be prepared. (2 marks)

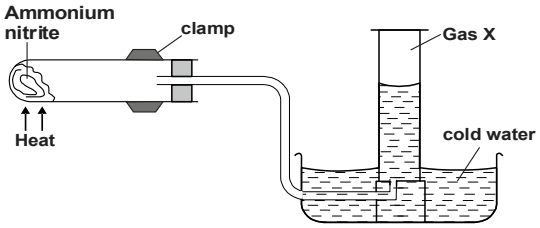
b) Give one use of magnesium hydroxide. (1 mark)

24. a) Study the set-up below and answer the question that follows.



State and explain the observation that would be made when the circuit is completed. (3 marks)

25. Ammonium nitrite was heated as shown in the set-up below.



a) Identify gas X. (1 mark)

b) State and explain the precaution that must be taken before heating is stopped. (2 marks)

26. a) Propane reacts with oxygen according to the equation below.

$$C_3H_{8(g)} + 5O_{2(g)} \rightarrow 3CO_{2(g)} + 4H_2O_{(l)} \qquad \Delta H = -2220\ kJ/mol$$

Calculate the volume of propane that would produce 1000kJ of heat when completely burnt (Molar volume of a gas at r.t.p = 24 litres) (2 marks)

b) Give the structural formula of propyne. (1 mark)

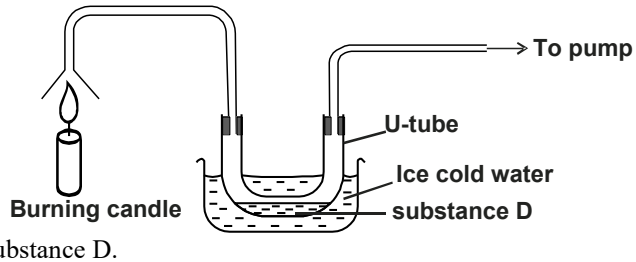
27. When a few drops of aqueous ammonia were added to copper (II) nitrate solution, a light blue precipitate was formed. On addition of more aqueous ammonia, a deep blue solution was formed

Identify the substance responsible for the

a) Light blue precipitate. (1 mark)

b) deep blue solution (1 mark)

28. Study the diagram below and answer the following questions



a) Identify substance D. (1 mark)

b) Describe how the other product of the burning candle could be prevented from getting into the environment. (2 marks)

29. Graphite is one of the allotropes of carbon.

a) Name one other element which exhibits allotropy. (1 mark)

b) Explain why graphite is used in the making of pencil leads. (1 mark)

Kenya Certificate of Secondary Education
233/2
CHEMISTRY
Paper 2

1. Form 4 students of Mundika High school carried out an experiment to determine the molar heat of combustion of ethanol (C_2H_5OH). A small spirit lamp containing ethanol was weighed and then lit. The heat produced by the combustion of the ethanol was used to heat 200cm³ of water. The spirit lamp was weighted again at the end of the experiment. The following results were obtained.

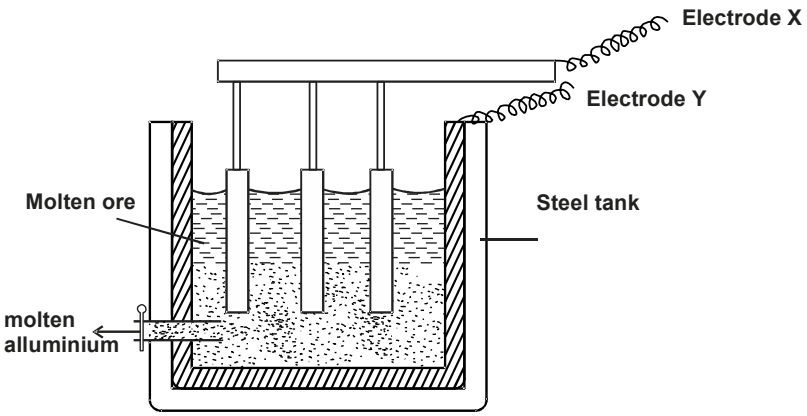
   Initial mass of spirit lamp = 85.3g
   Final mass of spirit lamp = 84.8g
   Initial temperature of water = 23.6°C
   Final temperature of water = 35.6°C

a) Calculate
   i) The mass of ethanol that burned (1 mark)
   ii) The rise in the temperature of water. (1 mark)
   iii) The heat gained by the water in kilojoules. (2 marks)
   iv) Molar enthalpy of combustion of ethanol. (2 marks)
   Density of water = 1.0gcm^{-3}; specific heat capacity of water is 4.2kJ^{-1} kg^{1})

b) The actual enthalpy of combustion of ethanol is 1371kJmol^{-1}. Give one source of error that makes the experiment value to differ from the actual value. (1 mark)

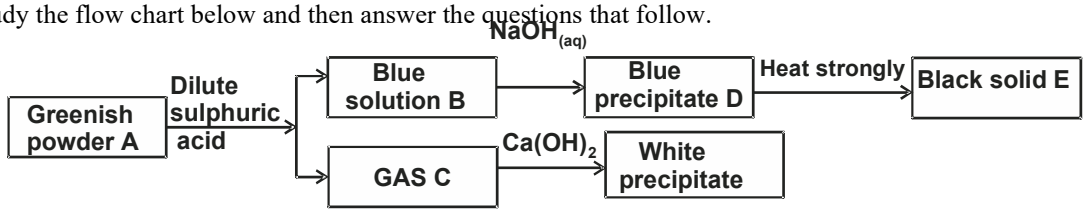
c) i) Write a balanced thermochemical equation to show the combustion of ethanol. (1 mark)
   ii) Sketch an energy-level diagram for the combustion of ethanol. (2 marks)

2. Aluminium is extracted using the electrolytic cell represented by the diagram **below**



a) Why is aluminium extracted by electrolytic method? (`1 mark)
b) Name the electrodes labelled X and Y (1 mark)
c) The chief ore from which aluminium is extracted is bauxite.
   i) Name **two** main impurities present in bauxite. (2 marks)
   ii) Aluminium oxide is the main component in bauxite with a melting point of 2015°C but electrolysis of molten aluminium oxide is carried out at 800°C. Explain how this is achieved. (2 marks)
d) Write the equations for the reaction taking place at the anode. (1 mark)
e) One of the electrodes is replaced periodically. Which one and why? (1 mark)
f) Duralumin (an alloy of copper, aluminium and magnesium) is preferred to pure aluminium in the construction of aeroplane bodies. Give **one** property of duralumin that is considered. (1 mark)

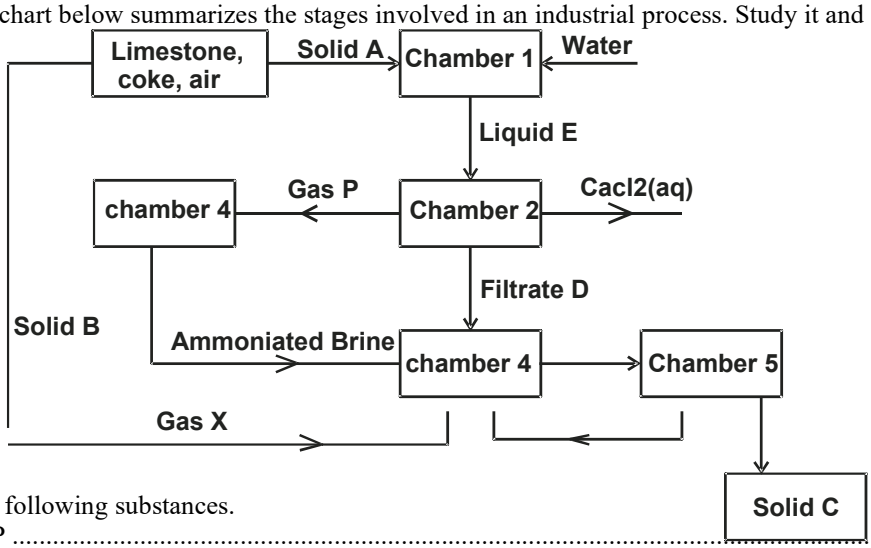
3. Study the flow chart below and then answer the questions that follow.



a) Name the substances A, B, C, D and E. (2½ marks)
b) Write equations for the :
   i) Action of sulphuric acid on solid A. (1 mark)
   ii) Action of sodium hydroxide on solution B (1 mark)
c) Suggest how A could be turned into E in one step and write the equation of the reaction. (1½ marks)

FOR MARKING SCHEMES INBOX 0724351706

B. The flow chart below summarizes the stages involved in an industrial process. Study it and answer the questions that follow.



a) Name the following substances.
   i) Gas P .....
   ii) Gas X .....
   iii) Solid A .....
   iv) Solid B .....
   v) Solid C .....
   vi) Filtrate D .....
   vi) Liquid E .....

b) Write chemical equations for the reactions that occur in
   i) Chamber 1 ii) Chamber 2 iii) Chamber 4

c) Name two substances that are recycled in this process. (1 mark)

d) State two uses of solid C (2 marks)

4. a) Study the data given in the table below and then answer the questions that follow. The letters do not represent the actual symbol of elements.

Element	Atomic number	Mpt/°C	Bpt./°C
A	11	98	890
B	12	650	1110
C	13	660	2470
D	14	1410	2360
E	15	442/590	280
F	16	113/119	445
G	17	-101	-35

a) Why do elements represented by letter E and F have two melting point values? (1 mark)

b) State the nature of oxide of elements represented by letters B and F. (2 marks)

c) Explain the following in terms of structure and bonding.
   i) There is an increase in boiling point from A to C. (1 mark)
   ii) Element D has a high melting point. (1 mark)
   iii) There is decrease in melting point from E to G. (1 mark)

b) a) The grid below represents part of the periodic table. (The letters do not represented the actual symbols of the elements).

					P			
Q					V	R		
T	U					S		

   i) Select an element that can form an ion with a charge of -2 (1 mark)
   ii) What type of structure will the chloride of Q have? (1 mark)
   iii) Explain how the reactivities of R and S compare. (1 mark)
   v) Compare the atomic radius of U and that of T. Explain. (1 mark)

   b) 2.5g of Q react completely with 1.2dm³ of gas R at S.T.P
   i) Write a balanced equation for the reaction between Q and R. (1 mark)
   ii) Determine the R.A.M of Q (Molar volume of gas at (S.T.P = 22.4dm³) (2 marks)

5. a) An electric current was passed through copper (II) nitrate solution using inert electrodes. A gas that relights a glowing splint was produced at electrode A and no gas was produced at electrode B.
   i) Show how gas X can be collected. (2 marks)

FOR MARKING SCHEMES INBOX 0724351706

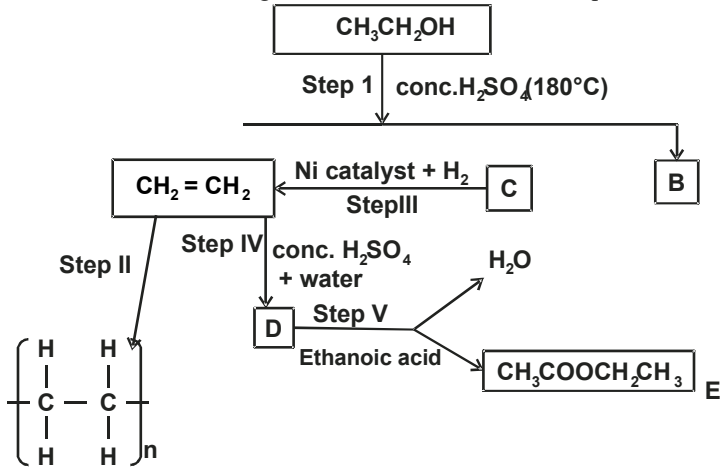
ii) Which of the electrodes is the cathode? Explain. (2 marks)
iii) Write an equation for the formation of gas at electrode A. (1 mark)
iv) Calculate the mass of copper deposited if a constant current of 5A was passed for 3 hours. (Cu=63.5, F=96500C)

b) The following are standard electrode potentials for some electrodes.

$A^{2+}_{(aq)} + 2e^-$ $A_{(S)}$
$B^{2+}_{(aq)} + 2e^-$ $B_{(S)}$ E = -2.92V
$\frac{1}{2}C^{2+}_{(aq)} + 2e^-$ $C_{(S)}$ E = -2.38V
$D^{2+}_{(aq)} + 2e^-$ $D_{(S)}$ E = -0.00V
$\frac{1}{2}E^{+}_{(aq)} + e^-$ $E_{(S)}$ E = +0.34V
E = +2.87V

i) Which is the strongest reducing agent? Explain (2 marks)
ii) Write the cell representation for the electrochemical cell obtained by combining the half-cell of B and D.
iii) Calculate the e.m.f of the cell in (ii) above. (2 marks)

6. Study the reactive scheme below starting with ethanol and answer the questions that follow.



a) Write down the formula of compound B, C and D. (1½ marks)
b) State the type of reaction represented by (2 marks)
Step 1 .....
Step II.....
Step IV .....
Step V .....
c) i) To what class of compounds does E and M belong? (1 mark)
ii) Name substance E (½ mark)
d) Write the equation of combustion of ethanol. (1 mark)
e) If the relative molecular mass of M is 47 600, determine the value of 'n' (C=12, H=1) (2 marks)
f) Using chemical test, state how you can distinguish $CH_2 = CH_2$ and $CH_3CH_2CH_3$. (2 marks)

7. The reaction between bromine and methanoic acid at 30° proceeds according to the information given below.

Concentration of Br2(aq) mol dm-3	Time (minutes)
10.0×10^{-3}	0
8.1×10^{-3}	1
6.6×10^{-3}	2
4.4×10^{-3}	4
3.0×10^{-3}	6
2.0×10^{-3}	8
1.3×10^{-3}	10

a) On the grid below plot a graph of concentration of bromine (vertical axis) against time. (3 marks)
From the graph determine:
i) The concentration of bromine at the end of 3 minutes. (1 mark)
ii) The rate of reaction at time 't' where t = 1½ minutes. (2 marks)
c) Explain how the concentration of bromine effects the rate of the reaction. (2 marks)
d) On the same axis, sketch the curve would be obtained if the reaction was carried out at 20°C and label the curve as curve II. Give a reason for your answer. (2 marks)

Kenya Certificate of Secondary Education
233/3
CHEMISTRY
Paper 3
PRACTICAL

You are provided with

- 2.5g of a monobasic acid, solid E
- 200cm³ of sodium hydroxide solution, F
- 100cm³ of 0.01M solution of dibasic acid G, ethanaioic (oxalic) acid.

You are required to

1. Prepare a saturated solution of solid E
2. Standardize sodium hydroxide solution F, using solution G.
3. Determine the solubility of solid E in water at room temperature.

Procedure 1

1. Measure out 100cm³ of distilled water using a measuring cylinder and transfer it to a dry clean conical flask. Add solid E and stir. Leave it to stand.
2. Fill the burette with solution F. Pipette 25.0cm³ of solution G into a conical flask. Add 2 - 3 drops of phenolphthalein indicator and titrate with solution F until the indicator colour changes. Record your results in table 1 below. Repeat the procedure and fill the table.
   Table 1

	I	II	III
Final burette reading (cm³)			
Initial burette reading (cm³)			
Volume of solution F used (cm³)			

i) Calculate the average volume of solution F used (cm³) (1 mark)
ii) Find the number of moles of F in the average volume calculated. (1 mark)
iii) Calculate the concentration of sodium hydroxide in solution F, in moles per litre. (2 marks)

Procedure II

1. Measure the temperature of solution E. using a dry filter paper and funnel, filter the solution into a clean conical flask.
2. Pipette 25.0cm³ of the filtrate into a clean conical. Add 75.0cm³ of distilled water using a measuring cylinder. Shake well and label this as E1. Pipette out 25.0cm³ of solution E1 into a conical flask, add 2-3 drops of phenolphthalein indicator and titrate with sodium hydroxide, solution F until indicator colour changes. Record your results in table II below.
   Temperature of solution F ..... (1 mark)
   Table II

	I	II	III
Final burette reading (cm³)			
Initial burette reading (cm³)			
Volume of solution F used (cm³)			

(4 marks)

i) Calculate the average volume of solution F used (cm³) (1 mark)
ii) Work out the number of moles of acid in 25.0cm³ of solution E1. (1 mark)
iii) Calculate the number of moles of acid in 100.0cm³ of solution E. (2 marks)
iv) Given that the molecular formula of acid E is $(BOH)_3$, calculate the solubility of the acid in grammes per 100cm³ of water. (B=11.0, O=16.0, H=1.0) (2 marks)

2. You are provided with a solid mixture H, in a boiling tube, add 10cm³ of distilled water to it. Shake and filter the mixture. Keep the residue for further tests and divide the filtrate into three portions.

a) To the first portion, add 2 - 3 drops of lead (II) nitrate solution.
To the second poritoin, add 2cm³ of barium nitrate solution followed by equal amount of nitric (V) acid solution.

Observation	Inference
(3mks)	(1½mks)

To portion three, add ammonia solution dropwise till excess.

Observation	Inference
(3mks)	(1½mks)

a) Using a metallic spatula, heat half of the residue on a non-luminous flame.Transfer the remaining solid into a test tube and add 2cm³ of nitric (V) acid solution.

c) Divide the resulting mixture into two portions

Observation	Inference
(3mks)	(1½mks)

i) To the first portion, add 3 drops of sodium hydroxide solution then excess

Observation	Inference
(3mks)	(1½mks)

ii) To the second portion, add ammonia solution dropwise then excess

Observation	Inference
(3mks)	(1½mks)

3. a) Using a clean metallic spatula, ignite about one half of solid I in a non-luminous bunsen flame.

Observation	Inference
(3mks)	(1½mks)

b) Place the other half of solid I into a boiling tube, add 10cm³ of distilled water and shake well. Label it solution I. Use it for the test below.

i) Determine pH of solution B.

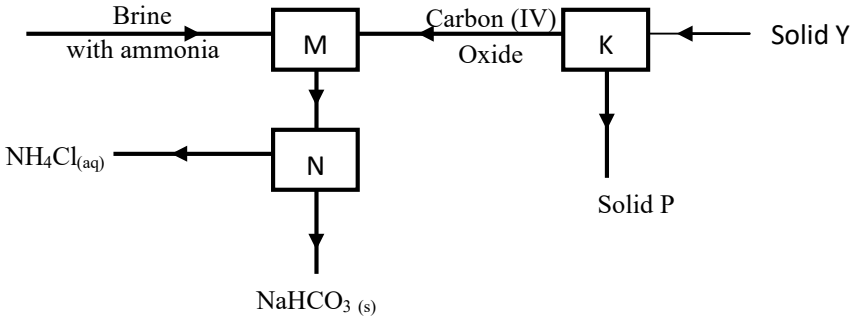
Observation	Inference
(3mks)	(1½mks)

ii) To about 2cm³ of solution 1 add 3 drops of acidified potassium manganate (VII) solution

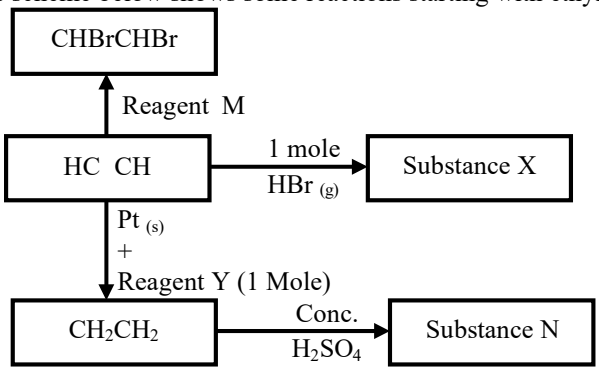
Observation	Inference
(3mks)	(1½mks)

KCSE PREDICTION 4 2022
***K*233/1**
CHEMISTRY
PAPER 1
(THEORY)

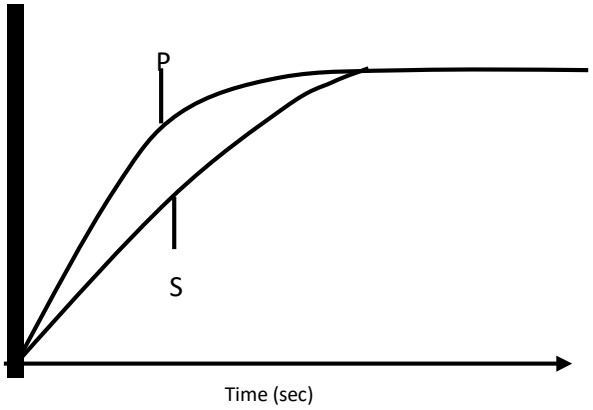
1. The diagram below shows part of Solvay Process.



   (a) Name solid P (½ Mark)
   (b) State the process taking place in chamber N. (½ mark)
   (c) State two uses of calcium chloride which is a by-product in this process. (½ mark)
2. $100cm^3$ of methane gas diffused through a porous partition in 40 seconds. How long would it take $90cm^3$ of ozone gas to diffuse through the same partition? C = 12, H = 1, O = 16 (2marks)
3. Calculate the volume of oxygen produced when 10g of silver nitrate was completely decomposed by heating at (s.t.p) (Ag = 108, N = 14, O = 16) Molar gas volume at s.t.p = $22.4dm^3$) (2 Marks)
4. The scheme below shows some reactions starting with ethyne. Study it and answer the questions that follow.



   (a) Name substance X and N (1mark)
   (b) Name reagent M (½ Mark)
   (c) Ethene undergoes polymerization to form a polymer. Give an equation for the reaction and name the product.
      (i) Equation; (1 mark)
      (ii) Name: (½ mark)
5. The curves below represent the volume of carbon (IV) oxide gas evolved once 2M(concentrated) hydrochloric acid was reacted with 100g of powdered calcium carbonate and also when 1M concentrated hydrochloric acid was reacted with the same quantity of carbonate.



(i) Which of the two curves represents the reaction of 2M concentrated HCl with powdered calcium carbonate. Give a reason. (2 marks)

(ii) Why do the two curves flatten at the same level of production of CO_2 (1 mark)

6. Study the following equilibrium equation.

$2X_2(g) + Y_{2(g)} \rightleftharpoons 2X_2Y_{(g)}$ $H = -197Kj/mol$

Suggest two ways of increasing the yield of X_2Y. (1 mark)

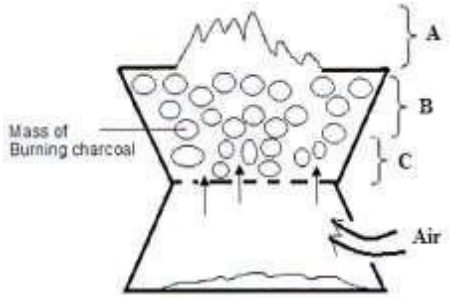
7. The table below gives some elements in the periodic table. Use it to answer the questions that follow. The letters do not represent the actual symbols of the elements.

Element	A	B	C	D	E
Atomic number	12	13	14	15	16

Which of the above letters represent:

(a) A metallic element which forms ions with the smallest ionic radius? Explain (1 mark) (b) A non metallic element with the largest atomic size? Explain. (1 mark)

8. The diagram below shows a burning jiko. Study it and answer the questions that follow.

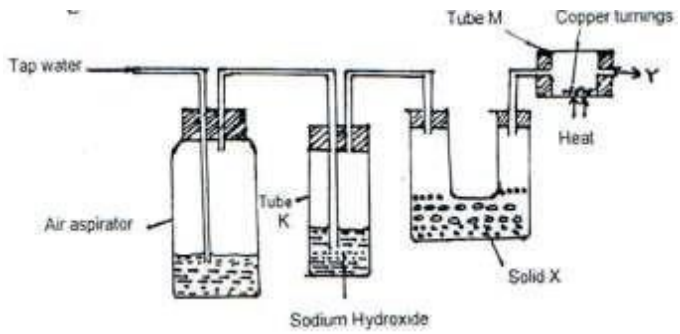


(a) Write the equation for the reaction taking place in region A. (1 Mark)

(b) Name the gas produced at region B. (1 Mark)

(c) State ONE use of the gas named in (b) above. (1 Mark)

9. Study the diagram below and answer the questions that follow.



(i) What is the purpose of passing tap water through the air aspirator? (1 Mark)

(ii) State and explain the observation that would be made in tube M after sometime. (1 Mark)

(iii) The sample of nitrogen collected at point Y had greater density than expected.What conclusion could be made about the gas? (1 Mark)

10. The table below gives the rate of decay of a radioactive element G.

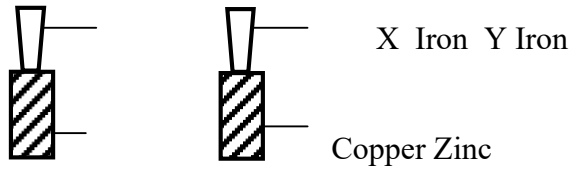
Number of days	Mass in g
0	48
270	1.5

Calculate the half-life of the radioactive element G. (2 Marks)

11. 15g of sodium chloride was dissolved in 120cm^3 of distilled water. Calculate the concentration of the resulting solution in moles per litre. (Na = 23, Cl = 35.5) (2 Marks)
12. (a) State Boyle"s Law. (1 Mark)
    (b) The volume of a gas at 30^{0}C and 780mmHg is 400cm^3. What will be its volume at 50^{0}C at 600mmHg.
13. Sulphur exhibits allotropy.
    (a) What is allotropy? (1 Mark) (b) Name the **two** allotropes of sulphur. (1 Mark)
    (c) Sulphur powder was placed in a deflagrating spoon and heated on a Bunsen Burner.
    (i) State the observation made. (1 Mark)
    (ii) The product obtained was dissolved in water. Comment on the PH of the solution formed. (1 Mark)
14. 0.318g of an oxide of metal M was completely reduced by hydrogen gas to 0.254g of metal. Calculate empirical formula of the metal oxide. (M = 63.5, O = 16) (3 Marks)
15. Given the following reagents: Solid sodium Carbonate, water, solid Lead (II) nitrate. Describe how a sample of Lead (II) Carbonate can be prepared in the laboratory. (3 Marks)
16. Volume of liquids can be measured using a pipette; measuring cylinder or burette. Explain which one would be best for measuring 29.1cm^3 of liquid. (1 Mark)
17. Study the information in the table and answer the questions below.

Substance	Solubility g/100g water
V	126
W	2

Describe how a solid sample of substance **V** could be obtained from a solid mixture of **V** and **W**. (2 Marks) 18.
A form two student in an attempt to prevent rusting put copper and zinc in contact with iron as shown below.



(i) State what would happen in set up X and Y after one week. (1 Mark)
(ii) Explain your answer in diagram Y. (1 Mark)

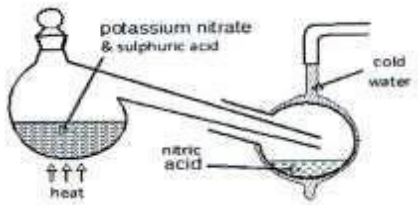
19. An element X has a relative atomic mass of 88. When a current of 0.5 ampere was passed through a fused chloride of X for 32 minute 10 seconds, 0.44g of X was deposited.
(i) Determine the charge of element X [1 Faraday = 96500C] (2 Marks)
(ii) Write the formula of hydroxide of X
20. The PH of a soil sample was found to be 5.7. An agricultural officer recommended addition of lime.
    (a) State **two** functions of the lime. (1 Mark)
    (b) Give the name of the process applied in (a) above.
21. The electronic configuration of ions X^{2+} is 2.8 while that of ion Y^- is 2.8.8.
    (a) Write down the electron arrangement of the atoms of X and Y (1 Mark)
    (b) Compare the atomic radii of the two elements. (1 Mark)
    (c) Give the name of the chemical family to which element X belongs (1 Mark)
22. Use the information given below to calculate the enthalpy of formation of propane. (3 Marks)

$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$ $H_c = -393KJ/Mol$

$H_{2(s)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}$ $H_c = -286KJ/Mol$

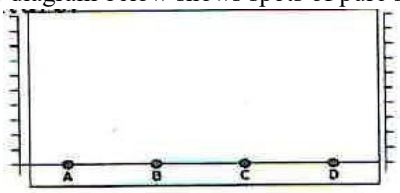
$C_3H_{8(g)} + 5O_{(2)} \rightarrow 3CO_{2(g)} + 4H_2O_{(l)}$ $H = -2220$ KJ/Mol

23. (a) (i) A student found a colourless liquid in the laboratory which he suspected to be water. Describe a chemical test he could have performed to confirm that the liquid is water. (2 Marks)
    (ii) What other test could he have done to prove that the liquid is pure water? (1 Mark)
24. The diagram below shows that the set-up that was used to prepare and collect a sample of nitric acid



(a) Give a reason why it is possible to separate nitric acid from sulphuric acid in the set-up. (1 Mark) (b) Name another substance that can be used instead of potassium nitrate. (1 Mark)
(c) Give one use of nitric acid.

25. The diagram below shows spots of pure substances A, B and C on a chromatography paper. Spot D is that of a mixture.

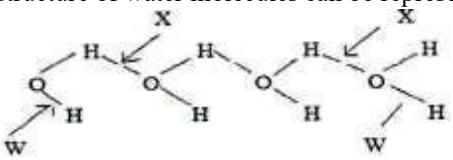


After development, A, B and C were found to have moved 8cm, 3cm and 6cm respectively. D had separated into two spots which had moved 6cm and 8cm. (i) On the diagram

I. Label baseline (1 Mark)

II. Show the positions of all the spots after development. (2 Marks) (ii) Identify the substances present in the mixture D. (1 Mark)

26. The structure of water molecules can be represented as shown below.



(i) Name the bond type represented by letter X and W. (1 Mark)

(ii) Relative molecular mass of methane and water are almost similar, however the boiling of water is 100^{0}C while that of methane is -161^{0}C. Explain. (1 Mark)

27. What is the oxidation number of:-

(i) Manganese in MnO_4^- (1 Mark)

(ii) Sulphur in SO_2 (1 Mark)

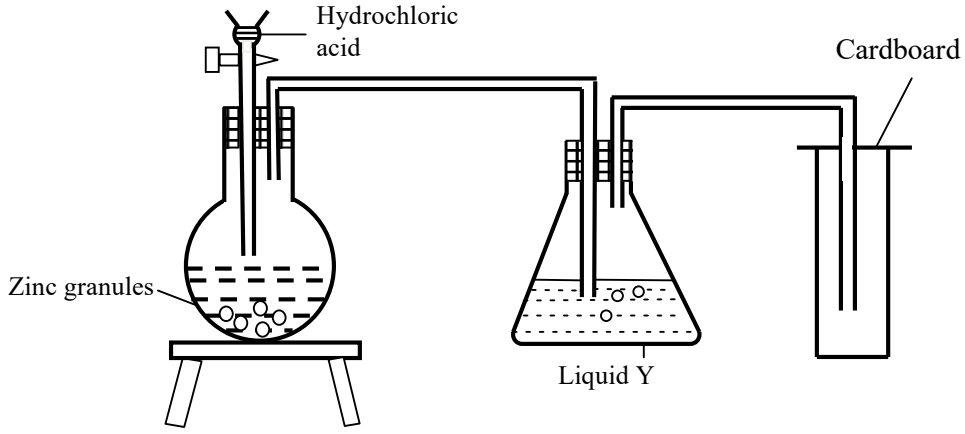
(iii) Chromium in $Cr_2O_7^{2-}$ (1 Mark)

28. Diamond and graphite are allotropes of carbon. In terms of structure and bonding, explain why?

(i) Diamond is used in drilling of hard rocks. (2 Marks)

(ii) Graphite is a lubricant. (2 Marks)

29. The set up was used to prepare dry hydrogen gas. Study it and answer the questions that follow.



(i) Is set-up used to prepare the gas correct? Give reason. (1 Mark)

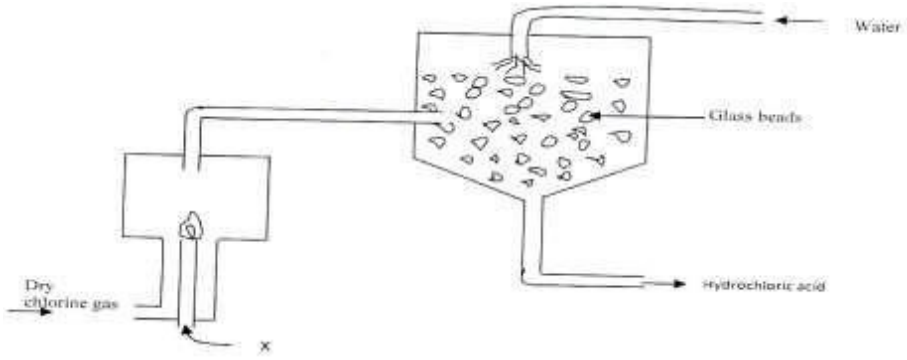
(ii) What would be liquid Y?
(iii) Give two physical properties of hydrogen gas (1 Mark)

30. Given element W has atomic number 14 and consists of isotopes as shown below.

Isotope	A	B	C
Isotope mass	28	29	30
Percentage abundance	92.2	4.7	3.1

Determine the relative atomic mass of W (2 Marks)

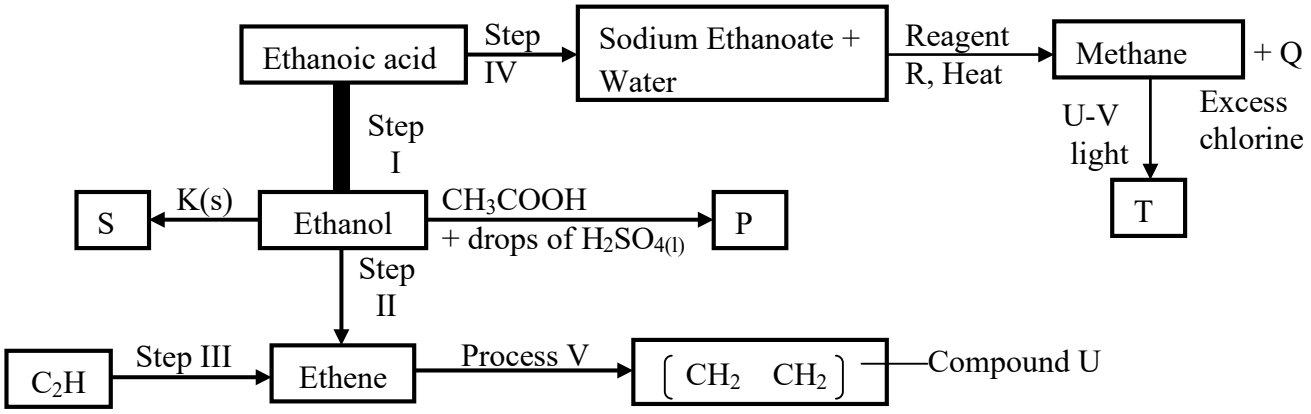
31. The diagram below represents a set up used for the large scale manufacture of hydrochloric acid.



(a) Name substance X (½ Mark)
(b) What is the purpose of the glass beads? (½ Mark)
(c) Give one use of hydrochloric acid

233/2
CHEMISTRY
PAPER 2
(THEORY)

1. The scheme below shows reactions starting with ethanol. Study it and answer the questions that follow.



a. (i) Name the compounds: P and S (2 marks)
(ii) State the type of reaction, reagents and conditions for the reactions in the following steps: (5 Marks)

Step	Type of reaction	Reagents	Conditions
I.			
II.			
III.			

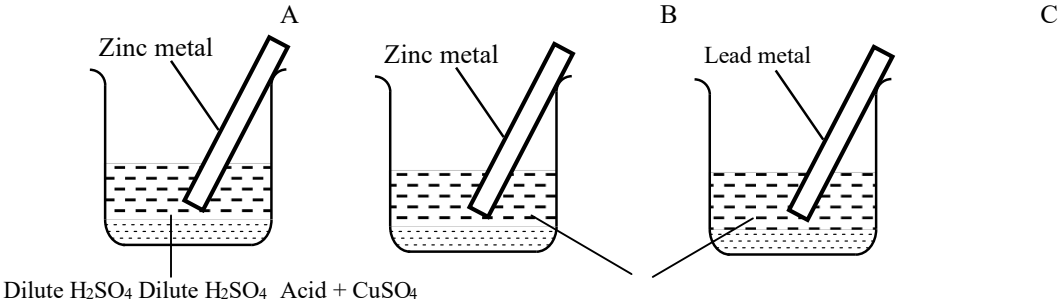
(iii) Name the reagent R. (1 Mark)
(iv) Write the equation for step IV. (1 Mark)
(v) Name compound T and draw its structural formula. (2 Marks)
(vi) Name compound U and state one use of U (2 Marks)
(vii) State one physical test to differentiate ethene from C_2H_2. (1 Mark)

2. The table below shows the positions of some elements in the periodic table. The letters are not actual symbols of the elements.

						A		
	B		C		D		E	
F	G							
							H	

(a) Select an element that can form an ion with a charge of +2. Give a reason. (1Mark)
(b) What type of structure would the oxide of C have. Explain your answer. (1½ Marks)
(c) How does the reactivity of H compare with that of E. Explain. (1½ Marks)
(d) Explain how you would expect the following to compare.
(i) Atomic radii of F and G (1½ mks)
(ii) The PH values of aqueous solutions of the oxides of B and D (1½ mks)
(e) Draw a diagram to represent an ion of element D (1 Mark)
(f) Calculate the volume of oxygen gas required to completely burn 1.95g of F to form its oxide. (F = 39, molar gas volume at s.t.p = 22,400cm^3) (3 Marks)

3. (a) A student set up an experiment as illustrated by the diagrams below to investigate the action of dilute Sulphuric (VI) acid on Zinc and Lead metals. Before introducing each metal into the acid it was cleaned.

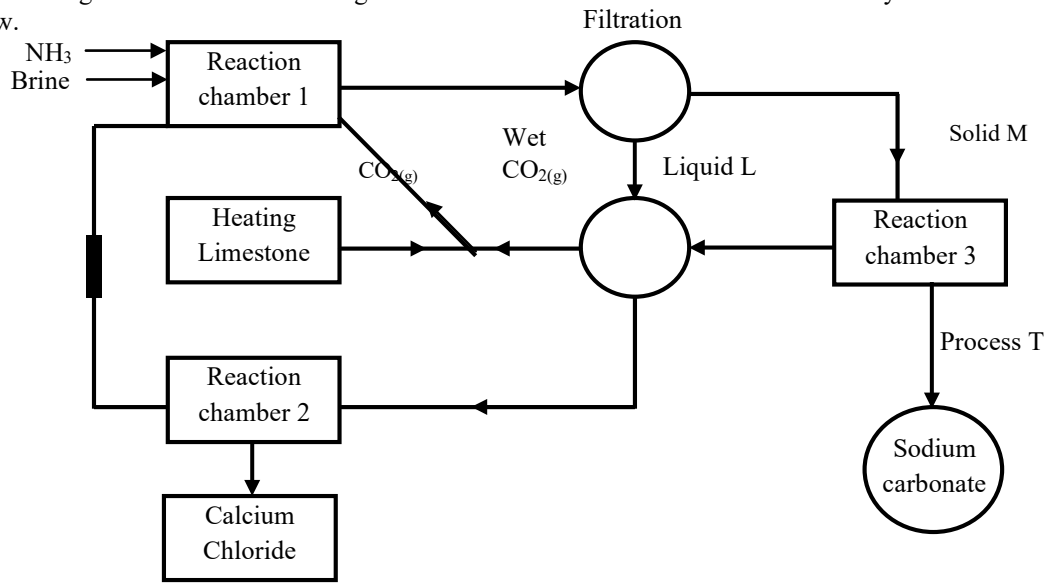


(i) Why was it necessary to clean the metal pieces before introducing them into their respective beakers. (1 Mark)
(ii) What observations were made immediately the pieces were introduced into the beakers A and C. (2 Marks)
(iii) Explain the observations made in beaker B (1 Mark)
(b) Compound X decomposes at 25^{0}C. The decomposition of compound X was monitored at 25^{0}C by measuring the concentration of the compound remaining at different time intervals. The following data was obtained.

Time (min)	0	1.0	2.0	3.0	4.0	5.0
Concentration	1.20	0.54	0.36	0.26	0.17	0.10

(i) Plot a graph of the concentration of compound X (Y – axis) against time. (3 Marks)
(ii) From the graph, determine the rate of decomposition of X at 2.5 minutes. (2 Marks)
(iii) One the same axis, sketch the curve that would be obtained if the decomposition was carried out at 10^{0}C. Label this curve II. Give a reason for your answer. (3 Marks)

4. The flow diagram below shows the stages in the manufacture of sodium carbonate. Study it and answer the questions that follow.



(a) Name the three raw materials for the manufacture of sodium carbonate. (3 Marks)
(b) (i) Name two substances that are recycled in this process and state the chambers in which each is regenerated. (2 Marks)

(ii) Give two advantages of industrial recycling of materials. (2 Marks)

(c) Identify liquid L and solid M (1 Mark)

(d) Write an equation for the reaction for the reaction which occurs in.

(i) Reaction chamber 1 (1 Mark)

(ii) Reaction chamber 2 (1 Mark)

5. The following results were obtained when the molar heat of neutralization between hydrochloric acid and sodium hydroxide was determined. 100cm^3 of 1.0M HCl acid was reacted with 50cm^3 of 2M NaOH solution. Initial temperature of the base was 25^{0}C and that of the acid was 27^{0}C. The final stable temperature when the acid and base were mixed was 34^{0}C.

(a) Write an ionic equation for the reaction. (1 Mark)

(b) Calculate the:

(i) Change in temperature T. (1 Mark)

(ii) Heat change for the reaction. (s.h.c = 4.2KJ/g^{0}K) and density of solution is 1.0g/cm^3. (2 Marks)

(iii) Molar heat of neutralization of HCl. (2 Marks)

(c) Draw an energy level diagram for the reaction. (2 Marks)

(d) Account for the heat loss (2 Marks)

(e) How can the heat loss be minimized. (1 Mark)

(f) Write the thermochemical equation for the reaction. (1 Mark)

6. I. An electric current was passed through concentrated solution of Copper (II) Chloride using inert pair of electrodes.

(a) Name a suitable pair of electrodes for this experiment. (1 Mark)

(b) Identify cations present in the solution. (1 Mark)

(c) Which ions are preferentially discharged at the anode (1 Mark)

(d) Write an ionic equation for the reaction that takes place at the cathode. (1 Mark) (e) Explain the observation that would be made on the electrolyte as the experiment progresses. (2 Marks) (II) Use the standard electrode potentials for elements V, W, X, Y and Z given below to answer the questions that follow.

		E Volts
$W_{2+(aq)} + 2e^- \rightarrow$	$W_{(s)}$	-2.87
$Z_{2+(aq)} + 2e^- \rightarrow$	$Z_{(s)}$	-2.37
$V_{+(aq)} + e^- \rightarrow$	$\frac{1}{2} V_{2(g)}$	0.00
$X_{2+(aq)} + 2e^- \rightarrow$	$X_{(s)}$	+0.34
$\frac{1}{2} Y_{(2)} + e^- \rightarrow$	$Y_{-(aq)}$	+1.99

(a) Identify the strongest reducing agent. (1 Mark)

(b) Which element is likely to be hydrogen? Give a reason for your answer. (1 Mark)

(c) Which elements would form a couple with the highest E.M.F. Calculate the E.M.F (2 Marks)

(d) Write the cell notation for the electrochemical cell formed by the cells in (c) above (1 Mark)

7. A mixture of iron fillings and sulphur was heated strongly. A red glow spread throughout the mixture and a black residue was formed. The cold residue reacts with dilute hydrochloric acid and a gas which gives a black precipitate with Lead (II) solution was given off.

(a) (i) What did the red glow indicate? (1 Mark)

(ii) Identify the gas evolved when black solid reacted with dilute hydrochloric acid. (1 Mark)

(iii) Write the formula of the black solid (1 Mark)

(iv) Write an ionic equation for the formation of the black precipitate. (1 Mark)

(b) (i) When chlorine gas is passed over heated iron wool, a chloride of iron is formed. Name the chloride. (1 Mark)

(ii) Calculate the mass of iron required to react completely with 0.12 litres of chlorine at room temperature and pressure (3 Marks)

(iii) Calculate the amount of chloride of iron formed in (ii) above (Fe = 56, Cl = 35.5, 1 mole of gas occupies 24 litres at room temperature (2 Marks)

233/3
CHEMISTRY
PAPER 3

1. You are provided with

- Solution P – 100cm^3 of 0.4M HCl
- Solid M – 0.5g X CO_3
- Solution Q – 0.1M NaOH
- Phenolphthalein indicator

Procedure

i. Add all solid M into 100cm^3 of solution P ii. When effervescence has stopped transfer the mixture above into a clean 250m volumetric flask and top up to the mark using distilled water. Label this as solution E. iiiFill the burette with solution E. iv. Pipette 25cm^3 of solution Q into a clean conical flask.
v. Add 3 drops of phenolphthalein indicator into conical flask. vi.

(a) Calculate the average volume of E used. (1 Mark)
(b) Determine the number of moles of solution Q that reacted with solution E (1 Mark)
(c) Calculate the number of moles of solution E in 250cm^3 of solution. (2 Marks)
(d) Determine the number of moles of the original solution P in 100cm^3 of solution. (1 Mark)
(e) Calculate number of moles of solution P that reacted with the carbonate (1 Mark)
Titrate the contents of the conical flask against solution E
vii. Repeat the procedure (iv and vi) two more times and complete the table. (4 Marks)

Final burette reading	I	II	II
Initial burette reading			
Volume of E used			

(f) Given ionic equation $2H^+_{(aq)} + CO^{2-}_{3\,(s)} \rightarrow CO_{2(g)} + H_2O_{(l)}$
Determine the number of moles of CO^{2-}_3 that reacted with solution P (1 Mark)
(g) Determine the mass of X (2 Marks)

2. You are provided with:
- Solution A 0.2M potassium iodide solution.
- Solution B 0.2M Sodium Thiosulphate solution.
- Solution C Hydrogen Peroxide solution.
- Starch indicator solution.

You are required to determine the effect of temperature on the rate of reaction.

Procedure

i. Transfer 10cm^3 of potassium iodide solution into test tube labelled A, 5cm^3 of sodium thiosulphate solution into test tube B and 5cm^3 hydrogen peroxide in test tube C.
ii. Transfer solution B into a conical flask followed by 5cm^3 of freshly prepared starch indicator solution.
iii. Simultaneously transfer solution A and C into the conical flask and immediately start the stop watch. Note the time taken for the mixture to turn to blue black and record the result. iv.Repeat the procedure at temperatures given hence fill the table.

Set	Vol of A(cm^3)	Vol of B(cm^3)	Vol of C(cm^3)	Vol of starch (cm3)	Temp ^{0}C	Time(sec)	($\frac{1}{t}$ sec $^{-1}$)
1	10	5	5	5	Room temp		
2	10	5	5	5	30		
3	10	5	5	5	40		
4	10	5	5	5	50		
5	10	5	5	5	60		

(6 Marks)

(a) Plot a graph of temperature against reciprocal of time($\frac{1}{t}$ sec $^{-1}$). (4 Marks)
(b) From your graph determine time taken for the colour to turn to blue black if solution is warmed to 42.5^{0}C. (2 Marks)
(c) Explain the formation of blue black colour. (2 Marks)
(d) Explain the shape of the graph obtained. (1 Mark)
(e) Suggest the effect of raising temperature on this experiment. (1 Mark)
(f) Apart from temperature, state any other two factors that affect rate of reaction. (1 Mark)

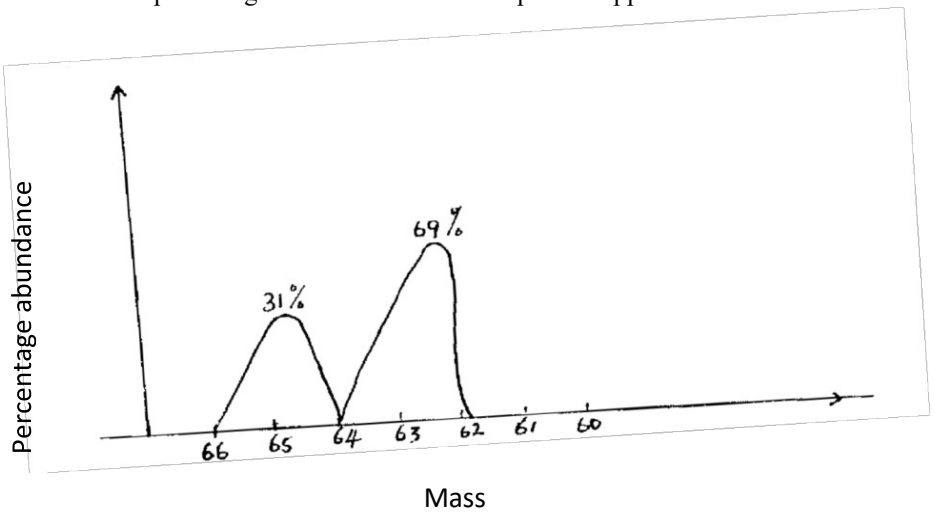
3. You are provided with solid V. You are required to carry out the test indicated and record your observations in the table.

Test	Observations	Deductions
(a) Place all the solid V in a boiling tube and add 6cm^3 of distilled water and shake	(1 Mark)	(1 Mark)
(b) Test the PH of the solution using universal indicator paper	(1 Mark)	(1 Mark)

(c) Divide the resultant mixture into three portions and to the 1^{st} portion add a spatula of sodium carbonate	(1 Mark)	(1 Mark)
(d) To the second portion add two drops of potassium permanganate solution	(1 Mark)	(1 Mark)
(e) To 3^{rd} portion add three drops of concentrated sulphuric acid, shake and add $2cm^3$ absolute ethanol	(1 Mark)	(1 Mark)

KCSE PREDICTION 5 2022
CHEMISTRY
PAPER 1
(THEORY)

1. Give two reasons why luminous flame is not used for heating purposes in the laboratory. (2mks)
2. The diagram below shows the percentage abundance of the isotopes of copper.



(a) Calculate the relative atomic mass of copper from the information on the graph. (2marks)
(b) Write the isotope formula of the most abundant isotope of copper indicating the mass number and atomic number.(copper has
29 protons) (1mark)

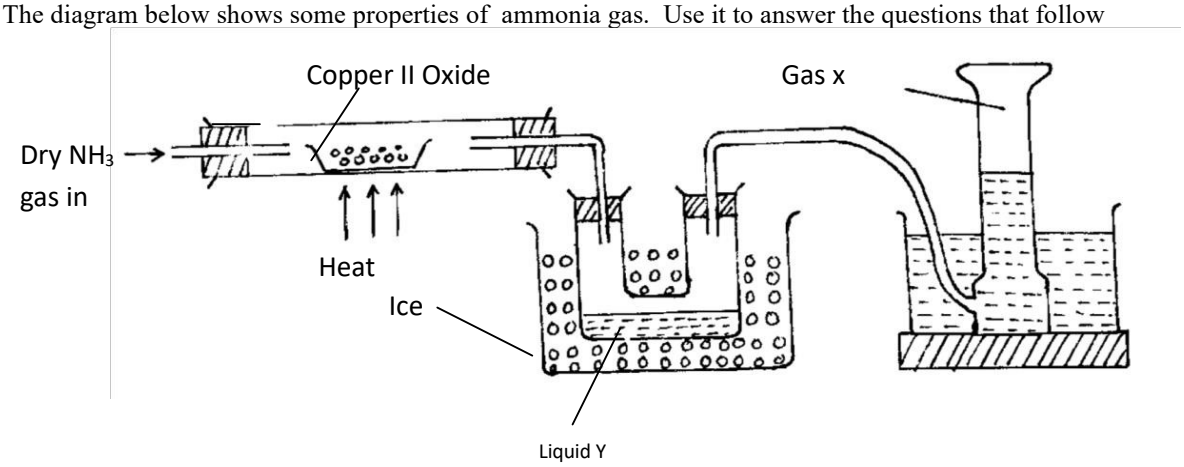
3. Three nitrates Q, R, and S were each heated and the products formed were tabulated as shown below.

Nitrate	**Products**
Q	Metal Nitrite + Oxygen
R	Metal + Nitrogen(IV) Oxide + Oxygen
S	Nitrogen(I)xide + water

(a) Identify S and R (2 marks)
(b) What is the name given to elements in the same group as Q? (1mark)

4. (a) Write an ionic equation for the reaction between copper II ions in solution and excess ammonia solution. (1mk)
(b) Name the complex ion formed in the reaction in (a) above. (1mk)

5. The diagram below shows some properties of ammonia gas. Use it to answer the questions that follow



(a) State the observation made in the combustion tube. (1mk)
(b) (i) Give the test that can be used to identify liquid Y. (1mk)
(ii) Name gas X (1mk)

6. a) A solution of 100cm^3 of 0.1M ethanoic acid has a different p.H value from that of 100cm^3 of 0.1M hydrochloric acid. Explain the difference. (2mks)

(b) Predict the p.H value of
(i) ethanoic acid. (½ mk)
(ii) hydrochloric acid (½ mk)

7. a) What is vulcanization of rubber? (1mk)

(b) State two properties that vulcanized rubber possesses as a result of vulcanization. (2mks) 8. Use the information below to answer the questions that follow.

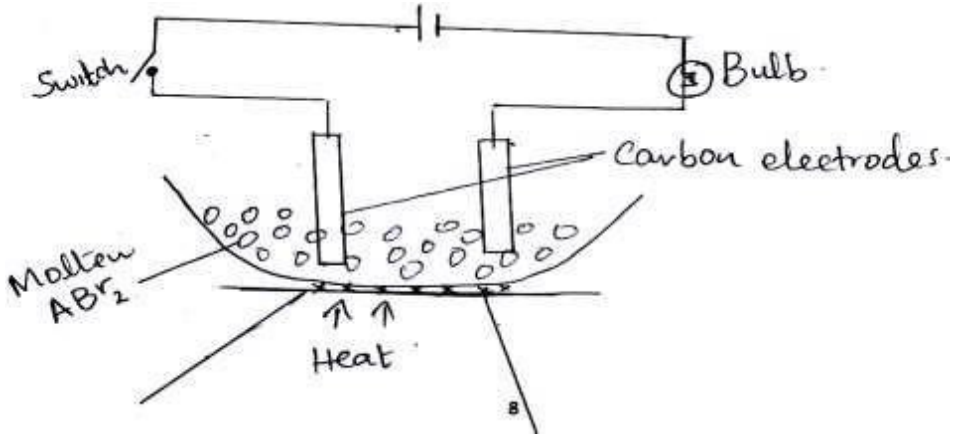
$C_{(s)} + O_{2(g)}$ ……> $CO_{2(g)}$ $\Delta H_1 = -393$ KJ/mol

$H_{2(g)} + ½\ O_{2(g)}$……> $H_2O_{(l)}$ $\Delta H_2 = -286$ KJ/mol

$C_4H_{10} + 6\ ½\ O_{2(g)}$ ……> $4CO_{2(g)} + 5H_2O_{(l)}$ $\Delta H_3 = -2877$KJ/mol

(a) Calculate the molar enthalpy of formation of butane (C_4H_{10}) from its elements in their normal states. (3mks)

9. The set-up below was used to electrolyse a metal bromide ABr_2. Study it and answer the questions that follow.



(a) From the diagram label the Anode (1mk)
(b) Write an equation for the reaction that occurred at the Anode. (1mk)
(c) A current of 0.4A was passed through the molten salt for 10 minutes and 20 seconds. Calculate the amount of metal deposited at the Cathode. (R.A.M of A = 207, IF = 96500 C) (2mks)

10. What is
(a) an alloy? (1mk)
(b) Give an example of an alloy of Iron. (1mk)
(c) State one use of the alloy in (b) above. (1mk)

11. A piece of burning Magnesium was introduced into a jar of nitrogen.
(a) State what was observed. (1mk)
(b) Write an equation for the reaction that took place. (1mk)
(c) Describe how a solid sample of dry Lead (II) Carbonate can be prepared using the following reagents: dilute nitric acid,

Lead (II)Oxide and Sodium carbonate. (3mks)

12. Cyanogen is a gaseous compound of carbon and nitrogen only. On complete combustion is oxygen, 250cm^3 of cyanogen from 500cm^3 of Carbon (IV) Oxide and 250cm^3 of nitrogen. Determine the formula of cyanogen. (2mks)
13. Substance L, M, N and P have the following properties.

Substance	M.P.	Solubility in water	Electrical conductivity	
			Solid state	Liquid state
L	Low	Soluble	Does not	Does not
M	High	Soluble	Does not	Conducts
N	High	Soluble	Conducts	Conducts
P	High	Insoluble	Does not	Does not

(a) Select the letter which represents a substance which is suitable for making kettle handles (½mk)

(b) Which letter represents a substance which is likely to be sodium chloride? (½mk)

(c) Name the bond structure and bond type likely to be in L. (1mk)

(i) Bond structure

(ii) Bond type

14. (a) The atomic number of Sulphur hydrogen and oxygen are 16, 1 and 8 respectively. Write the electron arrangement of Sulphur in the following substances.

(i) H_2S…… (1mk)

(ii) SO_3^{2-}…… .(1mk)

(b) State the number of neutrons and electrons in the species of Aluminiumshown below:

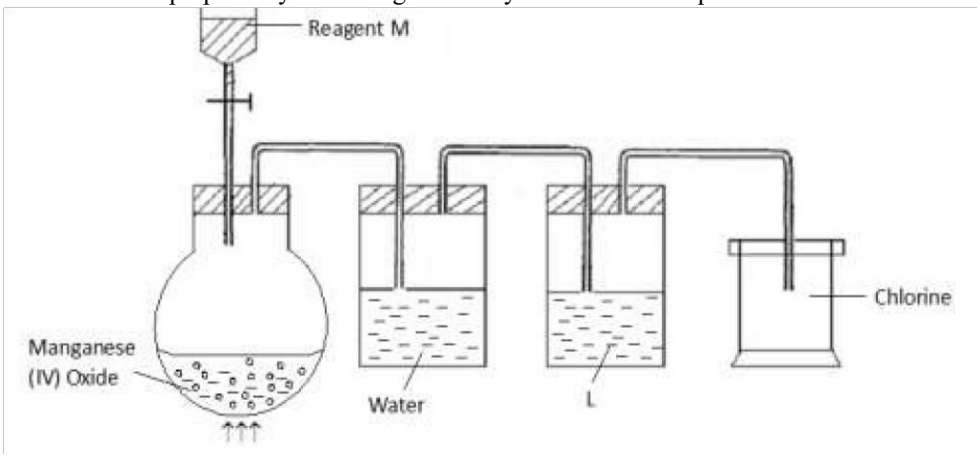
$^{27}_{13}Al^{3}$

Neutrons …… (½mk) Electrons …… (½mk)

15. An organic compound with the formula $C_4H_{10}O$ reacts with sodium metal to give hydrogen gas and a white solid.
    (a) Give the formula of the white solid (1mk)
    (b) To which homologous series does the white solid belong (1mk)
    (c) Write the equation for the reaction between the organic compound $C_4H_{10}O$ and sodium metal. (1mk)

(d) Suppose 180cm^3 of a 2.0M solution is diluted to 1.0dm^3. What will be the concentration of the resulting solution? (2mks)

16. The set-up **below** was used to prepare dry chlorine gas. Study and answer the questions that follow



(a) Name reagents **M** and substance **L**.

(b) A warm red phosphorus was lowered into the gas jar of chlorine using a deflagrating spoon:

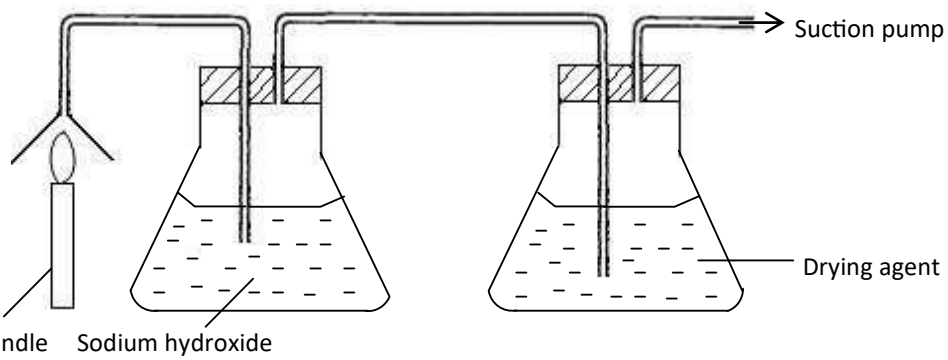
(i) State any **one** observation made in this experiment. (½ mark)

(ii) Identify the substance formed in the above reaction. (½ mark)

(c) Both substances in **(ii) above** undergo hydrolysis when exposed to air. Write an equation to show how anyone of them undergoes hydrolysis. (1 mark)

17. The set up of diagram shown **below** is used to prepare dry nitrogen gas from air. Study it and answer the questions that

follow.

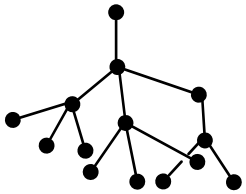


(a) What is the purpose of using:
(i) A burning candle. (½ mark)
(ii) Sodium hydroxide solution. (½ mark)
(b) Name:
(i) **One** impurity present in nitrogen gas prepared. (½ mark)
(ii) A suitable drying agent used. (½ mark)

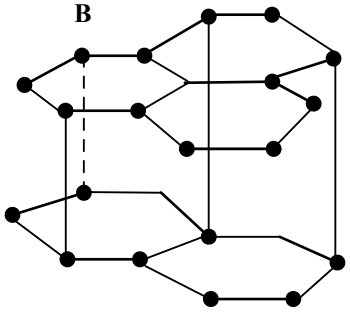
18. (i) Using a dot (**.**) and cross (x) show how NH_4 ion is formed from NH_3 molecule and H^+ ion.(2 marks)
(ii) State the type of bond that exists between the NH_3 and H^+ ion. (½ mark)
(iii) Molecular substances have low melting points. Give **one** reason why they have low melting points. (½ mark)

19. The following diagrams show the structure of two allotropes of carbon. Study them and answer the questions that follow.

A



B



(a) Name the allotropes. A and B (1 mark)
(b) Give **one** use of **A**. (½ mark)
(c) Which allotrope conducts electricity? Explain. (1½ marks)

20. Give **two** reasons why helium is used in weather balloons. (2 marks)

---

21. Ammonia is produced in large scale by Haber process.
(i) Write an equation for the formation of ammonia gas. (1 mark)
(ii) State **two** optimum conditions for obtaining a high yield of ammonia in the process. (2 marks

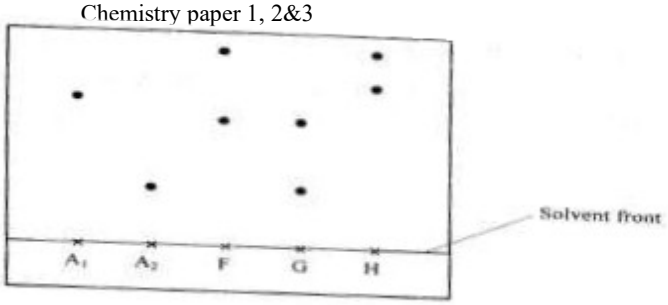
22. When a hydrated sample of calcium sulphate $CaSO_4.xh_2O$ was heated until all the water was lost, the following data was recorded:

Mass of crucible	=	30.296 g
Mass of crucible + hydrated salt	=	33.111 g
Mass of crucible + anhydrous salt	=	32.781 g

Determine the empirical formula of the hydrated salt
(CA = 40, S = 32, O = 16 H = 1) (3mks)

23. Zinc reacts with both concentrated and dilute sulphuric (VI) acid. Write equations for the two reactions. (2mks)

24. Samples of urine from three participants F, G and H at an international sports meetings were spotted onto chromatography paper alongside two from illegal drugs A1 and A2. A chromatogram was run using methanol. The figure below shows the chromatogram.

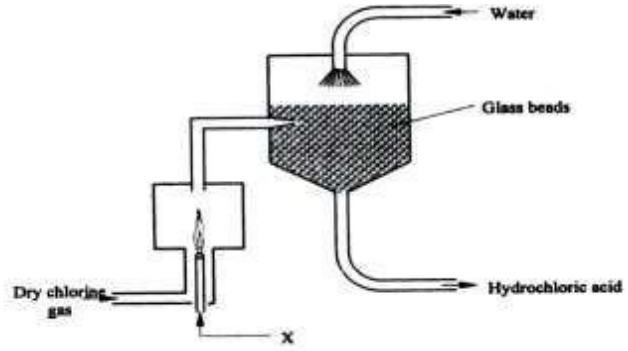


(a) Identify the athlete who had used an illegal drug. (1mk)
(b) Which drug is more soluble in methanol? (1mk)

25. Hardness of water may be removed by either boiling or addition of chemicals.
(a) Write an equation to show how boiling removes hardness of water. (1mk) (b) Name two chemicals that are used to remove hardness of water. (2mks)

26. Carbon (II) oxide is described as a "silent killer".
(a) State one physical property of carbon (II) oxide that makes it a "silent killer". (1mks)
(b) State and explain one chemical property that makes carbon (II) oxide poisonous to human beings. (2mks)

27. The diagram below represents a set up for large scale manufacture of hydrochloric acid. Study it and answer the questions that follow.



(a) Name substance X. (1mk)
(b) What is the purpose of the glass beads? (1mk)
(c) Give two uses of hydrochloric acid (1mk)

28. The half equations involved in a cell are:

$2H_{2(l)} + 2e \rightleftharpoons H_{2(g)} + 2OH^-_{(aq)} : E\theta = +0.40V$

$O_{2(g)} + 2H_2O_{(l)} + 4e \rightleftharpoons 4OH^-_{(aq)} : E^\theta = +0.40V$

(a) Write the overall equation for the electrochemical cell. (1mk) (b)Calculate the e.m.f generated by a battery consisting of ten cells. (1mk)

233/2
CHEMISTRY
PAPER 2
(THEORY)

1. a) The grid below represents part of the periodic table. Study it and answer the questions that follow. (The letters do not represent the actual symbols of the elements).

A					B			
C	D				E	F		
						G		

i) Select an element which forms a divalent cation. (1mk) ii) What type of structure will the chloride of A have? (1mk) iii) How do the reactivities of B and E compare? Explain. (2mks) iv) Compare the atomic radius of C with that of D. Give a reason for your answer. (2mks) v) C and E burn in oxygen to form oxides. Compare the pH values of the solutions of the oxides of C and E. (2mks)

b) Study the information in the table below and answer the questions that follow. (The letters are not the actual symbols of the substances)

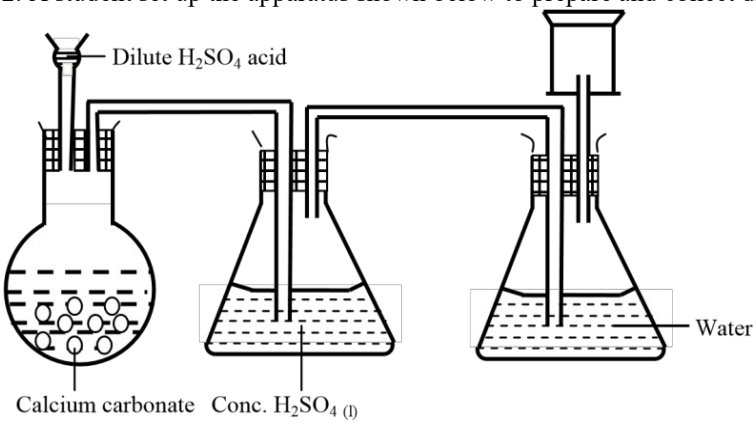
Substance	Melting point (°C)	Boiling point (°C)	Solubility in water
P	-117	78.5	Very soluble
Q	-78	-33	Very soluble
R	-23	77	Insoluble
S	-219	-18	Slightly soluble

i) Which substance would dissolve in water and could be separated from the solution by fractional distillation? Give a reason. (2mks)

ii) Which substance is a liquid at room temperature and when mixed with water two layers would be formed? (1mk)

iii) Which letter represents a substance that is a gas at room temperature and can be collected over water? Explain. (2mks)

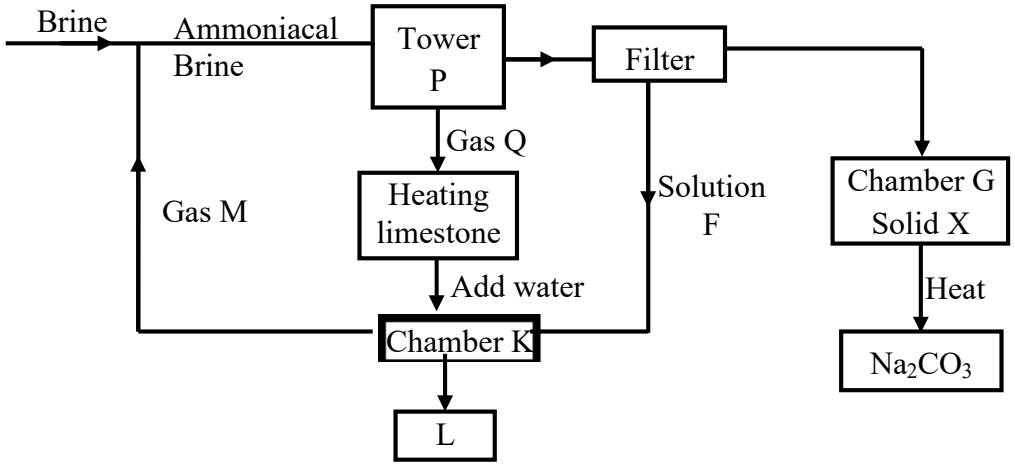
2. A student set up the apparatus shown below to prepare and collect dry carbon (IV) oxide gas.



(a) State a correction for three mistakes in the set up above (3 mks)

(b) Give two reasons why carbon (IV) oxide is used as a fire extinguisher (1 mk)

(c) The flow chart below is for the manufacture of sodium carbonate by the Solvay process. Use it to answer the questions that follow.



(i) Name gas M and Q (1Mark)

(ii) Name solution F and solid X (1 Mark)

(iii) Name the product L formed and give one of its uses (2 Marks)

(iv) Write equations of the reactions in (2 Marks)

Tower P

Chamber K

(v) Name the two raw materials required in the manufacture of sodium carbonate (1 Mark)

3. a) The list below gives the formulae of some organic compounds. Use it to answer the questions that follow.

K_1: CH_3CH_2OH

K_2: $CH_3CH_2CH_2CH_3$

K_3: $CH_3CH=CH_2$

K_4: $CH_3CH_2CH_2C(=O)OH$

K_5: $CH_3\,CH_3$

(i) Select two compounds which:

I. Are not hydrocarbons. (1mk)

II. Belong to the same homologous series (1mk) III

Identify the compound that is likely to undergo addition polymerization. Give a reason for your answer. (1mk) b) The structure below represent two cleansing agents

$R - COO^-Na^+$

$R- OSO_3^-Na^+$

In the table below,give one advantage and one disadvantage of using each one of them (2mks)

	Advantage	Disadvantage
$R\text{-}COO^-Na^+$		
$R\text{-}OSO_3^-Na^+$		

c) Under certain condition ethanoic acid ($C_2H_4O_2$) and ethanol (C_2H_5OH) react to form a sweet smelling compound.

(i) What is the general name of the compound to which the sweet smelling compound belongs? (1mk)

(ii) Write the structural formula of the sweet smelling compound (1mk)

(iii) Give the conditions for the formation of the sweet smelling compound (1mk)

(iv) Write the equation for the reaction between dilute ethanoic acid and solid sodium carbonate (1mk)

v) Explain why the reaction between 1g of potassium carbonate and 2M HCl is faster than the reaction between 1g sodium carbonate and 2M ethanoic acid (2mks)

d) Fibres are either synthetic or natural. Give one:

(i) Example of a natural fibre (1mk)

(ii) Advantage synthetic fibres have over natural fibres. (1mk)

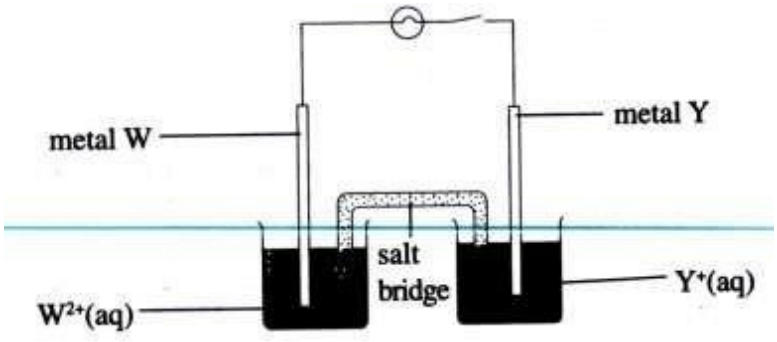
4. The table below gives reduction potentials obtained when the half – cells for each of the metals represented by letters, V,W,X, Y and Z were connected to a copper half – cell as the reference electrode.

Metal	**Electrode Potential (volts)**
V	-1.10
W	-0.47
X	0.00
Y	+0.45
Z	+1.16

(a) What is metal X likely to be? Give a reason. (1mk).

(b) Which of the metals cannot be displaced from the solution of its salt by any other metals in the Table? Give a reason. (2mks)

(c) Metals W and Y were connected to form a cell as shown in the diagram below.



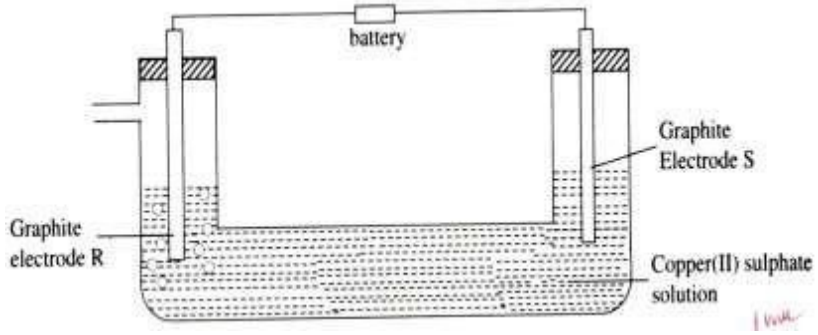
(i) Write the equations for the half – cell reactions that occur at :

I. Metal W electrode. (1mk)

II. Metal Y electrode. (1mk)

(ii) If the salt bridge is filled with saturated potassium nitrate solution, how does it help to complete the circuit? (2mks)

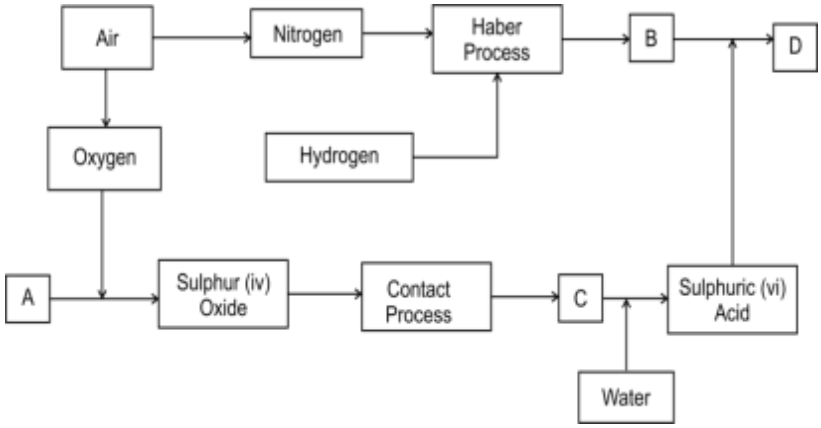
(d) When electric current is passed through Copper (II) sulphate solution for several hours as shown in the diagram below, a gas that relights a glowing splint is produced at electrode R.



(i) Which of the electrodes is the cathode? Give a reason. (1mk)

(ii) State and explain the observations that would be made at the electrodes. (2mks)

5. The flow chart below illustrates two industrial processes



a) (i) Give the name of the process by which air is separated into nitrogen and oxygen (1mk)

(ii) Apart from the gases given in (a) (i) above, name one other gas produced (1mk)

b) Name the substances represented by letters A and C (1 mark)

i) Write down the reversible reaction in contact process (1mk) ii) What is the effect of high pressure on the yield of the product in the reaction above? (1mk) iii) Name the catalyst used in Haber process and explain how it increases the rate of the reaction (1mk)

c) Calculate the percentage by mass of nitrogen in substance D (2mks)
(N=14, S=32, H=1, O=16)

d) 4g of N-13 decays by emitting a beta particle. The half life of N-13 is ten minutes

i) What is meant by half life? (1mk)

ii) How many grams of the isotope will remain after the fourth half life? (2mks)

(iii) State two differences between nuclear and chemical reaction (2mks)

Nuclear reaction	Chemical reaction

6. The table below shows the volume of nitrogen (IV) oxide produced when different volumes of 1M Nitric (V) acid- were each reacted with 4.14g of lead at room temperature.

Volume of 1M Nitric (V) acid (cm^3)	**Volume of Nitrogen (IV) oxide gas (cm^3)**
10	120
30	360
50	600
70	840
90	960
110	960

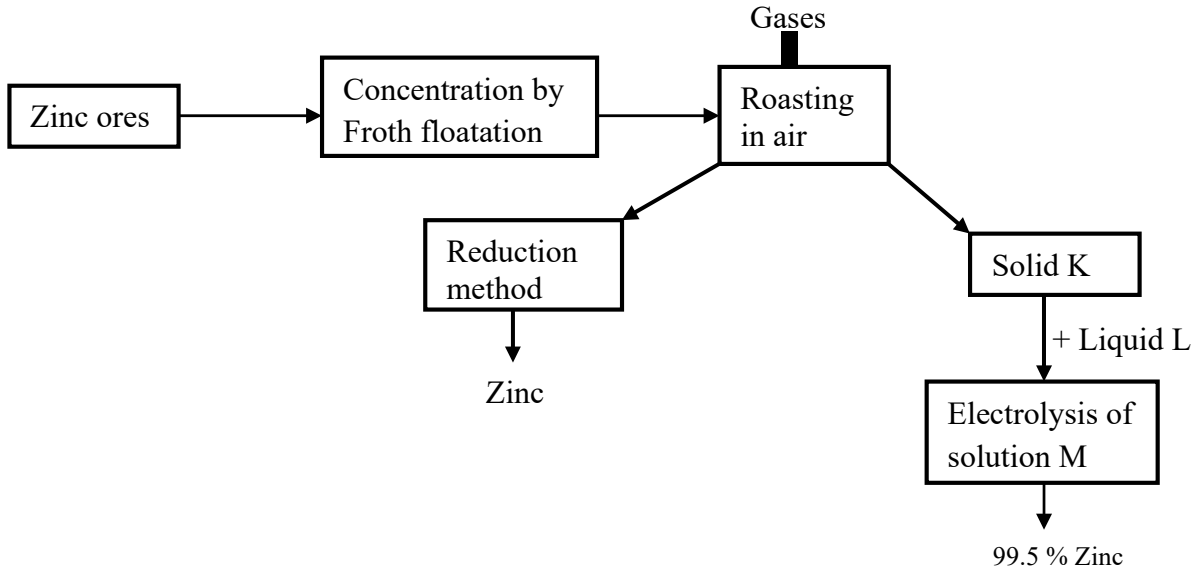
(a) Explain how the rate of the reaction between lead and nitric (V) acid would be affected if the temperature of the reaction mixture was lowered. (2mks)

(b) On the grid provided below plot a graph of the volume of the gas produced (vertical axis) against volume of acid.

(3mks)

(c) Using the graph, determine the volume of
(i) Nitrogen (iv) oxide produced when 60cm^3 of 1M Nitric (V)acid were reacted with 4.14g of lead.(1mk)
(ii) 1M Nitric (V) acid which would react completely with 4.14g of lead. (1mk)
(d) Using the answer in d (ii) above, determine
(i) the volume of 1M Nitric (V) acid that would react completely with one mole of lead. (Pb = 207)
(2mks) (ii) the volume of nitrogen (IV) oxide produced when one mole of lead reacts with excess 1M Nitric (V) and acid at room
temperature. (1mk)
(e) Calculate the number of moles of
(i) 1M Nitric (IV) acid reacted with one mole of lead. (1mk)
(ii) Nitrogen (IV) oxide produced when one mole of lead were reacted with excess nitric acid. (Molar gas volume is 24,000cm^3) (1mk)

7. Study the following reaction scheme for the extraction of zinc metal and then answer the questions that follow.



(a) (i) Name two chief ores from which zinc can be extracted (1mk)
(ii) Write the equations for the reaction that take place at the roasting chamber. (2mk)
(b) (i) Name the reducing agents used in the reduction chamber. (1mk)
(ii) Write the equations for the reduction process to obtain zinc (2mk)
(c) Identify the following: (1mk)
Solid K
Liquid L
(d) State two uses of zinc metal (1mk)

233/3 Inst.
CHEMISTRY PRACTICAL(Confidential)

In addition to the apparatus ordinarily present in the chemistry laboratory each student should have:

- 150cm^3 Solution P
- 150cm^3 solution Q 200cm^3 Solution T
- 50cm^3 of 2M hydrochloric acid
- Burette
- 2 conical flasks
- Pipette
- Pipette filler
- Stand
- White tile
- 6 test tubes in a rack
- 10cm^3 measuring cylinder
- 100cm^3 measuring cylinder
- Thermometer (-10 to 110 ºC)
- One 100cm^3 glass beaker
- Stop watch
- 1 g Solid U 1 g Solid V
- 2cm^3 ethanol
- 1 Boiling tube
- Distilled water in a wash bottle.
- White paper (10 by 10 cm)
- Universal indicator paper (What man) and its pH chart.
- Tripod stand and wire gauze
- Test tube holder
- Metallic spatula
- Thermometer (-10 -110ºC)
- 2 labels
- Volumetric flask 250ml
- ACCESS TO
- dilute sulphuric acid and dropper
- 2M sodium hydroxide and a dropper
- 2M Ammonia solution and a dropper
- 0.1M potassium iodide solution and a dropper
- Acidified potassium manganate (VII) and a dropper
- Bromine water and a dropper
- Concentrated sulphuric acid and a dropper Phenolphthalein indicator and a dropper.
- Source of heat NOTES

1. Solution Q is *ethane dioic acid (oxalic acid) solution containing 25.2 per litre of solution*.
2. Solution P is *sodium hydroxide solution containing 80g per litre of solution*.
3. Solution T is *sodium thiosulphate solution containing 49.6 g per litre of solution*
4. Solid U *is aluminium ammonium sulphate,* solid V *is maleic acid.*
5. Acidified potassium manganate (VII*) is made by dissolving 3.16g in about 200cm^3 of dilute sulphuricacid and add water up to 1000cm^3 of solution.*

Kenya Certificate of Secondary Education
CHEMISTRY
Paper 3
(PRACTICAL)
2¼ hours

1. You are provided with:
   -2M sodium hydroxide solution labeled **solution P**
   -solution Q containing 25.2g per litre of a **dibasic** alkanoic acid

You are required to;

(a) prepare solution **R** by diluting the sodium hydroxide solution **P** (b) determine the molar mass of the alkanoic acid.

Procedure

Place 25.0cm^3 of solution **P** into a 250cm^3 volumetric flask using pipette filler.

Add about 100cm^3 of distilled water and shake well. Add more distilled water to make up to the mark. Label this solution **R**. Fill the burette with solution **Q**. Pipette 25.0cm^3 of solution **R** into a 250cm^3 conical flask using a pipette filler. Add two drops of phenolphthalein indicator and titrate with solution **Q**. Record your results in table 1 below. Repeat the titration two or more times and complete the table.

Table 1

	I	II	III
Final burette reading(cm^3)			
Initial burette reading(cm^3)			
Volume of solution **Q** used (cm^3)			

(4 marks)

Determine the;

(i) average volume of solution **Q** used. (1 mark)
(ii) concentration of solution **R** in moles per litre. (2 marks)
(iii) concentration of the alkanoic acid in solution **Q** in moles per litre (2 marks)
(iv) molar mass of the alkanoic acid. (1 mark)

2. You are provided with:

-2M hydrochloric acid -Solution T

You are required to determine the effect of temperature on the rate of reaction between solution **T** and hydrochloric acid.

Procedure

Using a 100cm^3 measuring cylinder, measure 30cm^3 of solution **T** and place it into a 100cm^3 beaker. Draw a thin cross(x) on the clean white paper provided. Place the beaker on the paper with a cross. Add 5cm^3 of dilute hydrochloric acid and at the same time start a stop watch. Record the time taken for the cross to become **invisible** when **viewed directly from above**. Repeat the procedure using the remaining solutions heated at temperatures of **30ºC, 40ºC, 50ºC** and **60ºC**. Record your results in the table 2 below.

Temperature of solution T (ºC)	**Time taken for the cross to be invisible *(t* seconds)**	**Rate $\left(\frac{1}{t}\ \text{sec}^{-1}\right)$**
Room temperature		
30		
40		
50		
60		

(5 marks)

(a) Plot a graph of the rate $\left(\frac{1}{t}\ \text{sec}^{-1}\right)$ against temperature **(ºC).** (3 marks)

(b) Identify the measurable change in this reaction.(1 mark)
(c) Explain why the graph shows a big deviation at higher temperatures from the expected linear relations. (2 marks)
(d) State one factor that was kept constant in the experiment.(1 mark).

3. You are provided with solids **U** and **V**. Carry out the tests below and write your observations and inferences in the spaces provided.

a) Place all of solid **U** in a boiling tube. Add about 15cm^3 of distilled water and shake it until all the solid dissolves. Label it as solution **U**.

i) To about 2cm^3 of solution **U** in a test tube add sodium hydroxide solution drop wise until in excess.

OBSERVATIONS (1 mk)	**INFERENCES** (1 mk)

ii) To about 2cm^3 of solution **U** in a test tube add aqueous ammonia drop wise until in excess.

OBSERVATIONS (1 mk)	**INFERENCES** (1 mk)

iii) To about 2cm^3 of solution **U** in a test tube add 3 drops of dilute sulphuric acid.

OBSERVATIONS (1 mk)	**INFERENCES** (1 mk)

iv) To about 2cm^3 of solution **U** in a test tube add 3 drops of aqueous potassium iodide.

OBSERVATIONS (1 mk)	**INFERENCES** (1 mk)

v) Place about 2cm^3 of solution **U** in a test tube and determine its pH.

OBSERVATIONS (½ mk)	**INFERENCES** (½ mk)

b) (i) Using a metallic spatula ignite about half of solid V in a Bunsen burner flame.

OBSERVATIONS (1 mk)	**INFERENCES** (1mk)

c) Place the other half of solid V into a boiling tube, add 15cm^3 of distilled water and shake well. Label this solution **V**.

Use the solution for the following tests; iv) To about 2cm^3 of solution **V**, add 2cm^3 of ethanol and 3 drops of concentrated sulphuric acid. Warm the mixture.

i) Place 2cm^3 of solution **V** in a test tube and determine its pH.

OBSERVATIONS	INFERENCES
(½ mk)	(½ mk)

ii) To about 2cm^3 of the solution obtained in (c) above (solution **V**) add 3 drops of acidified potassium manganate (VII).

OBSERVATIONS	INFERENCES
(1 mk)	(1 mk)

iii) To about 2cm^3 of solution **V** add 2 drops of bromine water.

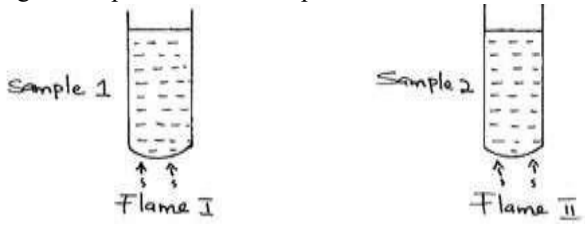
OBSERVATIONS	INFERENCES
(1 mk)	(1 mk)

OBSERVATIONS	INFERENCES
(1 mk)	(1 mk)

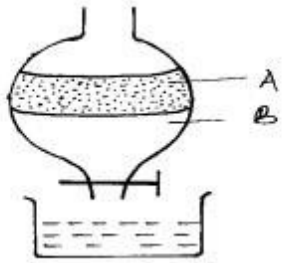
Kenya Certificate of Secondary Education
233/1
CHEMISTRY
PAPER 1
(THEORY)

1. (a) A patient was given tablets with prescription 2 x 3 on the envelope. Clearly outline how the patient should take the tablets. (1 mark)

(b) Two samples of equal volumes of water were put in 250cm³ beaker and heated for 10 minutes. Sample 1 registered a higher temperature than sample 2.



State the conditions under which flame I is produced in Bunsen burner. (1 mark) 2. The apparatus below was used to separate a mixture of liquid A and B.



(a) State two properties of the liquids that make it possible to separate them are using such apparatus. (2 marks)

3. Describe how solid samples of salts can be obtained from a mixture of lead (II) chloride, sodium chloride and ammonium chloride. (3 marks)

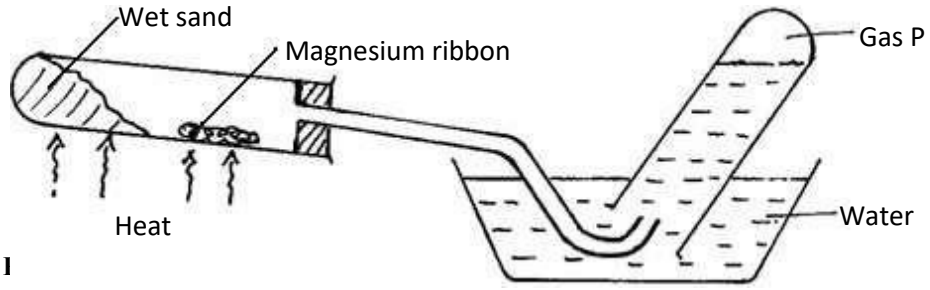
4. An ion of element is represented as:

$$^{24}_{12}X^{2+}$$

(i) Write electronic configuration of ion of . (1 mark)

(ii) To which group does element belong? (1 mark)

5. The set-up below can be used to study the reaction of magnesium and steam.



(a) Name gas I (1 mark)

(b) How would you expect copper to behave compared to magnesium in the combustion tube? (1 mark)

(c) Write the equation for the reaction between magnesium and steam. (1 mark)

6. An approximately molar solution of potassium managanate (VII) solution was standardized against precisely 0.1M iron (II) ammonium sulphate $[(NH_4)_3 Fe (SO_4)_2. 6H_2O]$ solution. 25.0cm³ of the solution of the iron (II) salt were oxidized by 24.15cm³ of the manganate (VII) solution. The equation of the reaction is:

$$MnO_{4\,(aq)} + 5Fe_{(aq)2} + 8H_{(aq)} \rightarrow Mn_{(aq)2} + 5Fe_{(aq)3} + 4H_2O_{(l)}$$

What is the molarity of the potassium manganate (III) solution? (3 marks)

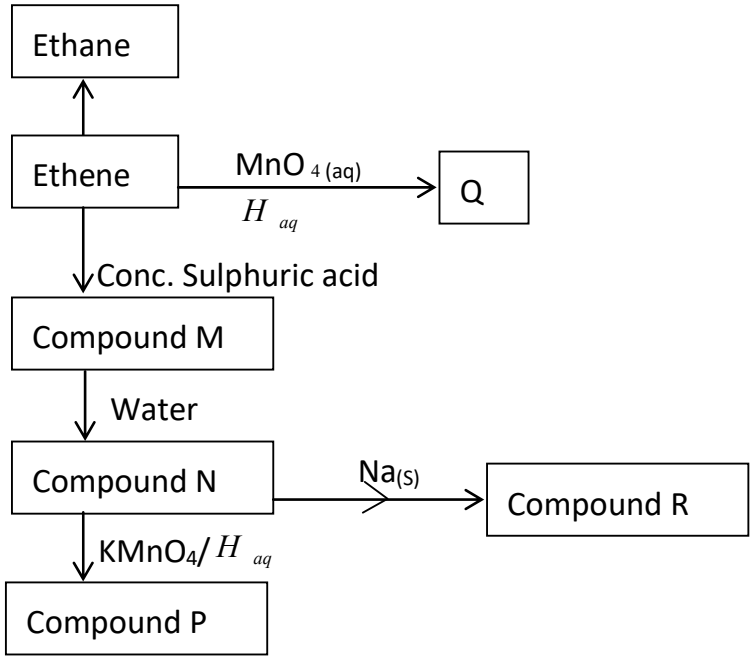
7. During extraction of iron in the blast furnace, state the uses of the following in the furnace.

(a) Molten slag. (1 mark)

(b) Waste gases leaving the furnace. (1 mark)

(c) Limestone. (1 mark)

8. The flow chart below gives some reactions starting with ethane. Study it and answer the questions that follow.



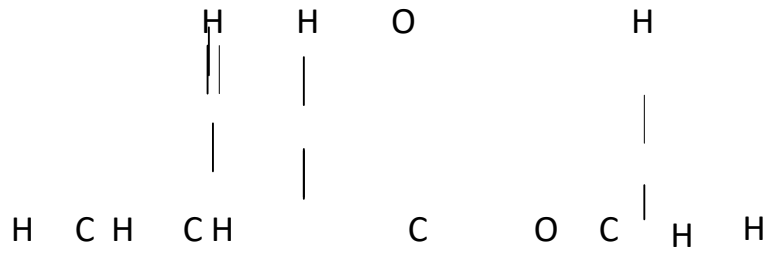
(a) Draw the structure of compounds:

P: (1 mark)

Q: (1 mark)

(b) Write the name of Compound R. (1 mark)

9. Study the organic compound below:



(a) In which homologous series does the compound belong to? (1 mark)

(b) Name and draw the structures of two compounds that can be used to prepare the above compound. (3 marks)

10. (a) State **one** factor that can determine the stability of an atom. (1 mark)

(b) Radioactive polonium – 216 decay as shown below.

$$^{216}_{90}Po \rightarrow ^{208}_{82}Pb + M + n$$

Find the value of M and n. (2 marks)

(c) If after 112 days $\frac{1}{16}$ of polonium remained, calculate the half-life of polonium. (1 mark)

11. A metal oxide has a formula M_2O_3.

(a) Write an equation to show how M form an ion. (1 mark)

(b) Write the formula of the chloride of M. (1 mark)

12. The thermodynamic equation for the formation of ammonia in the Haber process is:

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} \qquad H = -92kJ\ mol^{-1}$$

(a) State and explain one way in which the yield of ammonia can be increased. (2 marks)

13. A certain carbonate, JCO_3, reacts with dilute hydrochloric acid according to the equation below.

$$JCO_3 + 2HCl_{(aq)} \rightarrow GCl_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$$

If 1gof the carbonate reacts completely with 20cm³ of 1M hydrochloric acid, calculate the relative atomic mass of J. (C = 12, O = 16). (4 marks)

14. (a) What is meant by the term solubility? (1 mark)

(b) The mass of a solution A is 120g. This solution has 8g of salt A dissolved in it. The solubility of this salt is 25g/100g of water at 30 C. 55g of salt A are added to the solution at 30 C. How much of salt A will remain undissolved. (2 marks)

15. (a) Using electrons in the outermost energy level, draw the dot ( ) and cross (X) diagrams to represent bonding in.

(i) C_2H_6 (C = 6, H = 1) (1 mark)

(ii) NH4Cl (N = 7, H = l, Cl = 17) (1 mark)

(b) The formula of a complex ion is $Cu\ NH_3\ _4\ ^2$ name the type of bond that is likely to exist between copper and ammonia in the complex. (1 mark)

16. (a) State Hess"s law. (1 mark)

(b) Study the information below and answer the questions that follow.

$$MgCl_{2(S)} \rightarrow Mg\ _{2g} + 2Cl\ _g, \qquad H_1 = -2487kJ\ mol^{-1}$$

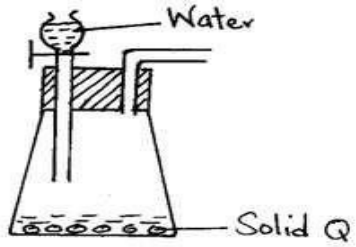
$$MgCl_{2(S)} + (aq) \rightarrow MgCl_{2(aq)}, \qquad H_2 = -5142kJ\ mol^{-1}$$

$2Cl_{(g)} + (aq) \quad 2Cl_{(aq)}, \qquad H_3 = -762kJ\ mol^{-1}$

(a) Name the enthalpies H_1 and H_2. (2 marks)
(b) Determine the enthalpy for the reaction: (2 marks)

$Mg_{2(g)} + (aq) \quad Mg_{2(g)}$

17. (a) Give two reasons why carbon (IV) oxide is used as a fire extinguisher. (1 mark)
(b) State the function of tartaric acid in baking powder. (2 marks)
18. When an electric current of 0.5A was passed through a molten chloride of J for 32 minutes and 10 seconds, a mass of 0.44g of J was deposited at the cathode. (IF = 96500C).
(a) Calculate the quantity of electricity used. (1 mark)
(b) Determine the value of if the ion of metal J is represented as J^+.
(R.A.M of J = 44). (1 mark)
19. (a) What is meant by the term basicity of an acid. (1 mark)
(b) Describe briefly how potassium sulphate can be prepared using 50cm³ of 1M potassium hydroxide. (3 marks) 20. The diagram below represents a set-up used to prepare oxygen gas.



(a) Name substance Q. (1 mark)
(b) Complete the set-up to show how oxygen gas is collected. (1 mark)
(c) Write the equation for the reaction that occur. (1 mark)
21. The table below shows some solutions and their PH values.

Solution	PH value
P	1.5
Q	6.0
R	14.0
S	8.0

Which of the above solution.
(a) Is strongly basic. (1 mark)
(b) Reacts with sodium carbonate more vigorously. (1 mark)
(c) Is ammonia solution. (1 mark)
22. In an experiment, a jar containing sulphur (IV) oxide was inverted over another jar containing hydrogen sulphide gas.
(a) State and explain the observation that was made. (2 marks)
(b) State two conditions necessary for the reaction to take place. (2 marks)
23. Two reagents that can be used to prepare chlorine gas are potassium manganate (VII) and hydrochloric acid.
(a) Write an equation for the reaction. (1 mark)
(b) Give the formula of another reagent that can be used instead of potassium manganate (VII). (1 mark)
(c) Using an equation illustrate how chlorine bleach coloured substances. (1 mark)
24. (a) Distinguish between ionization energy and electron affinity. (2 marks)
(b) Explain why fluorine is more reactive than iodine. (2 marks)
25. 280cm³ of nitrogen gas diffuse through a porous plug in 70 seconds. How long will it take 400cm³ of carbon (IV) oxide gas to diffuse through the same porous plug. (C = 12, O = 16, N = 7). (3 marks)
26. An iron spoon was to be electroplated with silver. Sketch the set-up that could be used. (2 marks) 27. Write the equation for decomposition of:
(a) Sodium nitrate. (1 mark)
(b) Copper (II) nitrate. (1 mark)

Kenya Certificate of Secondary Education
233/2
CHEMISTRY
PAPER 2

(THEORY)

1. Study the table below and answer the questions that follow. The letters do not represent the actual symbols of the elements.

Element	A	B	C	D	E	F	G	H
Atomic no.	11	12	13	14	15	16	17	16
Boiling point (C)	890	1110	2470	2360	280	445	- 34.7	-186
Formulae of oxide		BO			E_2O_3	FO_2		xxxx
Boiling point of oxide (C)	1193	3075	2045	1728	563	-72	-91	xxxx

(a) (i) Write the electronic arrangement for ion of element **C** and **F**. (1 mark)

(ii) To which period and group do element **B** belongs. (1 mark)

Period _____

Group _____

(b) Explain the difference in boiling points of element **B** and **F**. (2 marks)

(c) Write the formula of the compound formed between elements **B** and **G**. (1 mark)

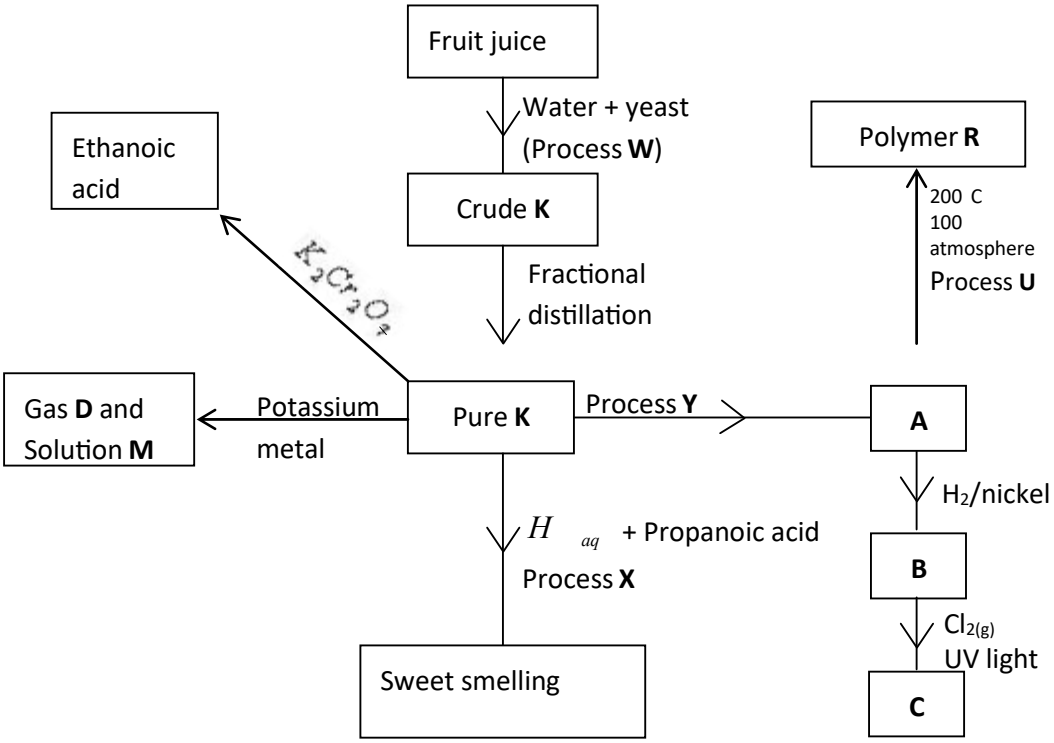
(d) The chloride of **A** has a higher boiling point than that of **C**. Explain. (2 marks)

(e) Complete the table to show the formulae of the oxides. (2 marks)

(f) Select an oxide that reacts with hydrochloric acid and potassium hydroxide. Explain. (1 mark)

(g) Determine the oxidation state of **F** in its oxide. (1 mark)

2. Study the reaction scheme below and answer the question that follows.

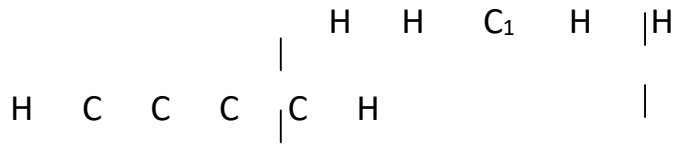


(a) (i) Give the na mes of the following substances A,B, C,D,K (2½ marks)

(ii) Give the structural formular of substance **M**. (1 mark)

(iii) Name the processes marked as: W, X and Y (3 marks)

(b) The compound below was formed when one mole of a hydrocarbon reacted with one mole of chlorine gas.



H C1 H H H

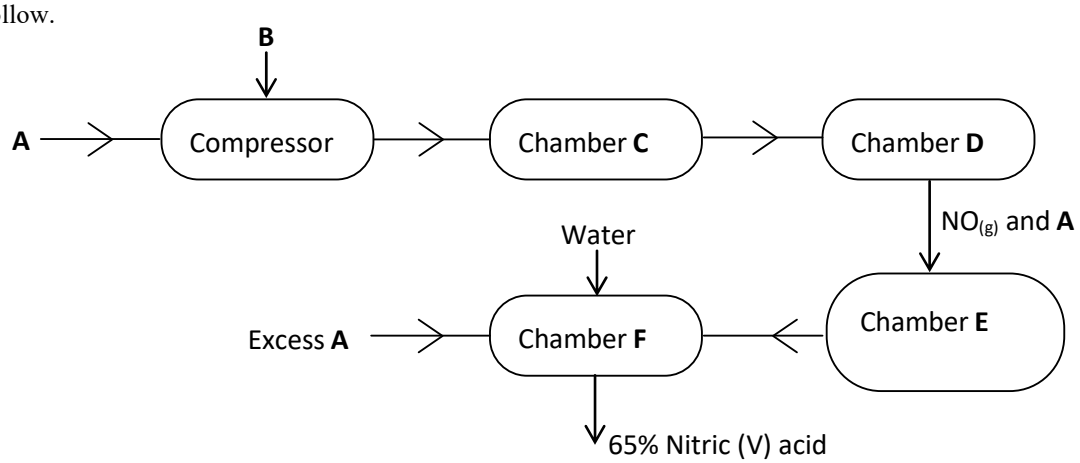
(i) Give the structure of the hydrocarbon. (1 mark)

(ii) Draw and name two isomers of the hydrocarbon. (2 marks)

(c) State **two** uses of ethane. (1 mark)

(d) Draw and name substance **Z**. (1 mark)

3. The flow chart below illustrates the major steps in the manufacture of nitric (V) acid. Study it and answer the questions that follow.



(a) Give reason for purifying the raw materials **A** and **B**. (1 mark)

(b) Name the substances: **A** ,**B** (1 mark)

(c) Name the parts labeled **D**, **E** and **F**. (3 marks)

(d) Write chemical equations for the reactions taking place in:

(i) Chamber **D**. (1 mark)

(ii) Chamber **F**. (1 mark)

(e) Name any other condition required in chamber **D** apart from maintaining temperature at 900 C. (1 mark)

(f) A mixture that comes out is 65% nitric (V) acid and 35% water. How could the concentration of nitric (V) acid be increased? (1 mark)

(g) Give **one** use of nitric (V) acid. (1 mark)

(h) When copper metal is reacted with dilute nitric (V) acid, a brown gas is evolved. Explain. (1 mark)

4. 150g of powdered brass (an alloy of zinc and copper) were added to excess 0.5M hydrochloric acid in a conical flask placed on top of a pan balance. The changes in mass of the flask and its contents with time were recorded in the following table. This experiment was carried out at room temperature.

Time (in seconds)	0	10	20	30	40	50	60
Mass in grams of flask and its contents	255.0	253.0	251.9	251.2	251.1	251.0	251.0

(a) Write an equation for the reaction that took place. (1 mark)

(b) State and explain the relationship between the mass of the flask and its contents with time. (2 marks)

(c) What observations was made in the flask at the end of the reaction? (1 mark)

(d) (i) Plot a graph of mass of the flask and its contents against time. (3 mark)

(ii) Using the graph determine rate of the reaction at the 20^{th} second. (2 marks)

(iii) How would the rate in 4d(ii) above be affected if the reaction was carried out using 0.5M hydrochloric acid at 45 C?

Explain. (2 marks)

5. (a) Use the reduction potentials below to answer the questions that follow.

E (Volts)

$Q_{aq2} \quad 2e \quad Q_{s} \quad 2.38$

$B_{(aq)}^{2+} \quad 2e \quad B_{(s)} \quad 1.14$

$D_{(aq)}^{2+} \quad 2e \quad D_{(s)} \quad 0.80$

$Fe_{(aq)}^{3+} \quad 3e \quad Fe_{(s)} \quad 1.66$

$C_{(aq)} \quad e \quad C_{(s)} \quad 0.76$

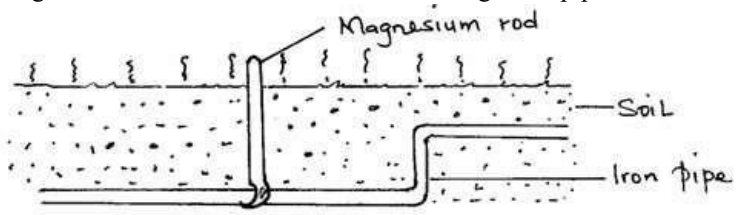
(i) Select the strongest reducing agent. Explain. (1 mark)
(ii) Calculate the e.m.f value of electrochemical cell obtained when elements **B** and **D** are paired together. (1 mark)

(iii) Write an ionic equation for the reaction that occurs when metal **Q** is immersed into a solution containing $C_{(aq)}$ ions. (1 mark)

(iv) State and explain whether the reaction given below occurs or not.

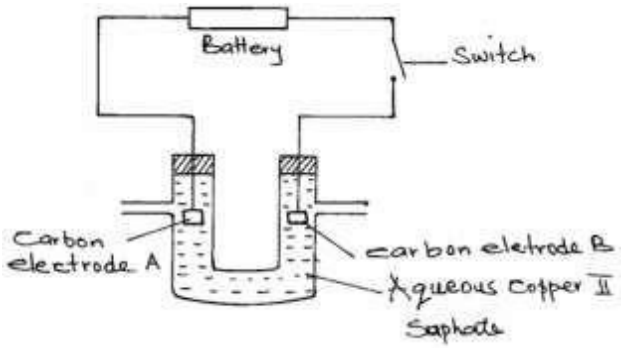
$3B_{(s)} \quad Fe_{(aq)}^{3+} \quad Fe_{(s)} \quad 3B_{(aq)}$ (1 mark)

(b) Magnesium metal was connected to an underground pipe made of iron as shown below:



Explain why it is necessary to carry out the process shown above. (2 marks)

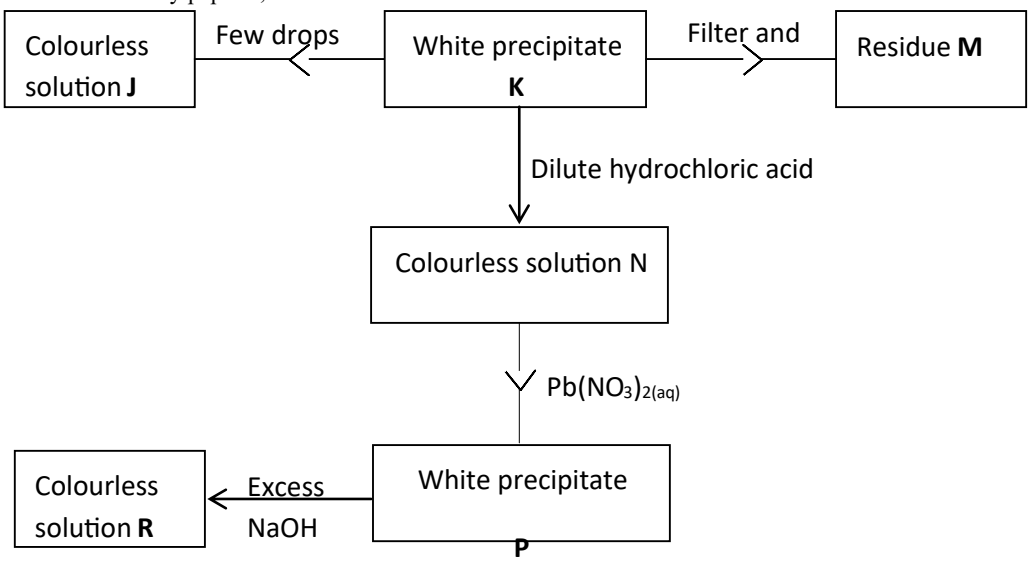
(c) Aqueous copper (II) sulphate was electrolysed using the set up shown below.



(i) When the switch was closed, a gas was produced at electrode **B**.
Which electrode is the anode?
(ii) Write the half equation for the reaction at electrode **B**. (1 mark)
(iii) State and explain the observation that will be made at electrode **A**. (1 mark)
(iv) What happens to the PH of the electrolyte above during electrolysis? Explain. (1 mark)

(d) If carbon electrodes were replaced with copper electrodes in the reaction in (a) above, write the equations of the reactions that would occur at the:
(i) Anode. (1 mark)
(ii) Cathode. (1 mark)
(iii) Name **one** industrial application of the above electrolysis. (1 mark)

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



Residue **M** was yellow when hot and white when cold.

(a) (i) Identify.

I White precipitate **K** _____ (1 mark)

II Solution **N** _____ (1 mark)

III Residue **M** _____ (1 mark)

(ii) Write an ionic equation for the reaction of solution N with $Pb(NO_3)_{2(aq)}$. (1 mark)

(iii) Write observations that would be made when ammonia solution is added drop wise till in excess to the colourless solution **N**. (1 mark)

(b) Ammonia gas bubbled into water forms a solution which conducts electricity whereas the solution formed when it is bubbled through methylbenzene does not. Explain. (2 marks)

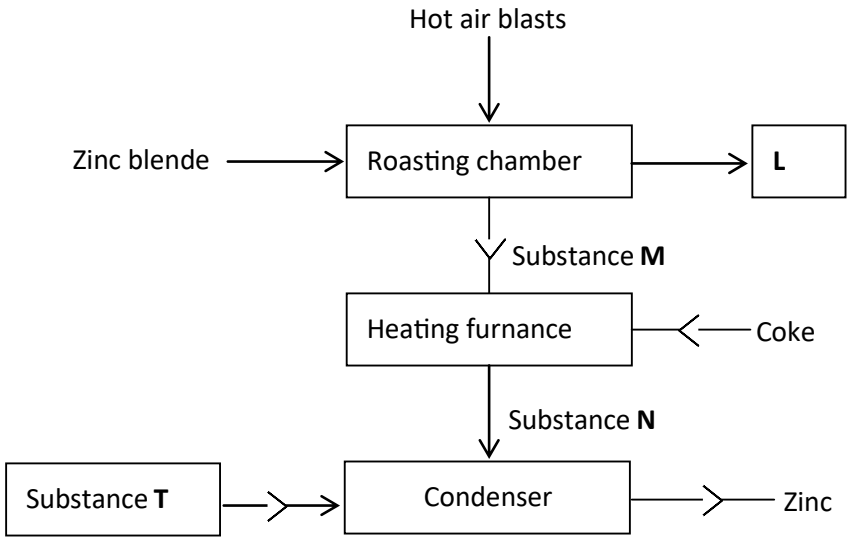
(c) Boilers used for boiling hard water are normally covered with boilers scale after sometime.

(i) What is the chemical name for boilers scales? (1 mark)

(ii) How is the boiler scale removed? (1 mark)

(d) Write the formula of the anion in solution **J**. (1 mark)

7. The flow chart below illustrates extraction of zinc from zinc blende. Study it and answer the questions that follow.



(a) Give an equation for the reaction in the roasting furnace. (1 mark)

(b) Name each of the substances marked **L**, **T**, **N** and **M**. (2 marks) (c) Why is it necessary to condense substance **N**? (1 mark)

(d) Which other factory can be set up near the zinc extraction plant? Explain. (2 marks)

(e) Give **one** use of zinc metal. (1 mark)

(f) (i) Zinc sulphide and sulphuric acid react according to the following equation: $ZnS_{(s)} + H_2SO_{4(aq)} \rightarrow ZnSO_{4(aq)} + H_2S_{(g)}$

2.91g of zinc sulphide reacted with 100cm³ of 0.2M sulphuric acid. Determine the reagent that was in excess. (Zn = 65.0, S = 32.0). (2 marks)

(ii) Calculate the volume of hydrogen sulphide (H_2S) gas produced in the reaction above at r.t.p. (Molar gas volume 24dm³). (2 marks)

Kenya Certificate of Secondary Education
233/3
CHEMISTRY
PAPER 3
(PRACTICAL)

1. (a) You are provided with solution X and Y solution X is acidified potassium manganate (VII) solution. Solution Y was prepared by dissolving 5.88g of an iron (II) salt $(NH_4)_2Fe(SO_4)_2.6H_2O$ in 250cm³ of solution. You are required to standardize solution X using solution Y.

Procedure:

(i) Fill the burette with solution X.

(ii) Using a pipette and pipette filler, transfer 25.0cm³ of solution Y into a 250cm³ conical flask.

(iii) Titrate solution X against solution Y until a permanent pink colour just appears.

(iv) Record your results in the table below.

(v) Repeat the titration two more times to obtain two other titres and complete table I below

Table I

Titration	1	2	3
Final burette reading (cm³)			
Initial burette reading (cm³)			
Volume of solution X used (cm³)			

(3 marks)

(a) Calculate:

(i) Average volume of solution X used. (1 mark)

(ii) Molarity of solution Y. (2 marks)

(iii) Number of moles of solution Y in the average volume of solution X. (2 marks

(b) Given that the equation for the reaction between X and Y is:

$$MnO_{4\,(aq)} \quad 5Fe_{(aq)}^{2} \quad 8H_{(aq)} \quad Mn_{(aq)}^{2} \quad 5Fe_{(aq)}^{3} \quad 4H_2O_{(l)}$$

Calculate:

(i) The number of mole of X in the average volume. (1 mark) (ii) Concentration of solution Y in mole dm³. (2 marks)

(b) You are provided with:

(i) 0.21M glucose solution V.

(ii) 0.02M potassium manganate (VII) solution W.

(iii) 1.0M acqueous sulphuric (VI) acid.

You are required to determine the rate of reaction between solution W and V at different temperature.

Procedure:

Place 2cm³ of solution W into a 250ml beakers using 100ml measuring cylinder add 50cm³ of 1.0M sulphuric (VI) acid to the beaker containing solution W.

Warm the mixture to about 65 C. Stop warming and allow the mixture to cool.

When the temperature is exactly 60 C add 15cm³ of solution V and start the stopwatch immediately.

Stir the mixture and measure the time taken for the colour of the mixture to change from purple to colourless.

Record the time in the table below also record the temperature at which the mixture becomes colourless. Clean the beaker and repeat the procedure at temperature 55 C, 50 C and 45 C instead of

60 C. I

(i) Calculate $\frac{1}{t}$ and complete the table below. (2 marks)

Temp. before mixing (C)	60	55	50	45
Temp. when solution becomes colourless (C)				
Time in (seconds)				
$\frac{1}{t}$				

(a) Plot a graph of $\frac{1}{t}$ (y-axis) against temperature at the point when the solution becomes colourless. (3 marks)

(b) From your graph:-

(i) Determine the time that the reaction would take if the temperature at which the solution becomes colourless is 42.5 C. (2 marks)

(ii) Describe the slope of your graphs. (1 mark)

2. (a) You are provided with solid B. Carry out the tests below and record your observations and inferences in the space below. Test for any gas produced using blue and red litmus paper.

(i) Place half spatula endful of solid B in a test tube and heat gently then strongly.

Observation	Inference
(3 mks)	(1 ½mks)

(ii) Place a spatula end ful of solid B into a boiling tube, and add about 10cm³ of distilled water. Shake well and filter the residue retain the residue. Divide the filtrate into three portions.

Observation	Inference
(1mk)	(1mk)

(iii) To the 1st portion, add $NaOH_{(aq)}$ drop wise until in excess.

Observation	Inference
(1mk)	(½mk)

(iv) To the second portion add aqueous ammonia drop wise until in excess.

Observation	Inference
(1 mk)	(½mk)

(v) To the 3rd portion add 3 drops of $HNO_{3(aq)}$ followed by 2-3 drops of lead II nitrate warm gently.

Observation	Inference
(½mk)	(½mk)

(vi) Place the residue obtained in (b) above into a boiling tube and add about 5cm³ of dilute hydrochloric acid and retain the resulting mixture.

Observation	Inference
(1mk)	(1mk)

(vii) To the resulting mixture in (vi) above, add aqueous ammonia dropwise until in excess.

Observation	Inference
(1 mk)	(½mk)

You are provided with an organic solid Z. Use it to carry out the following tests.

(i) Heat a spatula end full of solid Z over a flame.

Observation	Inference
(1mk)	(1mk)

(ii) Put the remaining portion of Z in a boiling tube. Add 10cm³ of distilled water. Shake and divide into three portions 2cm³ each.

Observation	Inference
(½mk)	(½mk)

(iii) To portion one add four drops of potassium chromate (VI) warm.

Observation	Inference
(1 mk)	(1 mk)

(iv) To portion two add small quantity of sodium hydrogen carbonate.

Observation	Inference
(½mk)	(½mk)

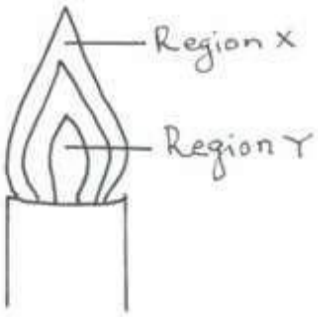
(v) To portion three add few drops of universal indicator, determine PH of the solution.

Observation	Inference
(½mk)	(½mk)

3.

KCSEPREDICTION 6 2022
233/1
CHEMISTRY
PAPER 1
(THEORY)

1. (a) The diagram below shows a non-luminous flame. Use it to answer the questions that follow:



Two wooden splints were placed across regions **X** and **Y** respectively. Draw labelled diagrams to show the effects observed on the wooden splint placed across each region. (2 marks)

(i) Region **X**.

(ii) Region **Y**.

(b) It is advisable to leave your flame in the luminous state when not in use. Give a reason why. (1 mark) 2. Explain the change in mass expected when each of the following substances is heated in an open crucible.

(a) Copper metal. (1 mark) (b) Copper (II) nitrate. (2 marks)

3. The table below shows PH values of solutions **A**, **B**, **C** and **D**.

Solution	PH
A	3.0
B	13.0
C	8.5
D	7.0

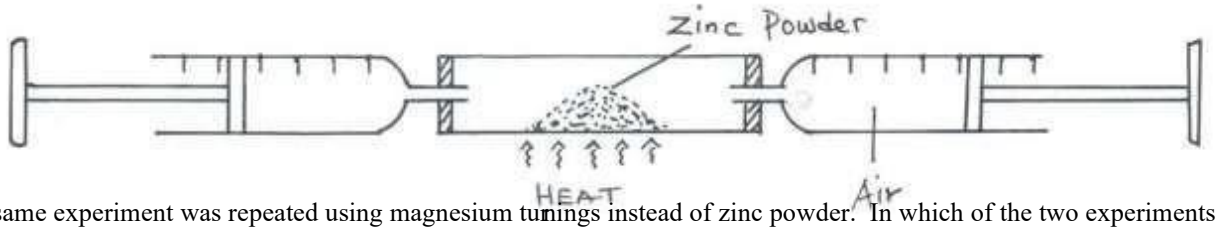
(a) Identify a solution which is

(i) Strongly acidic. _____ (½ mark)

(ii) Strongly basic _____ (½ mark)

(b) Which to solutions would react with lead (II) oxide? Explain. (2 marks)

4. In an experiment a certain volume of air was repeatedly passed between two syringes over heated zinc powder as shown below.



The same experiment was repeated using magnesium turnings instead of zinc powder. In which of the two experiments was the overall change in volume greater? Explain. (3 marks)

5. The grid below is part of the periodic table. Study it and answer the questions that follow. The letters are not actual symbols of elements.

A			D	E			H	I
B	C		M		F	G		J

(a) What is the name given to the chemical family of element **C**? (1 mark)

(b) Would element **B** react with **J**? Explain. (1 mark)

(c) Compare the melting points of **B** and **M**. (1 mark)

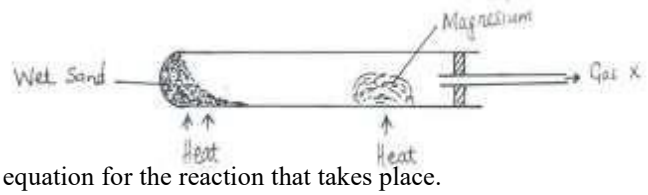
6. The atomic numbers of nitrogen, oxygen and sodium are 7, 8 and 11 respectively.

(a) Write the electron arrangements of their ions, N^{3-}, O^{2-} and Na^{+}. (1 mark)

(b) Arrange the 3 ions in increasing order of size. Give a reason for your answer. (2 marks)

7. The melting point of phosphorous (III) chloride is -91 C while that of magnesium chloride is +715 C. In terms of structure and bonding explain the difference. (3 marks)

8. The diagram below illustrates how lithium would react with steam. Study it then answer the questions that follow.

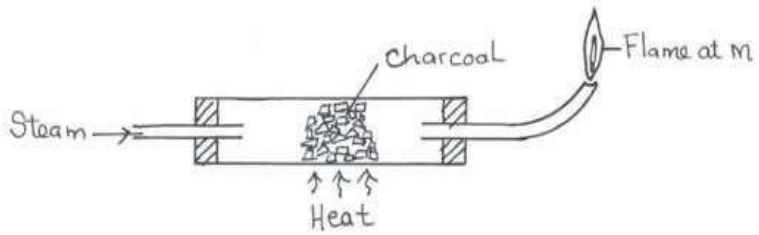


(a) Write the equation for the reaction that takes place.

(1 mark)

(b) Explain why this experiment cannot be carried out with potassium in the same way as shown. (1 mark)

9. Explain why this experiment cannot be carried out with potassium in the same way as shown. (2 marks)
10. Calculate the volume of carbon (IV) oxide that would be produced if 15g of calcium carbonate reacted with 100cm³ of 2.0M hydrochloric acid (C = 12.0, O = 16.0, Ca = 40.0) molar gas volume = 24000cm³. (3 marks)
11. (a) Study the diagram below hence answer the questions that follow.



(i) Explain why it is necessary to have the flame at **M**. (1 mark)

(ii) Write down the equation for the reaction inside the apparatus. (1 mark)

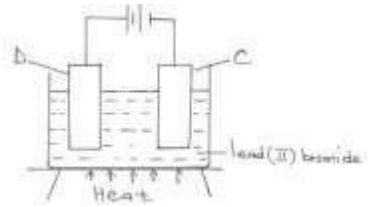
(b) Explain potassium hydroxide is not a suitable reagent for testing carbon (IV) oxide. (1 mark)

12. The table below contains information regarding a species of helium.

Species	Number of electrons	Number of neutrons
$_{2}{}^{3}He_{2}$		

Complete the table by indicating the numbers of electrons and neutrons. (2 marks)

13. (a) The diagram below represents a set-up of apparatus used to investigate the effect of electric current on lead (II) bromide.

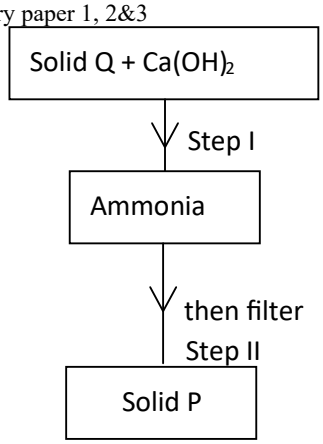


Describe what is observed at electrode C. (1 mark)

(b) A current of 2.5A was passed through a cell containing N^{2+} ions for 25 minutes. The mass of the cathode increased by 0.36g. Determine the R.A.M of N. ($F = 9.65 \times 10^{4} Cmol^{-1}$). (2 marks)

14. When aluminum chloride is dissolved in water, the resulting solution has a PH of 3. Explain. (3 marks)
15. Study the scheme below hence answer the questions that follow.

Pass into



aluminium sulphate

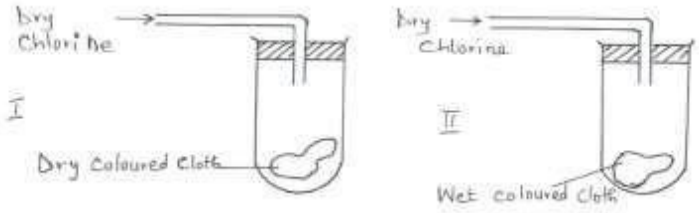
(a) Identify solid **Q**.
(1 mark)

(b) Write an ionic equation for the reaction in Step **II**. (1 mark)

(c) State the condition necessary for Step **I**. (1 mark)

16. When sulphur is heated in a boiling tube in the absence of air, the yellow crystals melt into a golden yellow mobile liquid at 113 C. The liquid turns into a dark brown viscous mass at 180 C. At 400 C the brown liquid becomes less viscous and flows easily. Explain these observations. (3 marks)

17. Study the diagrams below.



(a) State the observations made at I and II (1 mark)

(b) Write the equation to show the reactions at II if dry sulphur (IV) oxide was used in place of dry chlorine. (2 marks)

18. In an experiment soap solution was used against 3 separate samples of water. Each sample was later boiled and soap added. Each water sample was 1000cm³. The results are tabulated below.

Volume of soap used to form lather	Sample		
	I	II	III
Before boiling (cm³)	27	3	10.6
After boiling (cm³)	27	3	3

(a) Which sample was likely to be soft water? Explain. (2 marks)

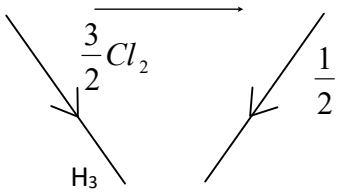
(b) State the cause of change in volume of soap used to form lather in sample (1 mark)

III.

19. Study the cycle below hence answer the questions that follow.

Fe(s) Cl_2 H_1 $FeCl_2$

Cl_2



2

(a) What is H_3? $Fe\,Cl_3$ (1 mark)

(b) Show the relationship connecting H_1, H_2 and H_3 (1 mark)

20. When bromine gas reacts with aqueous sodium hydroxide an equilibrium is established as shown below.

$$Br_{2(aq)} + 2OH^-_{(aq)} \rightleftharpoons Br^-_{(aq)} + OBr^-_{(aq)} + H_2O_{(l)}$$

(Brown) (Colourless)

What observation would be made if a few drops of dilute sulphuric (VI) were added to the equilibrium mixture? Explain. (2 marks)

21. (a) Aqueous sodium sulphate was electrolysed using platinum. Name the products at each electrode. (1 mark)

I Cathode

IIAnode

(b) Explain why it is not advisable to use potassium chloride as salt bridge in the cell shown below.

$$Pb_{(S)} / Pb^{2+}_{(aq)} \;//\; Cu^{2+}_{(aq)} / Cu_{(S)} \quad E = +0.47V$$ (1 mark)

22. A compound has empirical formula C_3H_6O and relative formula mass of 116. Determine it"s molecular formula. (C = 12, H = 1, O = 16). (2 marks)

23. (a) State the law of combining volumes of gases. (1 mark)

(b) What volume of methane would remain if a burner containing 40cm³ of methane burns in 40cm³ of enclosed air (assuming that oxygen is 20% of air)? (2 marks)

24. The molecular formula of compound T is C_3H_8O. T reacts with acidified potassium manganate (VII) to form another compound U whose formula $C_3H_6O_2$. T also reacts with sodium metal to produce hydrogen gas and T is neutral to litmus.

(a) Suggest the homologous series to which T belongs. (1 mark)

(b) Name the type of reaction leading to the formation of U in the reaction described above. (1 mark)

(c) Write the structural formula of U. (1 mark)

---

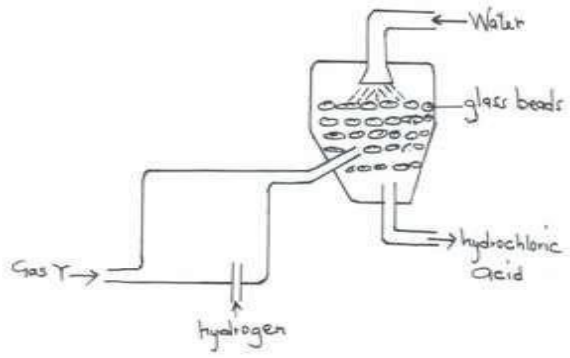
25. Potassium has two isotopes $^{39}_{19}K$ and radioactive $^{40}_{19}K$.

(a) State how the two isotopes differ. (1 mark)

(b) The half-life of $^{40}_{19}K$ is 1.3 x 10^9 years. Determine how long it would take for 4g of the isotope to decay to 1g. (1 mark)

(c) $^{39}_{19}K$ undergoes beta decay to form an isotope of calcium. Write the equation for this decay. (1 mark)

26. The diagram below represents a section of the hydrochloric acid manufacturing plant.



(a) Name **Y**. (1 mark)

(b) State the role played by glass beads. (1 mark)

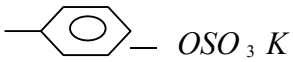
(c) Chlorine reacts with hydrogen sulphide gas according the equation shown below:

$$H_2S_{(g)} + Cl_{2(g)} \quad 2HCl_{(g)} + S_{(S)}$$

From the equation identify the oxidizing agent. (1 mark)

27. The formulae below belong to 2 cleansing agents.

I $RCOO^- K^+$

II R  OSO_3K

(a) Which of the two cleaning agents would lather readily with hard water? (1 mark)
(b) State **one** disadvantage of the continued use of cleansing agent II. (1 mark)
(c) Write the formula of the compound formed when cleansing agent I is used with water containing Mg^{2+} ions. (1 mark)

28. Starting with solid lead (II) carbonate, briefly describe how a sample of lead (II) chloride can be prepared. (3 marks)
29. (a) State Boyle"s law. (1 mark)
    (b) 60cm³ of oxygen gas diffused through a porous hole in 50 seconds. How long will it take 80cm³ of sulphur (IV) oxide to diffuse through the same hole under the same conditions (S = 32, O = 16). (2 marks)

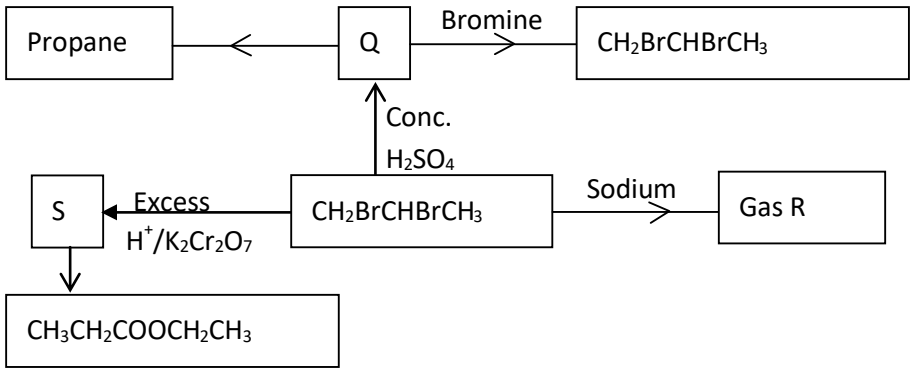
Kenya Certificate of Secondary Education
233/2
CHEMISTRY
PAPER 2
(THEORY)

1. Use the table below to answer the questions that follow. (The letters are not actual symbols of the elements).

Element	Atomic number	M.P(C)
A	11	97.8
B	13	660
C	14	1410
D	17	-101
E	19	63.7

(a) Write the electronic arrangement for the ions formed by the elements **D** and **E**. (½ mark)
(b) Select and element which is:
(i) A poor conductor of electricity. (½ mark)
(ii) The most reactive non-metal. (½ mark)
(c) To which period of the periodic table does element **E** belongs? (½ mark)
(d) Element **E** losses its outermost electron more readily than **A**. Explain. (2 marks)
(e) Use dot (**.**) and crosses (X) to represent the valence electrons and show the bonding in the compound formed between element **C** and **D**. (2 marks)
(f) Explain why the melting point of element **B** is higher than that of element **A**. (2 marks)
(g) Write an equation for the reaction that takes place between element **A** and water. (1 mark)
(h) Describe how a solid mixture of the sulphate of element E and lead (II) sulphate can be separated into solid samples. (3 marks)

2. The scheme below shows several reactions starting with propanol. Study the scheme and answer the questions which follow.



(a) Name gas **R** (½ mark)
(b) Name and draw the structural formula of compound **Q**. (1 mark)

(c) What conditions and reagents are necessary to convert **S** to $CH_3CH_2COOCH_2CH_3$ (2 marks)

Reagents

Conditions

(d) Write an equation for the reaction that takes place when equal volumes of chlorine gas react with propane. (1 mark) (e) The table below shows some properties of organic compounds **U**, **V** and **W**. Use the information to answer the questions that follow.

	W	V	U
Reaction with liquid bromine	Decolourise bromine very fast	No reaction	Decolourises bromine liquid slowly
Combustion	Burns with yellow smoky flame	Burns with a blue flame leaving no residue	Burns with a yellow sooty flame
Reaction with conc. H_2SO_4	No reaction	It is dehydrated to form compound U	Reacts to form V

To which homologous series do the compounds belong? (3 marks)

U _____

V _____

W _____

(f) $CH_2 = CH - CH_3$ when heated under high temperatures and pressures forms a solid with large molecular mass.

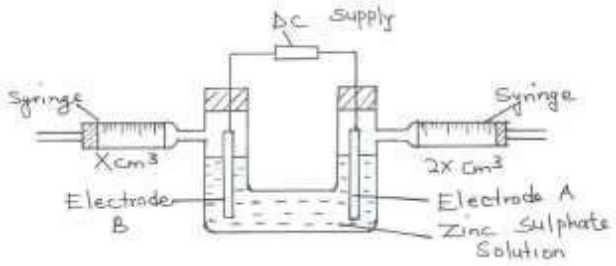
(i) Write the equation for the reaction which involves the formation of the solid. (1 mark)

(ii) Name the solid and give one use of the solid

Name _____ (½ mark)

Use _____ (1 mark) (g) State **two** uses of cracking. (2 marks)

3. (a) An aqueous solution of zinc sulphate is electrolysed using platinum electrodes as shown in the set up below.



(i) Write a half equation for the reaction taking place at electrode **A**. (1 mark)

(ii) Identify electrode **B**. (1 mark)

(iii) Explain observation at electrode **B** if copper plate was used instead of platinum electrode. (2 marks)

(b) 0.22g of metal Q is deposited by electrolysis when a current of 0.06A flows for 99 minutes (RAM of Q = 184, IF = 96500C)

(i) Find the number of moles of Q deposited. (1 mark)

(ii) Determine the value of n in the metallic ion Q^{n+}. (3 marks)

(c) An iron spoon is to be electroplated with silver. Draw a labelled diagram to represent the set-up that could be used to carry out this process. (2 marks)

(d) The following are half-cell equations for some elements. The letters do not represent actual symbols. Use the information to answer the questions that follow.

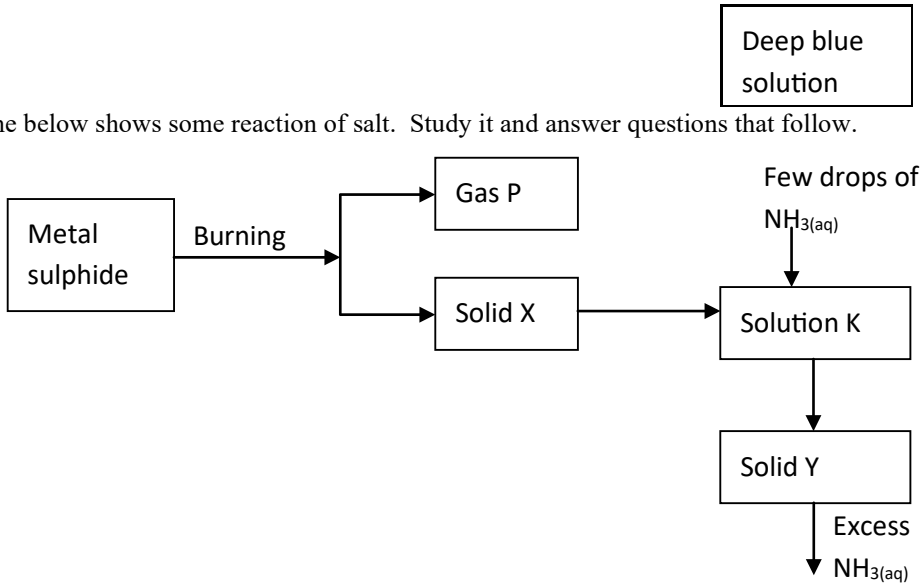
Half cell	E , V
$M_{aq2} \; \overline{\;} \; 2e \;\; M_s$	+0.34
$L_{aq2} \;\; 2e \;\; L_s$	+0.84
$K_{aq2} \;\; {}^{-}2e \;\; K_s$	-0.13
$J_{aq2} \;\; 2e \;\; J_s$	-0.76

(i) Select the two half cells that would produce the highest emf of a cell. (1 mark)

(ii) Calculate the emf of the cell in d(i) above. (2 marks)

(iii) Give the cell diagram notation for the cell in d(ii) above. (1 mark)

4. (a) The results of an experiment to determine the solubility of solid Y in water at 40 C were as follows.
Mass of dish = 16.9g
Mass of dish + saturated salt at 40 C = 26.955g
Mass of dish + solid after evaporation to dryness = 17.96g Determine solubility of solid Y using the data above. (3 marks)



(b) The scheme below shows some reaction of salt. Study it and answer questions that follow.

(i) Write an equation for the reaction to show formation of gas **P** and solid **X**. (1 mark)

(ii) Give the name and formula of the complex ion responsible for the deep blue colour in the solution. (2 marks)

(c) Study the equation below and answer the questions that follow. $NH_{aq} + H_2O_{(l)} \rightleftharpoons NH_{3(aq)} + H_3O_{aq}$

Identify the reactant that acts as an acid in the reverse process. Explain your answer. (2 marks)

(d) (i) What is meant by hard water? (1 mark)

(ii) Using an ionic equation, explain how sodium carbonate removes permanent hardness of water. (1 mark)

5. (a) In an experiment to determine the molar heat of displacement when magnesium displaces copper 0.36g of magnesium powder were added to 25cm³ of 1M copper (II) chloride solution, the temperature of solution increased by 43 C. (Cu = 63.5, Mg = 24.0 specific heat capacity 4.2J/g/K).

(i)Other than increase in temperature, state and explain the other observation made. (2 marks)

(ii) Determine the molar heat of displacement of copper. (3 marks)

(b) Given the following reactions

$2C_{(S)} + O_{2(g)} \quad 2CO_{(g)} \quad H = -220kJ$ $2CO_{(g)} + O_{2(g)} \quad 2CO_{(g)} \quad H = -566kJ$

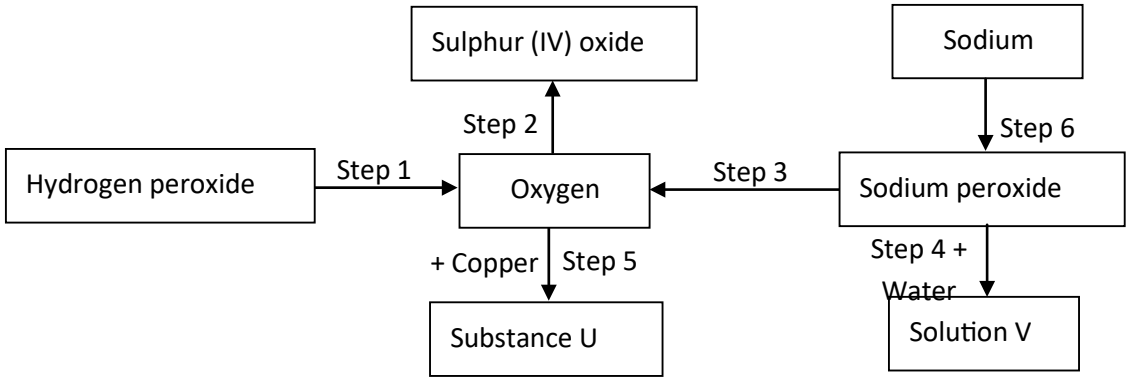
Using an energy cycle diagram, calculate the molar heat of formation of carbon (IV) oxide. (3 marks) (c) Study the table of bond energies below.

Use the information to calculate the enthalpy of the reaction shown below. (2 marks)

$H_{2(g)} + Br_{2(g)} \quad Hbr_{(g)}$

Bond	Bond energy $kJmol^{-1}$
H – H	435
Br – Br	224
H - Br	336

6. Study the reaction scheme below and answer the questions that follow.



(a) Identify the substances labeled **U** and **V**. (2 marks)

(b) Name the reagents necessary for the reactions in the following steps. (4 marks)

Step **1** _____

Step **2** _____

Step **3** _____

Step **6** _____

(c) Give the condition necessary for the reaction in Step **5** to take place. (1 mark)

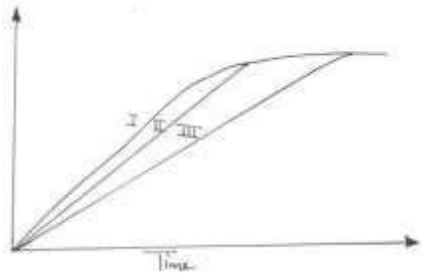
(d) Write equations for the reactions in the following steps. (2 marks)

Step **1** _____

Step **6**_____

(e) State and explain the observation made in Step 5. (2 marks)

7. (a) Below is a graph that was obtained when different concentrations of hydrochloric acid was reacted with equal amount of calcium carbonate.



The concentrations of hydrochloric acid were 0.8m, 0.5m and 0.1m. The calcium carbonate was in powder form. Match the graphs with concentrations.

Graph I _____ (1 mark)

Graph II _____ (1 mark)

(b) A state of equilibrium between dichromate (VI) and chromate ions is established as shown in the equation below.

$Cr_2O_{7(aq)} + 2OH_{aq} \rightleftharpoons 2CrO_{4\ aq} + H_2O_{(l)}$

Orange Yellow

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

(ii) State and explain observation made when a few pellets of potassium hydroxide are added to the equilibrium mixture. (2 marks)

(c) An experiment was done using magnesium ribbon and dilute hydrochloric acid of different concentrations. The time needed to produce 50cm³ of the gas for every experiment was recorded in the table below.

Conc. of HCl in mol/litre	2.0	1.75	1.50	1.25	1.00	0.75	0.50	0.25
Time in sec(s)	8.8	10.0	11.7	13.5	17.5	22.7	35.5	70.0
$\frac{1}{t}$ sec^{-1}								

(i) Complete the table above. (2 marks)

(ii) Plot a graph of rate $\frac{1}{Time}$ against concentration. (3 marks

(i) Determine from your graph the concentration needed to produce 50cm³ of hydrogen gas, when time is 15 seconds. (1 mark)

Kenya Certificate of Secondary Education
233/3
CHEMISTRY
PAPER 3
(PRACTICAL)

1. You are provided with:-
(i) Solution M containing 1g of sodium hydroxide in 250cm³ of the solution.
(ii) 1.60g of a dibasic acid H_2Y labelled solid Z.
(iii) Phenolphthalein indicator You are required to:-
(a) Prepare 250cm³ of solution Z using solid Z.
(b) Determine the value of Y on the formular (H_2Y).

PROCEDURE I:

(i) Place all of solid Z in a 250cm³ beaker.
(ii) Add about 100cm³ of distilled water to the beaker and swirl until all the solid dissolves.
(iii) Transfer the solution into a 250cm³ volumetric flask.
(iv) Top up with distilled water to the mark and label it solution V.

Using a measuring cylinder transfer about 100cm³ of solution V into a 250cm³ beaker. Preserve the rest in the volumetric flask for procedure II.

(a) Pipette 25cm³ of solution M into a clean conical flask. Add 3 drops of phenolphthalein indicator to the 25cm³ solution in the conical flask.
(b) Fill the burette with solution V from the beaker.
(c) Titrate until the colour disappears.
(d) Repeat two more times and record your results in the table below.

Table I

Titre	1	2	3
Final burette reading (cm³)			
Initial burette reading (cm³)			
Volume of solution V used (cm³)			

(4 marks)

(a) Calculate the average volume of solution V used. (1 mark)
(b) Calculate the molarity of solution M. (Na = 23, O = 16, H = 1). (2 marks)
(c) How many moles sodium hydroxide were pipetted. (1 mark)
(d) How many moles of the acid, solution Z reacted with 25cm³ of solution M? (1 mark)
(e) How many moles of H_2Y were present in 1.60g of solid Z? (1 mark)
(f) Determine the value of Y in the formular H_2Y. (1 mark)

PROCEDURE II:

You are provided with:-

A thermometer
A stopwatch
0.02M acidified potassium manganate (III) solution H.
Solution V diabasic acid (H_2Y)

You are required to determine how the rate of reaction of solution H potassium manganate (III) with the dibasic acid (solution v) varies with change in temperature.

(i) Using a 10ml measuring cylinder place 1cm³ portions of solution H into five separate test tubes.
(ii) Using a burette place 19cm³ of solution V into a boiling tube and insert a thermometer.
(iii) Warm the solution until the temperature reaches 40 C.
(iv) Place the boiling tube in a test tube rack, then add the first portions of solution H and at the same time start the stopwatch.
(v) Record the time taken for the purple colour of the mixture to decolourise and record the time in table II below.
(vi) Repeat the experiment by using 19cm³ of solution V at temperatures 50 C, 60 C, 70 C and 80 C and complete the table below.

Table II

Temperature of solution V(C)	40 C	50 C	60 C	70 C	80 C
Time for colour to disappear (t) seconds					
$\frac{1}{t}$ sec^{-1}					

(4 marks)

(i) Using the grid provided plot a graph of $\frac{1}{t}$ sec^{-1} (y-axis) against temperature C. (3 marks)

(ii) From the graph determine the time taken for decolouration of the mixture if the temperature of the solution V was 65 C. (1 mark)

(iii) How does the rate of reaction of potassium manganate (VII) with dibasic acid H_2Y vary with temperature? (1 mark)

2. You are provided with solid W. Carryout the test below and record your observations and inferences. Take half a portion of the solid W, put it into a boiling tube and add about 10cm³ of distilled water and shake. Divide the resulting solution into three portions.

Observation	Inference
(1 mk)	(1 mk)

(i) To the first portion add aqueous ammonia drop wise full in excess.

Observation	Inference
(1 mk)	(1 mk)

(ii) To the second portion, scoop the solution carefully using a clean metallic spatula and introduce it to a non-luminous flame.

Observation	Inference
(1 mk)	(1 mk)

(iii) To the third portion add 2 drops of barium nitrate and retain contents for test (iv) below.

Observation	Inference
(1 mk)	(1 mk)

(iv) To the contents in (iii) above add 4 drops of hydrochloric and followed by 2 drops of acidified potassium manganate (VII).

Observation	Inference
(1 mk)	(1 mk)

3. You are provided with solid B. Carryout the test below and record your observations and inferences.

(i) Describe the appearance of the solid. (1 mark)

(ii) Scoop a portion of the solid using a clean metallic spatula and introduce it to a non-luminous flame.

Observation	Inference
(1 mk)	(1 mk)

(iii) To the remaining portion of solid B, add about 10cm³ of distilled water. Shake and divide the solution into three portions.

Observation	Inference
(½mk)	(½mk)

(iv) To the first portion add about 1cm³ of acidified potassium manganate(VII) solution.

Observation	Inference
(1mk)	(1 mk)

(v) To the second portion add about 1cm³ of acidified potassium dichromate (VI) solution.

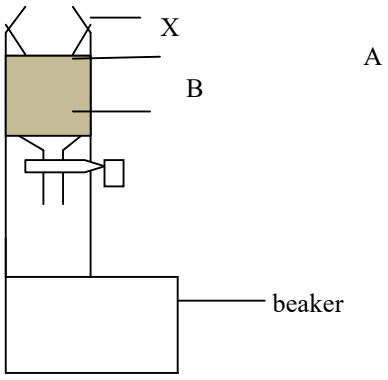
Observation	Inference
(1 mk)	(1 mk)

(vi) To the third portion; determine the PH of the solution.

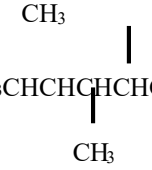
Observation	Inference
(1 mk)	(1 mk)

KCSE PREDICTION 7 2022
233/1
CHEMISTRY
PAPER 1
(THEORY)

1. The diagram below represents a method of separation used to separate two liquids A and B. use it to answer the questions that follow



a) Name two properties that makes it possible for the two liquids to be separated. (2mks)
b) Give one alternative method that may be used to separate the two liquids. (1mk)
2. Name the following organic compounds (2mks) a)



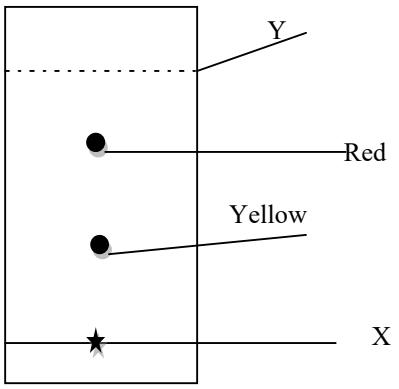
$CH_3CHCHCHCHCH_2CH_3$ .....

b)

$CH_3COOCH_2CH_2CH_2CH_3$ .....

3. Name the following processes;
   a) When anhydrous calcium chloride is left in an open beaker overnight a solution was formed. (1mk)
   b) When sodium carbonate decahydrate crystals are left in an open beaker for some days it turned into a powder. (1mk)

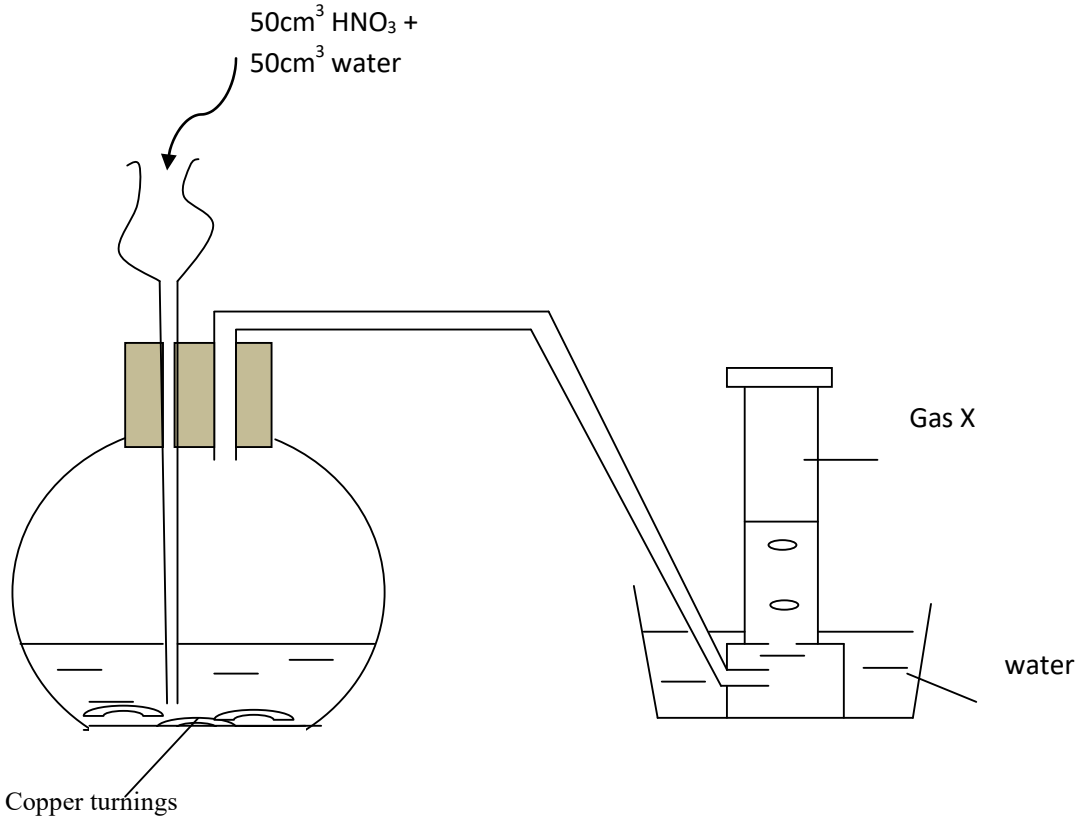
4. In 35 seconds, it was found that 140cm^3 of nitrogen (N_2) had diffused through a strip of porous porcelain. How long will it take 400cm^3 of carbon (IV) oxide to diffuse through the same strip of porous porcelain? (3mks)
5. The chromatogram below shows the constituents of a flower extract. Study it and answer the questions that follow



   a) Explain the different positions of red and yellow pigments. (2mks)
   b) What does lines X and Y represent (1mk)
6. Name the chief ore of iron and write its formula (2mks)
7. In an experiment, two pieces of iron sheets were wrapped in each case with zinc and copper metal sheets as shown below. They were left in the open for some months.

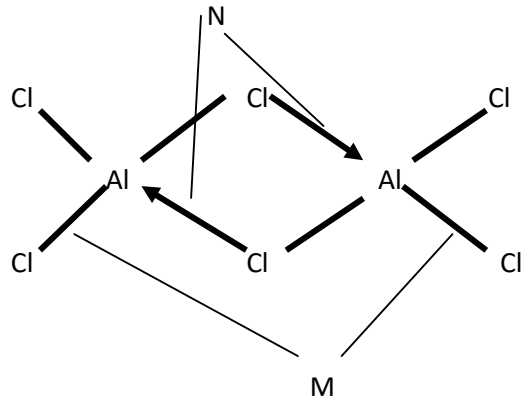


   State and explain the observations made in the experiments; (I), (II) (3mk)
8. Compare the atomic sizes of sodium and magnesium. Explain. (2mks)
9. The set up below was used to prepare gas X. study it and answer the questions that follow;



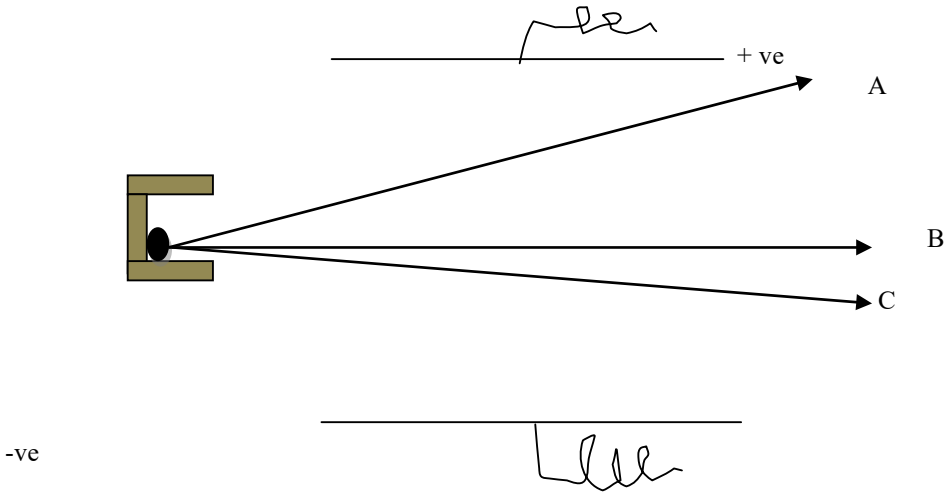
a) Name gas X (1mk)
b) Write an equation for production of gas X in the set up (1mk)
c) It"s hard to test whether gas X supports burning using a glowing splint. Explain. (1mk)

10. When solid M is dissolved in water, it dissolves and forms a blue solution. Addition of ammonia solution to this solution forms a blue precipitate which dissolves in excess to form a deep blue solution. Write the formula and name of the ion responsible for the deep blue solution. (2mks)
11. The diagram below represents the structure of aluminium chloride.



a) Identify the bonds labeled M and N. (2mk)
b) What Is the difference between bonds M and N (1mk)

12. Study the diagram below and answer the questions that follow



a) Name particles A and B

b) What property of B makes it not to be deflected by magnetic/electric field (1mk)

13. The table below shows the first ionization energies of elements Y and Z.

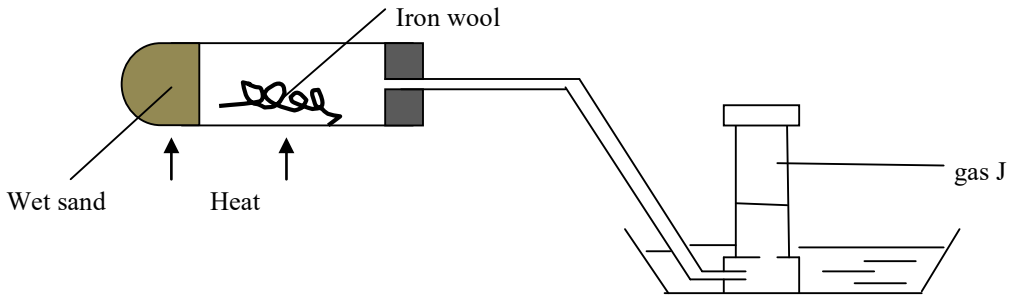
element	Ionization energy kJ/mol
Y	494
Z	418

a) What is ionization energy? (1mk)

b) Which of the two elements is the most reactive? Explain (2mks)

14. The standard enthalpies of combustion of ethyne (C_2H_2), carbon (c) and hydrogen (H_2) are -1300,-394 and -286 kJ/mol respectively. Calculate the enthalpy of formation of ethyne. (3mks)

15. Study the diagram below and answer the questions that follow.



a) Name gas J (1mk)

b) Explain why its important to heat the wet sand before heating the iron wool. (1mk)

c) Name the product formed in the combustion tube. (1mk)

16. An element X has a relative atomic mass of 44. When a current of 0.5 A was passed through the molten chloride of X for 32 minutes and 10 seconds, 0.22g of X were deposited at the cathode

Determine the charge on an ion of X (1F=96,500c) (3mks)

17. Study the reaction below and answer the questions that follow

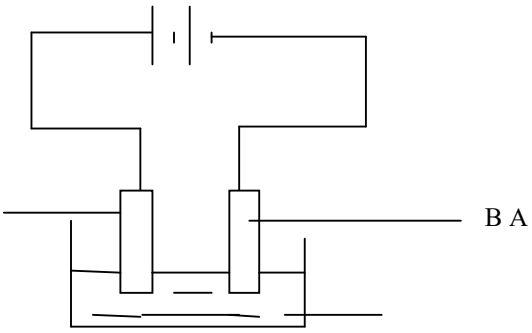
$$2NO_{2\,(g)} \rightleftharpoons N_2O_{4\,(g)} \qquad \Delta H = -ve$$

a) State and explain the observation made when a mixture at equilibrium is heated. (2mks)

b) If pressure is exerted at the mixture at equilibrium, what observation will be made? (1mk)

18. State and explain the trend in the boiling points of group (VII) elements down the group. (2mks)

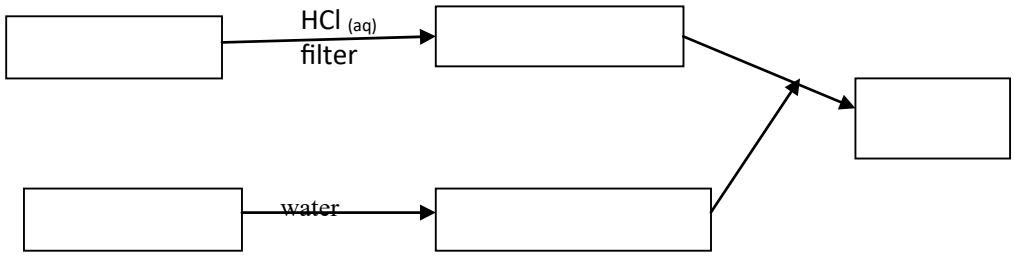
19. The diagram below shows electrolysis of dilute copper (II) sulphate solution using copper electrodes;



a) State the observations made at electrode A and B (2mks)

b) Write the equation of reaction at electrode A (1mk)

20. The flow chart shows a process of preparation of salt P.

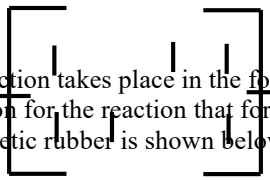


a) Name salt P. (1mk)

b) What type of reaction takes place in the formation of salt P. (1mk)

c) Write the equation for the reaction that forms salt P. (1mk)

21. The structure of synthetic rubber is shown below;



H
H
H

a) Determine the relative molecular mass of a polymer made of 250 monomers (2mks)
(c=12,H=1 and Cl=35.5)

b) Give one advantage of natural polymers over synthetic ones. (1mk)

C -

C = C - C

H Cl H n

22. 0.92g of ethanol were found to burn in excess air producing a temperature rise of 32.5C in 200cm^3 of water(C=12.0,H=1.0, O=16.0) Density of water is 1g/cm^3, specific heat capacity of water is 4.2KjKg^{-1}K^{-1}

(a) Write the equation for the combustion of ethanol (1mk)

(b) Determine the molar heat of combustion of ethanol
(2mks)

23.

a) The formula for cane sugar is ($C_{12}H_{22}O_{11}$). Use an equation to show what happens when sugar is added to conc. Sulphuric (VI) acid (1mk) b)

What name is given to the type of reaction above? (1mk)

c) Calculate the oxidation state of sulphur in sodium thiosulphate ($Na_2S_2O_3$) (1mk)

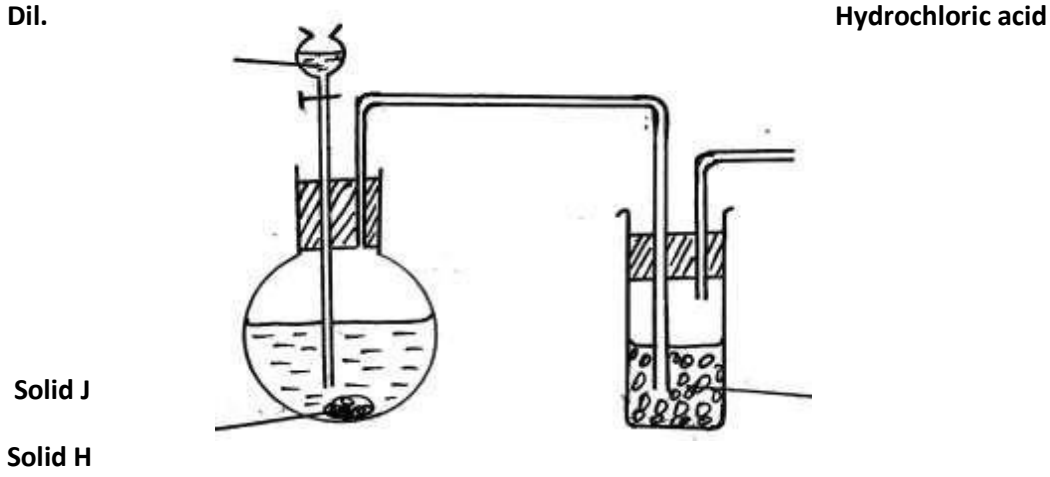
24. Iron (III) chloride can be prepared in the laboratory by passing dry chlorine gas over hot steel wool.

a) Name the above method of preparing salts (1mk)

b) Why should we prepare the salt in a dry environment? (1mk)

c) A solution of iron (III) chloride in water changes a blue litmus paper to red. Explain. (1mk)

25. The set-up below was used to prepare dry sample of hydrogen Sulphide gas



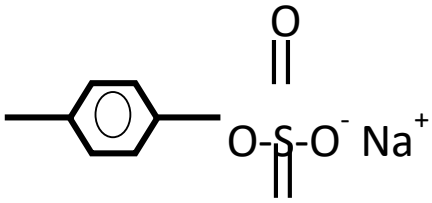
(a) (i) Complete the diagram to show how the gas was collected (2mks)

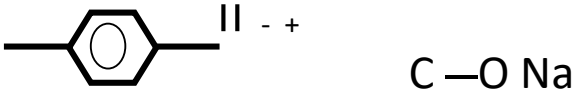
(ii) Identify the following

I: Solid H ($^1/_2$mk)

II.Solid J ($^1/_2$mk)

26. Study the structures below and answer the questions that follow.





a) Which structure represents a detergent suitable for washing in water containing calcium ions? (1mk)

b) Give one advantage of continued use of detergent B over A (1mk)

c) Name the process of manufacturing detergent B (1mk

27. Aluminium is used in making cooking vessels and overhead cables. State the property of aluminium that makes it suitable for the two uses separately.

Cooking vessels…… (½ mk)

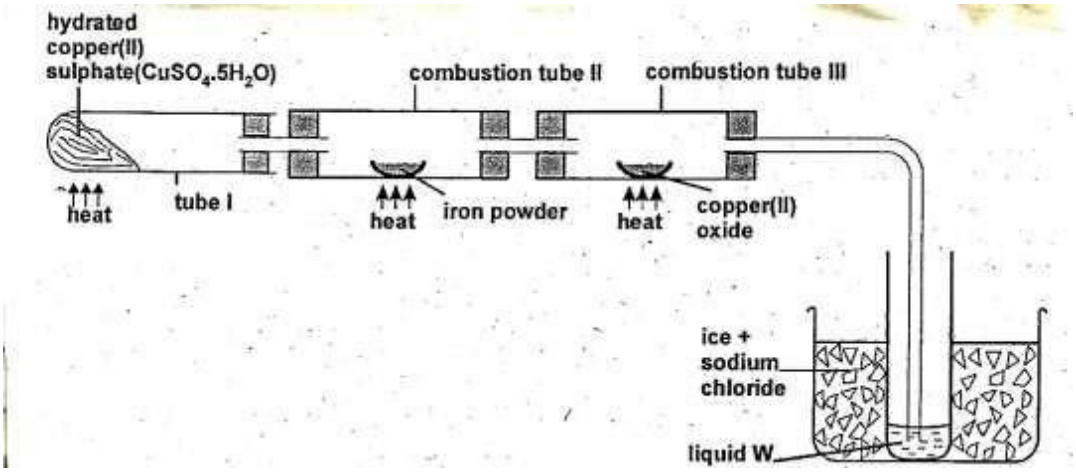
Overhead cables ……. (½ mk)

(b) Explain why it is not advisable to clean surfaces of cooking vessels made of aluminium using wood –ash solution (2mks)

28. 10g of an oxide of sodium contains 5.9g sodium. Its molar mass is 78. Determine its molecular formula. (3mks)
29. Differentiate between the terms atomic number and mass number (2mks)

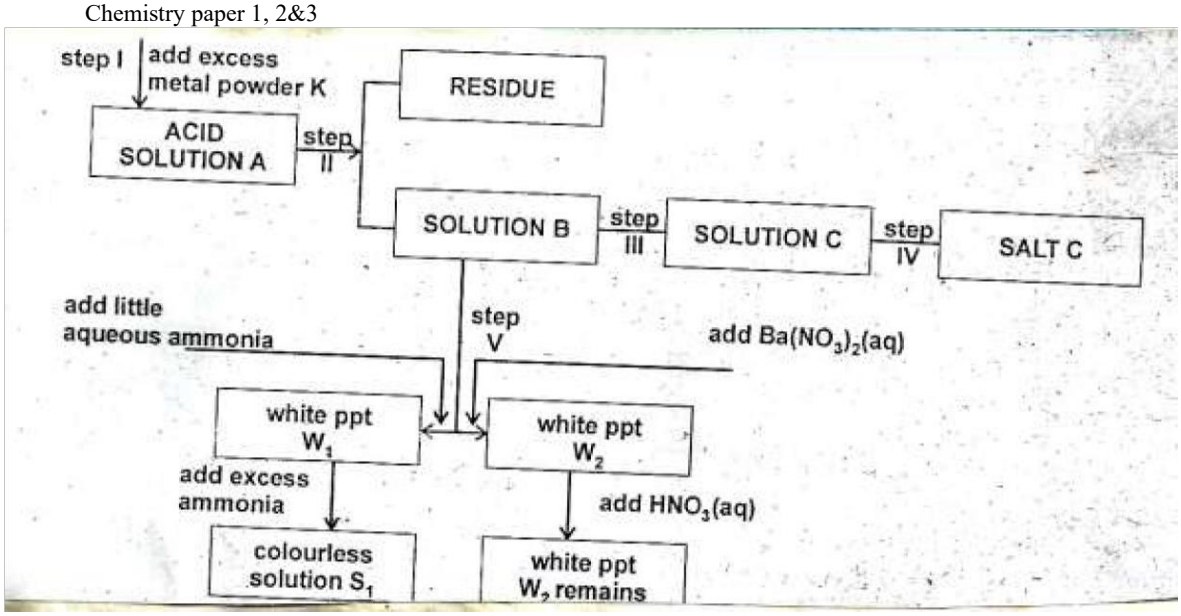
233/2
CHEMISTRY
PAPER II (THEORY)

1. The diagram below shows the apparatus for the preparation of gas A and investigate on its properties . Study it and answer the questions that follow.



a) (i) Name gas A. (1 mark)
(ii)Suggest the property of gas A under investigation. (1 mark) (iii) Write chemical equations for the reactions in the;
Boiling tube I (1 mark)
Combustion tube II (1 mark) b) (i) State and explain the observation made in
Tube I. (2 marks)
Combustion tube II (2 marks)
c) What is the use of hydrated copper (II) sulphate in the experiment? (1 mark)
(i) Name one other substance that comes out of tube III. (1 mark)
(ii) Name liquid W. (1 mark)
(iii) What is the role of sodium chloride in the ice (freezing mixture) (1 mark)
(iv) Explain why hydrogen gas has been replaced by helium in filling of aeroplane tyres. (1 mark)

2. The flow diagram below shows the reactions involved in the process for the preparation and reactions of salt C. Study it and answer the questions that follow.



a) Identify (3 marks) (i)
Metal K
(ii) Acid A
(iii) Salt C

b) In step III the solution B is transferred into an evaporation dish and heated in a water bath until it is saturated.
(i) What is a saturated solution? (1 mark)
(ii) Why is heating done over a water bath? (1 mark)
(iii) How would one determine whether a solution is saturated? (1 mark) c) Explain why metal powder K is used in excess. (1 mark)

d) Name step (II) and state its importance. (1 mark)

e) Identify (3 marks)
(i) White precipitate W_1
(ii) White precipitate W_2
(iii) Colourless solution S_1

f) Write equations for step I and for the formation of S1
Equation step I (1 mark)
Formation of S_1 (1 mark)

3. a. (i) Sulphur is allotropic. What does this mean? (1 mark)

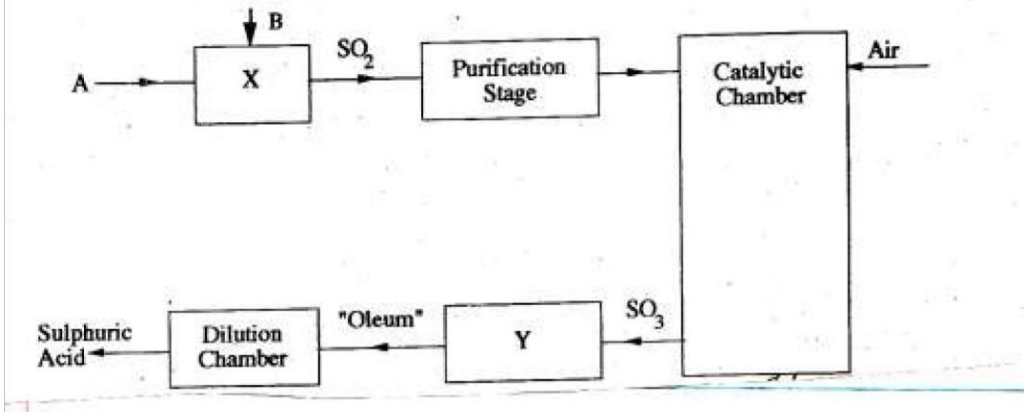
(ii) Give two differences between rhombic and monoclinic sulphur. (2 marks)

(iii) State and explain using an equation the observations made when sulphur reacts with hot concentrated nitric (v) acid. (3 marks)

Observations

Equation

The flow chart below shows how sulphuric acid is manufactured in a large scale. Study it and then answer the questions that follow.



I. (i) Name the raw materials A and B. (2 marks)

(ii) Name the chambers X and Y. (2 marks)

II. (i) Name two impurities that are removed during the purification stage. (2 marks)

(ii) Why must the impurities in (i) above be removed. (1 mark) III.

(i) Name the catalyst used in this process. (1 mark)

(ii) The equation below shows what happens in the catalytic chamber.

$$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_3 \qquad \Delta H = -197KJ/Mol$$

State the two conditions that are necessary for maximum production of SO_3 (1 mark)

4. a) Define the term standard heat of formation of a substance. (1 mark)

b) Butane cannot be prepared directly from its elements and so it"s standard heat of formation (ΔH_f) must be obtained indirectly. Write down an equation;

(i) For the formation of butane from it"s elements in their normal physical states at standard condition of temperature and pressure. (1 mark)

(ii) For the combustion of 1 mole of butane. (1 mark) c) (i) State the Hess"s law. (1 mark) If the following heats of combustion are given.

ΔH_c^{θ} carbon(s) = -393Kj/Mol

ΔH_c^{θ} $H_{2(g)}$ = 286Kj/Mol

ΔH_c C_4H_{10} = -2877 Kj/Mol

II. Draw an energy cycle diagram linking the heat of formation of butane with its heat of combustion and the heat of combustion of constituent elements. (2 marks)

III. Calculate the heat of formation of butane ΔH_f^{θ} (C_4H_{10}) (2 marks)

d) Use the equations below to answer the questions that follow.

$$MX_{(s)} \longrightarrow M^{n+}_{(g)} + X^{p-}_{(g)}$$

$$M^{n+}_{(g)} \xrightarrow{\text{water}} M^{n+}_{(aq)}$$

$$X^{p-}_{(g)} \xrightarrow{\text{water}} X^{p-}_{(aq)}$$

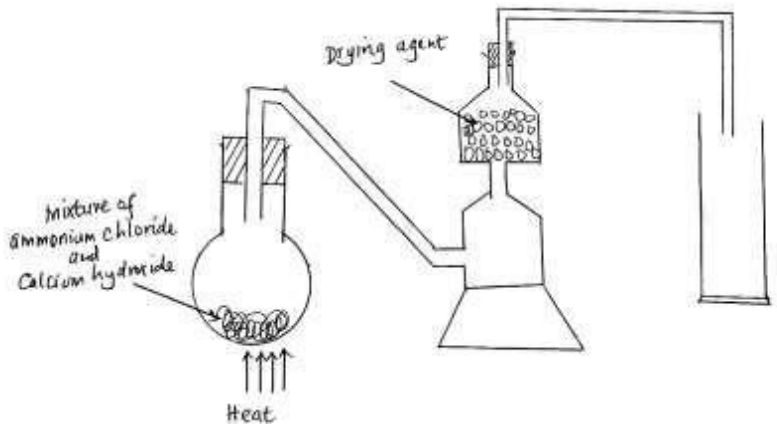
(i) Name the types of enthalpy changes represented by

ΔH_1 ..... (1 mark)

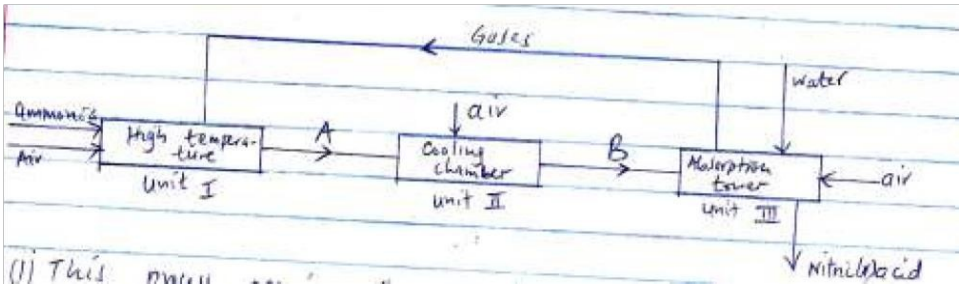
ΔH_2 ..... (1 mark)

(ii) Given that enthalpy change of ΔH_l is +690Kj/Mol, and ΔH_2 and ΔH_3 are -322Kj and -364Kj respectively, Calculate the enthalpy change of solution of $MX_{(s)}$. (2 marks)

5. A student set up the apparatus as shown in the diagram below to prepare and collect dry ammonia gas.



a) Identify two mistakes in the set up and give a reason for each mistake. (2 marks)
b) Name a suitable drying agent for ammonia. (1 mark)
c) Write an equation for the reaction that occurred when a mixture of ammonium chloride and calcium hydroxide was heated. (2 marks)
d) Ammonia gas is used in the manufacture of nitric (v) acid as shown below;



(i) This process requires the use of a catalyst. What is the name of catalyst used and in which unit is the catalyst used? (2mks) -

Catalyst –
- Unit;-

(ii) Identify compounds A and B. (2 marks)
(iii) Ammonia and nitric (v) acid are used in the manufacture of ammonium nitrate fertilizer. Calculate the amount of nitric
(iv) (v) acid required to manufacture 1000kg of ammonium nitrate using excess ammonia (N = 14.0, H = 1, O=16) (3 marks)
(v) Nitric (v) acid is packed in dark containers. Explain. (1 mark)

6. During the extraction of copper from copper pyrites ($CuFeS_2$) some of the processes include
a) Crushing the ore
b) Mixing the crushed ore with water and oil and then bubbling air through it. c) Roasting the ore

---

A. (i) Name two other ores that can be used. (2 marks)
(ii)Name the process marked (b) above and give its use. (2mks)
Name -
Use -
(iii) Write an equation for the roasting of copper pyrites. (1 mark)
B. (i) Pure copper is obtained from impure copper by electrolysis. Name the; (3 marks)
Anode ……
Cathode…….
Electrolyte…….
(ii)Write equations for the reactions at (2 marks)
I Anode…….
II Cathode……..
(iv) Calculate the time taken for a current of 10 amps to deposit 32g of pure copper (Cu=64, IF = 96500c) (3 marks)
C. Give one use of copper metal (1 mark)

233/3
CHEMISTRY
PAPER 3

CONFIDENTIAL

In addition to the apparatus and fittings found in the laboratory, each student will require the following:

1. About 80cm^3 of solution A
2. About 100cm^3 of solution B
3. About 70cm^3 of solution C
4. 1 pipette
5. 1 burette
6. 3 conical flasks (250ml)
7. A 250ml volumetric flask
8. 1 thermometer (-10º C to 110ºC)
9. 8 test tubes
10. 2 boiling tubes
11. 10ml measuring cylinder
12. 7 labels
13. a test-tube holder
14. Solid G (about 0.3g)
15. Solid T (about 0.3g)
16. Glass rod
17. Metallic spatula
18. Solid sodium hydrogen carbonate (about 0.2g)
19. 500 ml distilled water Access To:

1. Bunsen burner
2. methyl orange indicator supplied with a dropper
3. Bromine water supplied with a dropper
4. 2M sodium hydroxide supplied with a dropper
5. Aqueous Barium nitrate supplied with a dropper
6. 2M Nitric (v) acid supplied with a dropper 7. universal indicator supplied with a dropper
8. PH scale chart.
9. Acidified potassium manganate (vii) supplied with a dropper.
10. Acidified potassium dichromate (vi) supplied with a dropper.

NB:

Solution A is prepared by dissolving 55ml of concentrated sulphuric (vi) acid in one litre of solution.

Solution B is prepared by dissolving 8g of anhydrous sodium carbonate in one litre of solution Sodium C is prepared by dissolving 80g of sodium hydroxide in one litre of solution.

Bromine water is prepared by dissolving 1cm^3 of 20 volumes bromine water in 100cm^3 of solution.

Acidified potassium manganate (vii) is prepared by dissolving 3.16g of $KMnO_4$ in 600cm^3 of $2MH_2SO_4$ and made to one litre solution.

Acidified potassium Dichromate (vi) is prepare by dissolving 6g of $K_2Cr_2O_7$ in 600cm^3 of $2MH_2SO_4$ and made to one litre solution.

2M bench reagent of Sodium hydroxide is prepared by dissolving 80g of sodium hydroxide in one litre of solution.

Nitric (v) acid (2) is prepared by dissolving 126Ml in one litre of solution.

Barium nitrate solution is prepared by dissolving 0.05g in one litre of solution. Solid G = hydrated sodium carbonate

Solid T = Maleic acid.

CHEMISTRY
PAPER 3
PRACTICAL

- You are provided with Aqueous sulphuric (vi) acid ,solution **A**
- 4.0g in 500 cm^3 of sodium carbonate , solution **B**
- An aqueous solution of substance **C**,solution **C** You are required to determine the;
- Concentration of solution **A**
- Enthalpy of reaction between sulphuric (vi)acid and substance **C** **Procedure A**

Transfer 25.0$cm^3$of the solution A into 250 ml conical flask using a pipette .Add water to make 250cm^3 of solution .Label this as solution D .Place solution D in a burette.

Clean the pipette and use it to place 25.0cm^3 of solution B into conical flask .Add 3 drops of methyl orange indicator provided and titrate with solution D .Record your result in table I below .Repeat the titration two more times and complete the table I below. Table I

	I	II	III
Final burette reading			
Initial burette reading			
Volume of solution D used (cm3)			

(4 mrks)

Calculate the

(i) Average volume of solution **D** used (1mrk) ii)

Concentration of sodium carbonate ,solution **B** in moles per Littre (Na=23,C=12,O=16) (1mrk)

i) Concentration of sulphuric (vi) acid in solution **D** in moles per litre (2mrks)

(iv) Concentration of Sulphuric (vi) acid in solution **A** in moles per litre

(1mrk) **PROCEDURE B**

Label six test tubes as 1, 2,3,4,5, and 6.Using a measuring cylinder, measure 2cm^3 of solution **A** into test –tube number 1, 4cm^3 in test –tube number 2. Continue with this process for all the other test tubes as shown in **table II** below.

Clean the burette and fill it with solution **C**. From the burette, Place 14$cm^3$of solution **C** into a boiling tube .Measure the initial temperature of this solution and record it in the **table II** below to the nearest 0.5c. Add the content of test tube number 1 to the boiling tube containing solution **C** . Stir the mixture with thermometer and record the highest temperature reached in table II below .Repeat the process with the other sample of solution **C** given in the table II and complete the table.

Table II

Test tube number	1	2	3	4	5	6
Volume of solution **A**(cm^3)	2	4	6	8	10	12
Volume of solution **C** (cm^3)	14	12	10	8	6	4
Highest temperature of mixture (^{o}c)						
Initial temperature of solution C (^{o}c)						
Change in temperature ,ΔT (^{o}c)						

(4mrks)

(i) On the grid below ,draw a graph of ΔT(vertical axis)against volume of solution **A** (3mrk)

(ii) From the graph ,determine ;

(i) The maximum change in temperature

(ii)The volume of A required to give the maximum change in temperature (1mrk)

(II) Calculate the

(i)Number of moles of sulphuric (vi) required to give the maximum temperature change. (1mrk)

(II) Molar enthalpy of reaction between sulphuric (vi) acid and substance C in kilojoules per mole of sulphuric (vi) acid. (Specific heart capacity =4.2J/g/k, density of solution =1.0g/cm^3) (2mrks)

2 . You are provided with solid **G**.Carry out the tests below and write your observation and inferences in the spaces provided.

a)Place a third of solid **G** into a dry ,Clean test tube .Heat gently and then strongly .

Observation	inference
(1 mk)	(1 mk)

b) Place the remaining solid in a boiling tube and add about $10cm^3$ of distilled water and shake well.Divide the mixture into 4 portions

(i) To the 1st portion, add 5drops of sodium hydroxide solution

Observations	inference
(1 mrk)	(1 mrk)

(ii)Dip one end of a glass rod into the 2nd portion and burn it on a non-luminous flame

Observation	inference
(½ mk)	(½ mrk)

(iii)

a) To the 3rd portion ,add 5 drops of barium nitrate provided .(Retain for use in (iii)b)

Observations	inference
	(1 mrk)

(1mrk)

b) To the mixture in (iii) a) above, add about $2cm^3$ of dilute nitric (v) acid provided.

Observation	inference
(1mrk)	(1mrk)

(iv)To the 4th portion, add 5drops of acidified potassium dichromate (vi)

Observation	inference
(½ mark)	(½ mrk)

3 You are provided with solid T .Carry out the tests below and record your observations and inference In the spaces provided. a) Using a metallic spatula 1/3 of the solid T on a non-luminous Flame.

Observation	inference
(1mrk)	(1mrk)

b) Place the remaining solid in a boiling tube .Add about $10cm^3$ of distilled water and shake until the solid dissolves . Divide the mixture obtained into 5 portion ,

(i)To the 1st portion, add solid sodium hydrogen carbonate provided.

Observation	inference
(1/2mrk)	(1/2mrk)

(ii)To the2nd portion, add 3 drops of universal indicator.

Observation	inference
(½ mrk)	(½ mrk)

(iii)To the 3rd portion, add 3 drops of acidified potassium manganate (vii)

Observation	inference
(1mk)	(1mrk)

(iv) To the 4th portion ,add 4drops of acidified potassium dichromate (vi)

Observation	inference
(1mrk)	(1mrk)

(v)To the 5th portion, add 4 drops of bromine water.

Observation	inference
(½ mrk)	(½ mrk)

KCSE PREDICTION 8 2022
CHEMISTRY
233/1
PAPER 1
(THEORY)

1. Element A and B with atomic numbers 12 and 17 respectively react together.

(a) Write the electronic configurations of each.

A _____ (1 mark)

B _____ (1 mark)

(b) Write the formula of the compound formed between A and B.

2. When a compound X was heated, a brown gas and a black residue were produced. Give the formula of:

(i) The brown gas. _____ (1 mark)

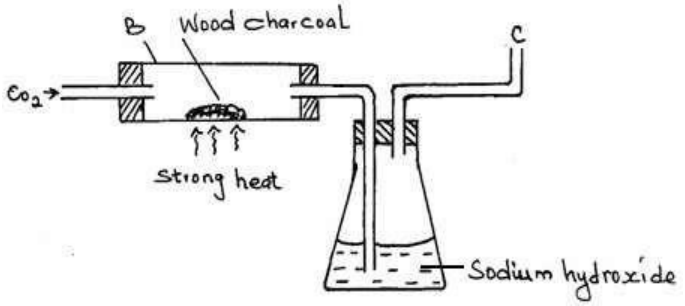
(ii) The black residue. _____ (1 mark)

3. 20cm³ of a dibasic acid required 25cm³ of 0.1M NaOH for complete neutralization.

(a) How many moles of sodium hydroxide reacted with the dibasic acid? (1 mark)

(b) Calculate the concentration of the dibasic acid in moles per litre. (2 marks)

4. The set-up was used to prepare carbon (IV) oxide and investigate its properties.



(a) Write an equation for the reaction in vessel B. (1 mark)

(b) What is the role of sodium hydroxide solution in the set-up? (1 mark)

(c) What would be observed if a burning splint is introduced at jet C? (1 mark)

5. Write down the property of concentrated sulphuric (VI) acid shown in the following reactions.

(a) $H_2C_2CO_4.2H_2O_{(S)} \xrightarrow{H_2SO_4\ l} 2H_2O_{(l)} + CO_{2(g)} + CO_{(g)}$

Property _____ (1 mark)

(b) $C_{(S)} + 2H_2SO_{4(S)} \rightarrow CO_{2(g)} + 2H_2O_{(l)} + 2SO_{2(g)}$

Property _____ (1 mark)

6. When 25cm³ of 0.5M HCl is added to 25cm³ of 0.5M NaOH the temperature of the solution rose from 23 C to 26 C. Given that the density of the solution is $1gcm^{-3}$ and its specific heat capacity is $4.2Jg^{-1}K^{-1}$.

(a) Determine the amount f heat evolved that caused the temperature rise. (1 mark) (b) Work out the molar enthalpy of neutralization for this reaction. (2 marks)

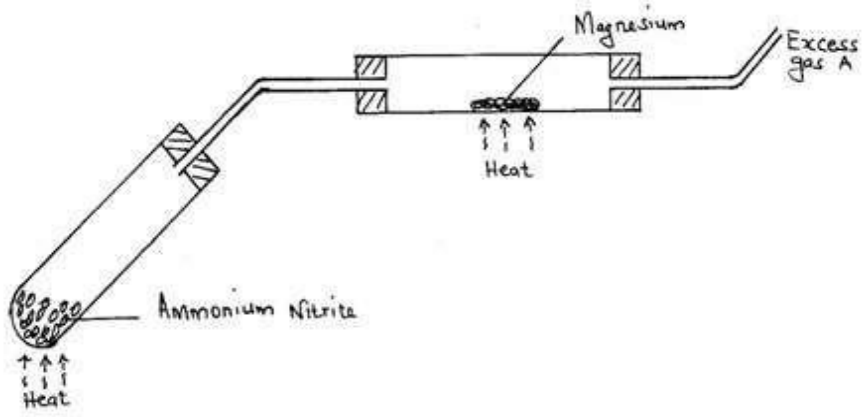
7. The empirical formula of a compound is CH_2 and its molecular mass is 42.

(a) What is the molecular formular of this compound? (1 mark)

(b) To which group of hydrocarbons does the compound above belong? (1 mark)

(c) Draw the structural formula of the fourth member of this series and give its IUPAC name. (1 mark)

8. The set-up below shows how gas A was prepared and reacted with heated magnesium.



(a) Give a reason why it is not advisable to heat magnesium before heating ammonium nitrite. (1 mark)

(b) (i) Identify gas A. (1 mark)

(ii) Write a chemical equation for the reaction between gas A and magnesium. (1 mark)

9. In the down‟s process (used for extraction of sodium) a certain salt is added to lower the melting point of sodium chloride from 800 C to about 600 C.

(i) Identify the salt added. (1 mark)

(ii) Why is it necessary to lower the temperature? (1 mark)

(iii) Give **one** use of sodium. (1 mark)

10. Consider the following reaction at equilibrium.

$PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$

Complete the table below to show the effect of different factors on the position of equilibrium. (3 marks)

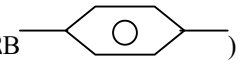
	Factor	Effect on the equilibrium position
(i)	Decrease pressure	
(ii)	Remove chlorine	
(iii)	Adding helium gas to the mixture	

11. (a) State Graham‟s Law of diffusion. (1 mark)

(b) 100cm³ of sulphur (IV) oxide takes 20 seconds to diffuse through a porous plate. What volume of oxygen gas would diffuse through the same plate in 30 seconds under similar conditions. (S = 32, O = 16). (2 marks)

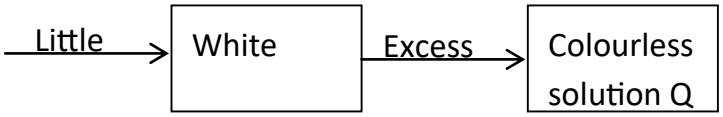
12. Element X contains isotopes with mass number 16 and 18 respectively existing in the ratio1:3 calculate the relative atomic mass of X. (2 marks)

13. The structures shown below represents two cleansing agents A and B.

RCOO (A) $^{-}Na^{+}$ (RB ) $OSO_3\ Na$

(a) Identify the cleansing agent B. (1 mark)
(b) Which cleansing agent would be more suitable for washing in water containing magnesium sulphate? Explain. (2 marks)

14. Study the reaction scheme below and answer the questions that follow.



$Al_2(SO_4)_{3(aq)}$

precipitat

(a) Write an ionic equation for the formation of the white precipitate. (1 mark)
(b) Write the formula of the complex ion present in the colourless solution Q. (1 mark)

15. Study the table below and use it to answer the questions that follow.

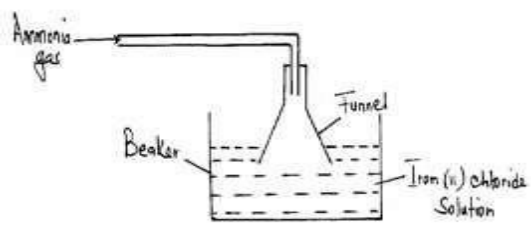
Solution	PH
A	3.5
B	14
C	8.5

(i) In which of the solution will phenolphthalein indicator be colourless. (1 mark)
(ii) Which of the solutions could be used to relieve heartburn? Explain. (2 marks)

16. Starting with dilute sulphuric (VI) acid, dilute nitric (V) acid and lead (II) carbonate powder, describe how you can prepare a dry sample of lead (II) sulphate. (3 marks)

17. (a) 384g of radioactive element was reduced to 48g in 540 days. Determine the half-life of X. (2 marks)
(b) Give **one** use of radioactive isotopes in industries. (1 mark)

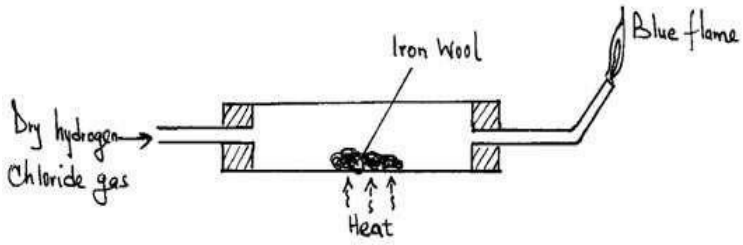
18. The diagram below is a set-up of apparatus used to react ammonia gas with iron (IV) chloride solution.



(a) State the observation made in the beaker after a few minutes. (1 mark)
(b) Explain why the funnel is used to deliver the ammonia into the solution. (1 mark)

19. (a) A mass of 40g of a saturated solution of potassium chlorate at 25 C yields 14g of potassium chlorate when evaporated to dryness. Calculate the solubility of potassium chlorate at 25 C. (2 marks)
(b) State **one** advantage of hard water. (1 mark)

20. Dry hydrogen chloride gas was passed over heated iron wool as shown below.



(a) State the observation made in the combustion tube at the end of the experiment. (1mk)
(b) Write the equation for the reaction taking place:-
(i) In the combustion tube. (1 mark)
(ii) Leading to production of the blue flame. (1 mark)

21. A dry cell is constructed using the following substances. Zinc metal, graphite rod, ammonium chloride paste and manganese (IV) oxide mixed with carbon powder.
(a) State the roles of:
(i) Ammonium chloride paste. (1 mark)

(ii) Manganese (IV) oxide mixed with carbon powder. (1 mark)

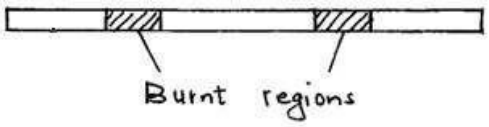
(b) Given that: $2NH_{4\ aq} \quad 2e \quad 2NH_{3\ g} \quad H_{2\ g} \quad E \quad 0.74V$

and $Zn_{\ aq2} \quad 2e \quad Zn_{\ s} \quad E$ ■ $0.76V$

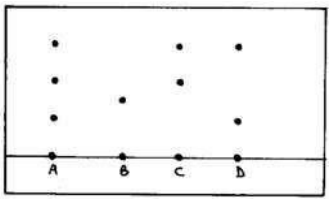
Calculate the e m f of the cell given zinc forms the negative electrode. (1 mark)

22. 1.26g of lead powder were dissolved in excess nitric (VI) acid to form lead nitrate solution. All the lead nitrate solution was reacted with sodium sulphate solution.
(a) Write an ionic equation for the reaction between lead nitrate and sodium sulphate solutions. (1 mark) (b) Determine the mass of lead salt formed in (a) above (Pb = 207, S = 32, O = 16). (2 marks)
23. The figure below shows a burning splint that was put across the middle of a non-luminous flame. Explain the results.

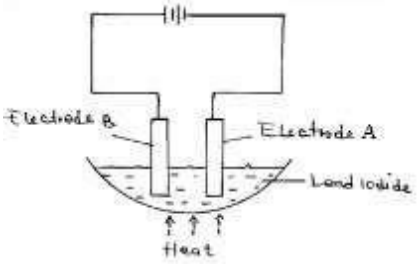
(2 marks)



24. The following chromatogram was obtained in an experiment to investigate the components present in certain dyes.



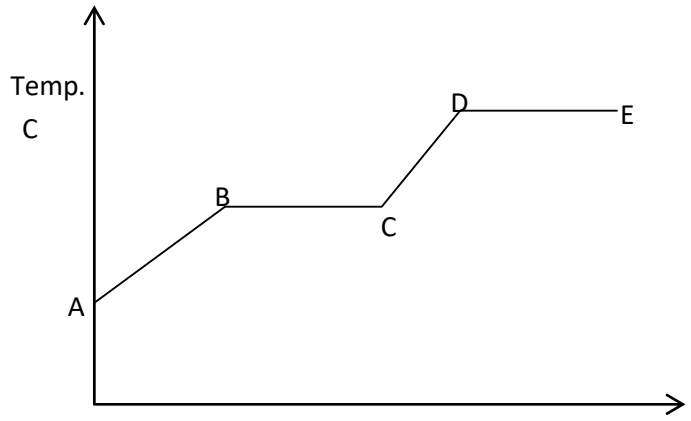
(a) Which two dyes when mixed would produce A? (1 mark)
(b) Which dye is pure? (1 mark)
(c) Indicate on the diagram the solvent front. (1 mark)
25. (a) Draw a dot (.)/cross (X) diagram to show bonding in C_2^1O. (Cl = 17, O = 8). (1 mark)
(b) In terms of structure and bonding explain why the component C_2^1O has a very low melting and boiling point. (2 marks)
26. Solid J reacts with cold water but solid K does not. L reduces the oxide of M but does not reduce the oxide of K. Arrange the elements in order of reactivity starting with the most reactive. (2 marks)
27. The figure below shows a set-up used in electrolysis of lead iodide.



(a) Why is heating necessary? (1 mark)
(b) Write the equation of the reaction that occurs at the cathode. (1 mark)
(c) At which electrode does reduction occurs. (1 mark)

28. 3.22g of hydrated sodium sulphate, $Na_2SO_4.XH_2O$ were heated to a constant mass of 1.42g. Determine the value of X in the formula. (Na = 23.0, S = 32.0, O = 16.0, H = 1). (3 marks)

29. The curve shown below was obtained when solid naphthalene was heated to boiling.



(a) Explain in molecular terms the changes occurring in portions.
(i) AB. (1 mark)
(ii) DE. (1 mark)
(b) What is the significance of portion BC? (1 mark)

30. Use the equation below to answer the questions that follow.

$$Cr_2O_{7\ aq}^{2} \quad OH_{\ aq} \quad 2CrO_{4\ aq}^{2} \quad 2H_2O_{\ l}$$

Using oxidation numbers show where reduction has taken place. (2 marks)

Kenya Certificate of Secondary Education
233/2
CHEMISTRY
PAPER 2
(THEORY)

1. (a) Study the table below and answer the questions that follow.

Element	Atomic radius (nm)	Ionic radius (nm)	Formula of oxide	Melting point of oxide (C)
A	0.364	0.421	A_2O	-119
B	0.830	0.711	BO_2	837
E	0.592	0.485	E_2O_3	1466
G	0.381	0.446	G_2O_5	242
J	0.762	0.676	JO	1054

(i) Which elements are non-metals? Give a reason. (3 marks)
(ii) Explain why the melting point of the oxide of **E** is higher than that of the oxide of **G**. (2 marks)

(iii) Give **two** elements that would react vigorously with each other. Explain your answer. (2 marks) (b) Study the information below and answer the questions that follow. The letters do not represent the actual symbols of the elements.

Element	Electronic Configuration	Ionization energy KJ/mol	
		1st I.E	2nd I.E.
X	2.2	900	1800
Y	2.8.2	736	1450
Z	2.8.8.2	590	1150

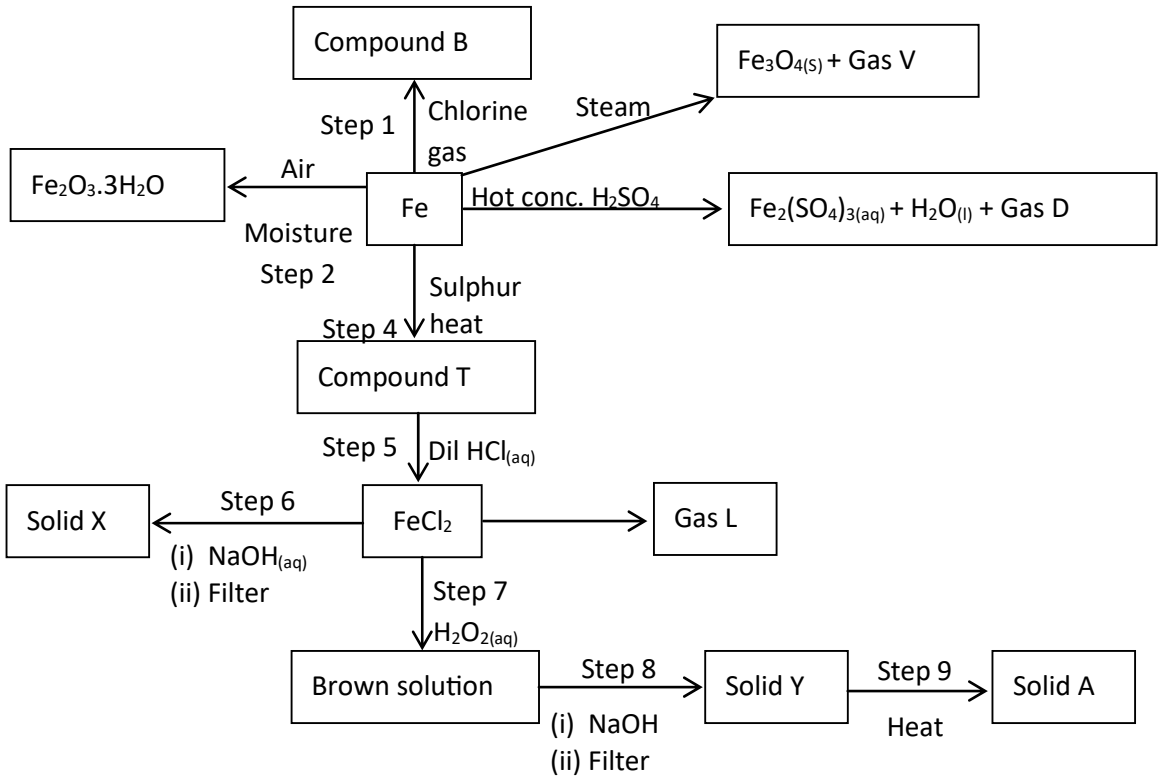
(i) What chemical family does the elements **X**, **Y** and **Z** belongs? (1 mark)

(ii) What is ionization energy? (1 mark)

(iii) The 2nd ionization energy is higher than the 1st ionization energy of each element. Explain. (1 mark)

(iv) When a piece of element Z is placed in cold water, it sinks to the bottom and effervescence of a colourless gas that burns explosively is produced. Use a simple diagram to illustrate how this gas can be collected during this experiment. (2 marks)

2. Study the flow chart below starting from iron metal and answer the questions that follow.



(a) Identify gases. (1½ marks)

(b) Identify the following substances. (2½ marks)

(i) Compound **B** _____

(ii) Compound **T** _____

(iii) Solid **A** _____

(iv) Solid **Y** _____

(v) Solid **X** _____

(c) What name is given to the reaction in Step **2**? _____ (1 mark)

(d) State the colour of solid **X**. _____ (1 mark)

(c) Write balanced equations for the reactions that occurred in

Step 1. (1 mark)

Step 5. (1 mark)

(f) What property of hydrogen peroxide (H_2O_2) is indicated in Step 7? (1 mark)

3. (a) One mole of heptane was thermally cracked, two hydrocarbons Q and P were formed. Q was an alkene molecule with three carbon atoms.

(i) Give the molecular formula of.

I Q (1 mark)

II P (1 mark)

(ii) Write the structural formula of Q. (1 mark)

(iii) Name the compound formed when Q undergoes self-addition reaction. (1 mark)

(iv) State **one** disadvantage of using the product named in a(iii) above. (1 mark)

(vi) Cracking can also be achieved using less amount of heat in the presence of a catalyst. Name one catalyst that is often used. (1 mark)

(b) An organic compound J has the following percentage by mass, carbon 64.86%, hydrogen 13.51% and the rest is oxygen. The relative molecular mass of the compound is 74. C = 12, O = 16, H = 1)

(i) Work out the molecular formula of compound J. (3 marks) (ii) To which homologous series does compound J belong? (1 mark)

(iv) Write a balanced chemical equation for the reaction that occurs when compound J reacts with sodium metal. (1 mark)

(iv) Name the type of reaction indicated in b(iii) above. (1 mark)

(v) Name the organic compound formed when J reacts with excess acidified potassium managanate (VII). (1 mark) 4. 2.5g of a pure metal carbonate MCO_3 was reacted with excess 2M nitric (V) acid.

The volume of carbon (IV) oxide evolved was measured and recorded at 10 second intervals. The results were recorded as shown in the table below.

Volume of gas (cm^3)	0	90	150	210	280	340	390	450	480	480	480
Time (seconds)	0	10	20	30	40	50	60	70	80	90	100

(a) (i) On the grid provided, plot a graph of volume (vertical axis) against time – Label it curve A. (3 marks)

(ii) From your graph determine the rate of reaction between 25 seconds and 40 seconds. (2 marks)

(iii) On the same axes, sketch a curve that would be obtained if the same experiment was repeated using excess 1M nitric (V) acid. Label it curve B. (1 mark)

(iv) Give that carbon (IV) oxide was measured at room temperature and pressure, work out the relative atomic mass of metal M. (Molar gas volume at r.t.p = $24dm^3$, C = 12, O = 16). (3 marks)

(b) When bromine is dissolved in water the equilibrium shown below is established.

$$Br_{2\,aq} \quad H_2O \rightleftharpoons \underbrace{Br_{aq} \quad OB_{aq} \quad 2H_{l\,aq}}$$

(Yellow) (Colourless)

State and explain the observation that would be made if aqueous sodium hydroxide was added to the equilibrium mixture. (2 marks)

5. (a) Use the standard electrode potentials for elements A, B, C, D and F given below to answer the questions that follow.

			E (Volts)
A_{aq2}	$\rightleftharpoons$	A $2e_{(S)}$	-2.90
B_{aq2}	$\rightleftharpoons$	B $2e_{(S)}$	-2.38
$C_{(aq)} \quad e$	$\rightleftharpoons$	D $_2C_{2\,g}$	0.00
D_{aq2}	$\rightleftharpoons$	F $2e_{(S)}$	+0.34
$1F \quad e_{(aq)}$			+2.87
$2_{2\,g}$			
—			

(i) Which element is likely to be hydrogen? Give a reason for your answer. (2 marks)

(ii) What is E of the strongest reducing agent? (1 mark)

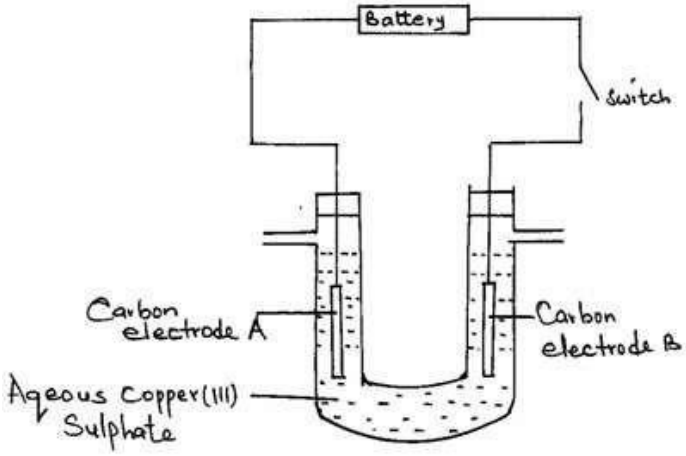
(iii) Calculate the e.m.f of the cell that would be formed when half cells of B and D are combined. (b) (1 mark)

Aqueous copper (II) sulphate was electrolysed using the set up below.

(i) When the switch was closed a gas was produced only at electrode B. Which electrode is the anode? (1 mark)

(ii) Write the half equation for the reaction occurring at electrode B. (1 mark)

(iii) What happens to the PH of the electrolyte during electrolysis? Explain. (2marks)



(vi) If carbon electrodes were replaced with copper electrodes in the cell above, write the equation of the reaction that would occur at the anode. (1 mark)

(c) During electrolysis of aqueous copper (II) sulphate using copper electrodes a current of 0.2 amperes was passed through the cell for 5 hours. Determine the change in mass of the cathode that occurred as a result of the electrolysis process. (Cu = 64, IF = 96500 coulombs). (3 marks)

6. (a) State Hess"s law. (1 mark)

(b) Use the following information to answer the questions that follow:

$C_{(S)} + O_{2(g)} \rightarrow CO_{2(g)} \quad H = -393KJ/mol$ 1

$H_{2(g)} + \frac{1}{2} O_{2\ g} \rightarrow H_2O_{(g)} \quad H = -296KJ/mol$

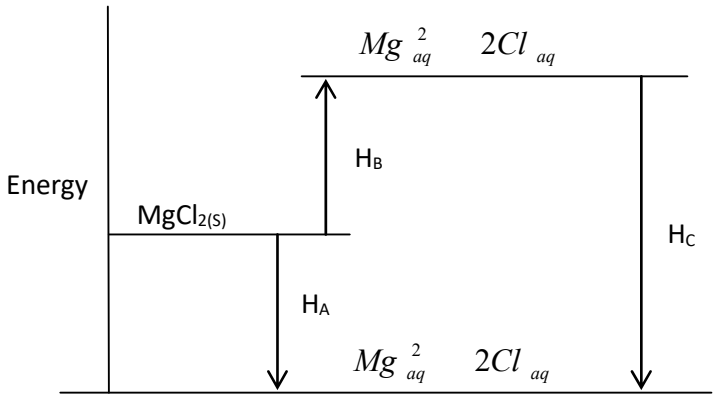
$C_4H_{10} + \frac{13}{2} O_{2\ g} \rightarrow 4CO_{2(g)} + 5H_2O \quad H = -2877KJ/mol$ 2

(i) Draw an energy cycle diagram relating heat of formation and combustion of butane. (2 marks)

(ii) Calculate the heat of formation of butane. (3 marks)

(c) Distinguish between hydration energy and lattice energy. (2 marks)

(d) The diagram below shows an energy level diagram for the formation of magnesium chloride. Study it and answer the questions that follow.



(i) State the enthalpy changes represented by

A _____ (½ mark)

B _____ (½ mark)

C_____ (½ mark)

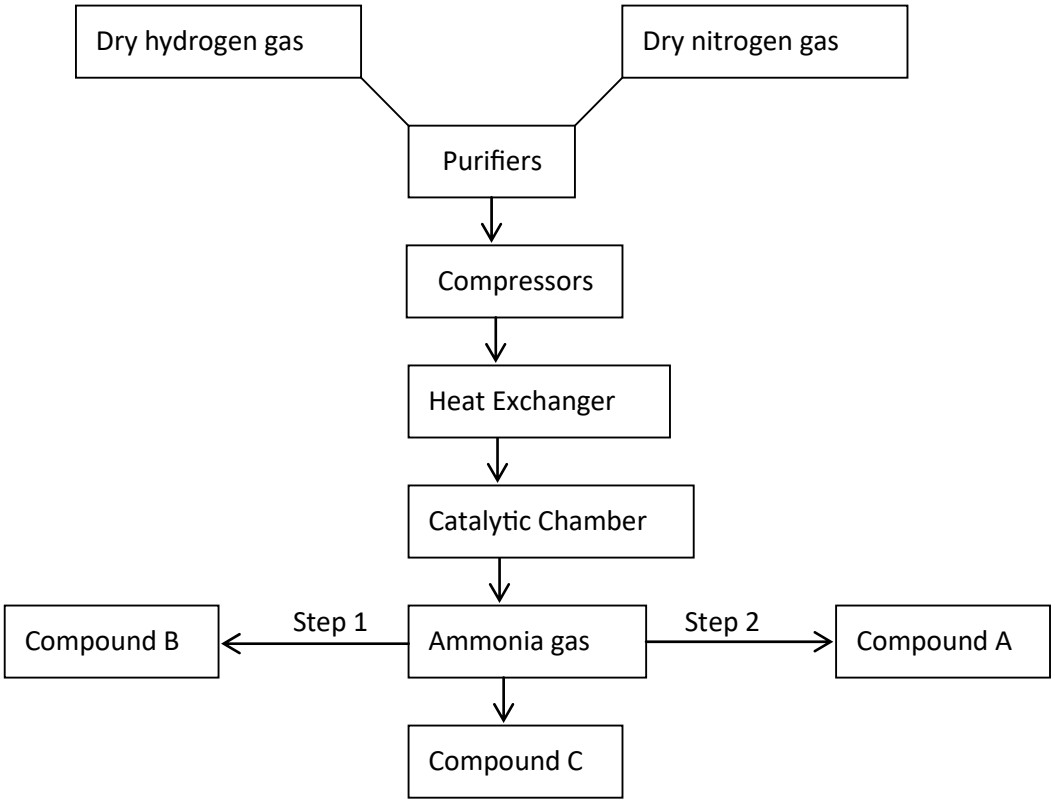
(ii) What is the relationship between H_A, H_{BA} and H_C. (½ mark)

(e) Define heat value of a fuel. (1 mark)

(f) Give **two** reasons why wood and charcoal are chosen for domestic heating. (2 marks)

---

7. The flow chart below shows the large scale manufacture of ammonia gas and some ammonium compounds. Study it and answer the questions that follow.



(a) What are the sources of the following raw materials?

(i) Hydrogen gas. (1 mark)

(ii) Nitrogen gas. (1 mark)

(b) What optimum conditions are needed during the manufacture of ammonia in the

(i) Compressor. (1 mark)

(ii) Catalytic chamber. (1 mark)

(c) Why should the gas be passed through the compressor. (1 mark)

(d) Write an equation for the reaction that occurs in Step **1**. (1 mark)

(e) Write the formula of the compound **B**. (1 mark)

(f) Calculate the percentage of nitrogen in compound **A**. (2 marks)

(g) What observation would be made if compound C was added to a sample suspected to contain copper (II) ions drop wise then in excess? (2 marks)

233/3
CHEMISTRY
PAPER 3
(PRACTICAL)
CONFIDENTIAL
Each candidate requires:

1. Solution A, 60cm³ of 2.5M HCl
2. Solution B, 100cm³ of 0.05M NaOH
3. Solid C, 10cm magnesium ribbon.
4. 10ml measuring cylinder.
5. 25ml pipette.
6. 50ml Burette.
7. Complete stand.
8. Stopwatch.
9. 2 labels.
10. Distilled water.
11. 6 test tubes.
12. 0.5g sodium hydrogen carbonate.
13. 5cm³ Ethanol.
14. 1-14 PH chart.
15. Solid R, 1g Oxalic Acid.
16. Solid Q, Mixture of $(NH_4)_2SO_4$ and $Al_2(SO_4)_3$ (Ratio 1: 1).
17. Pipette filler.
18. Phenolphthalein indicator.
19. 250ml conical flasks (2).
20. 250ml volumetric flask.
21. 1 boiling tube.
22. 1 spatula.

ACCESS TO:

23. Universal indicator solution.
24. Acidified potassium manganate (VII) solution.
25. Bromine water.
26. Conc. Sulphuric (VI) acid with a dropper.
27. Means of heating.
28. 2M Lead (II) nitrate solution.
29. 2M Dilute nitric (V) acid solution.
30. 0.5M Barium nitrate solution.
31. 2M Sodium hydroxide solution.
32. 2M Aqueous ammonia.
33. 2M Hydrochloric acid.

Kenya Certificate of Secondary Education
233/3
CHEMISTRY
PAPER 3
(PRACTICAL)

1. You are provided with:
- Solution A, Dilute hydrochloric acid.
- Solution B, made by dissolving 0.5g of sodium hydroxide in water and made to 250cm³ of solution.
- Solid C, Magnesium ribbon.
- Phenolphthalein indicator.

You are required to:

(i) Standardize solution A.

(ii) Determine the rate of reaction between solution A and maganesium.

PROCEDURE I:

(i) Measure exactly 10cm³ of solution A using a burette and transfer into a 250ml volumetric flask. Top up to the mark using distilled water. Label this solution D.

(ii) Drain the remaining solution A in the burette, rinse the burette thoroughly and fill the burette with solution D.

(iii) Pipette 25cm³ of solution B into a conical flask. Add three drops of phenolphthalein indicator.

(iv) Titrate solution D with solution B. Record your results in the table below. Repeat procedures (i) to (iv) to complete the table.

	1	2	3
Final burette reading (cm³)			
Initial burette reading (cm³)			
Volume of base, solution A used (cm³)			

(3 marks)

(a) Calculate the average volume of solution D used. (1 mark)

(b) Calculate:

(i) Number of moles of solution B reading. (1½ marks)

(ii) Number of moles of solution D in 250cm³ of solution. (1½ marks)

(iii) Molarity of solution A. (1 mark)

PROCEDURE II:

(i) Cut solid C into equal pieces, each 2cm long.

(ii) Using a burette, measure 12cm³ of solution A, into a clean boiling tube.

(iii) Drop one piece of solid C into the boiling tube containing solution A and start the stopwatch immediately. Stop the stopwatch when all solid C has just reacted. Record your results in the table below.

(iv) Repeat steps (ii) and (iii) above using 10cm³, 8cm³, 6cm³ and 4cm³ of solution A. Top up each with distilled water to make12cm³ of solution and complete the table below.

(4 marks)

Volume of Solution A (cm³)	Volume of distilled water (cm³)	Concentration of solution A (moles/l)	Time(s)	$\frac{1}{t}$
12	0			
10	2			
8	4			
6	6			
4	8			

(a) Plot a graph of $\frac{1}{t}$ (y-axis) against the concentration of solution A.

(b) From the graph, determine the time taken for the reaction to reach completion when 1.5 moles of solution A are used. (2 mark)

(c) Comment on the shape of the graph. (1 mark)

2. You are provided with solid Q. Carry out the tests below and record your observations and inferences in the spaces provided. (a) Strongly heat a spatula-end full of solid Q in a dry test tube.

Observation	Inference
(1 mk)	(1 mk)

(b) (i) Place the remaining solid Q in a boiling tube. Add 10cm³ of distilled water. Divide the solution into five portions.

Observation	Inference
(½mk)	(½mk)

(ii) To the first portion, add aqueous lead (II) nitrate solution.

Observation	Inference
(½mk)	(½mk)

(iii) To the second portion, add dilute nitric (V) acid, followed by bar ium nitrate solution.

Observation	Inference
(½mk)	(½mk)

(iv) To the third portion add a few drops of sodium hydroxide until in excess.

Observation	Inference
(1 mk)	(1mk)

(v) To the fourth portion, add a few drops of aqueous ammonia until is excess.

Observation	Inference
(1 mk)	(½mk)

(vi) To the fifth portion, add a fe w drops of hydrochloric acid. Warm the contents.

Observation	Inference
(1 mk)	(½mk)

3. You are provided with solid R. Carry out the tests belo w and record your observations and inferences.

(a) Place a spatula-end full of solid R in a dry boiling tube and add about 10cm³ of distilled water. Shake thoroughly and heat to boil. Divide the solution into five portions.

Observation	Inference
(1mk)	(½mk)

(b) (i) Test the first portion with the universal indicator solution provided.

Observation	Inference
(½mk)	(1 mk)

(ii) To the second portion, add a few drops of acidified potassium manganate (VII) solution.

Observation	Inference
(1 mk)	(1 mk)

(iii) To the third portion, add a few drops of bromine water.

Observation	Inference
(1 mk)	(1mk)

(iv) To the fourth portion, add half spatula of sodium hydrogen carbonate.

Observation	Inference
(½mk)	(½mk)

(iv) To the fifth portion in a boiling tube, add 5cm³ of ethanol followed by a few drops of concentrated sulphuric (VI) acid. Warm the mixture.

Observation	Inference
(1 mk)	(½mk)

KCSE PREDICTION 9 2022
(The Kenya Certificate of Secondary Education)
233/1
CHEMISTRY
Paper 1

1. What is the importance of the shape of a conical flask? (1 mark)
2. A mixture consists of sulphur powder and iron filings.
(i) Describe how to obtain sulphur from the mixture using methylbenzene. (2 marks)
(ii) Is the mixture homogeneous or heterogeneous? Explain. (1 mark) 3. Nitrogen gas can be prepared in the laboratory using a mixture of ammonium chloride solution and sodium nitrite solution.
(a) The reaction occurs in two steps. State the two steps in the correct order. (2 marks)
(b) State two uses of nitrogen. (1 mark) 4. (a) Draw structural formulae of two positional isomers with molecular formula C_4H_8. (2 marks) (b) Study the equation below and answer the questions that follow. $C_6H_{14} + Cl_2 \longrightarrow C_6H_{13}Cl + HCl$
(i) State the condition under which this reaction occurs. (1 mark)
(ii) Give the general name of this type of reaction. (1 mark)
5. (a) Define hydration energy. (1 mark) (b) Given that: the hydration energies of Ca^{2+} and Cl^- are -1891 kJ mol^{-1} and -384 kJ mol^{-1} respectively, and that the lattice energy of calcium chloride is +2237 kJ mol^{-1}.Calculate the molar enthalpy change of solution of calcium chloride. (3 marks)
6. The standard electrode potentials of a metal G and iron are given below.
$Fe^{2+}(aq) + 2e \longrightarrow Fe(s)$ -0.44V
$G^{2+}(aq) + 2e \longrightarrow G(s)$ -0.91V
A piece of iron is coated with metal G. If the coating is scratched, would the iron be protected form rusting? Explain. (3 marks)
7. (a) Why is the percentage of carbon (IV) oxide in the atmosphere fairly constant? (1 mark)
(b) Calculate the volume of carbon(IV)oxide in 8,000 m^3 of air contained in a hall. (2 marks) 8. State two conditions that would make the boiling point of water to be higher than 100°C. (2 marks)
9. Explain the effects of the accumulation of nitrogenous compounds in water masses? (2 marks)
10. Study the table below and use it to answer the questions that follow. (The letters do not represent the actual symbols of the elements).

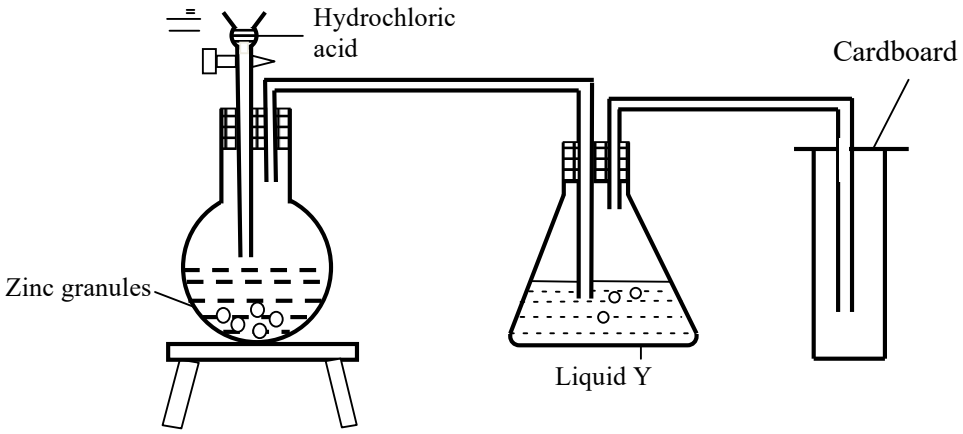
Element	Q	R	S	T	U
Atomic number	5	20	3	18	5
Atomic mass	10	40	7	40	11

(a) Select two letters that represent the same element? Give a reason. (2 marks)
(b) Give the number of neutrons in an atom of element S. (1 mark)
11. Dry carbon (II) oxide gas was passed over heated lead (II) oxide.
(a) Write an equation for the reaction. (1 mark)
(b) Give one industrial application of the above reaction. (1 mark)
(c) Name another gas that can be used in the above reaction. (1 mark)
12. (a) Proteins are obtained from amino acids monomers. Complete the equation below to show the polymer formed. (1 mark)

2 2 2 3 H

(b) Name the type of polymerization shown above. (1 mark)
13. The set up below was used to prepare dry hydrogen gas. Study it and answer the questions that follow.

NCH COOH + H NCHCH COOH ⟶



(i) With a reason, identify the mistake in the set-up above. (1 mark)

(ii) What would be liquid Y? (1 mark)

(iii) Give two physical properties of hydrogen gas (1 mark)

14. Study the following equilibrium equation.

$2X_2(g) + Y_{2(g)} \rightleftharpoons 2X_2Y_{(g)}$ H = -197kJ/mol

(a) Suggest two ways of increasing the yield of X_2Y. (1 mark)

(b) Draw the energy level diagram for the forward reaction. (2 marks)

15. 5.0g of calcium carbonate were allowed to react with 25cm^3 of 1.0M hydrochloric acid until there was no further reaction. Calculate the mass of calcium carbonate that remained unreacted. (3 marks)
(Ca = 40, C = 12, O = 16)

16. (a) State Graham"s law of diffusion. (1 mark)

(b) 50cm^3 of Carbon (IV) Oxide diffuses through a porous plate in 15 seconds. Calculate the time taken by 75cm^3 of Nitrogen (IV) Oxide to diffuse through the same plate under similar conditions. (C = 12, 0 = 16, N = 14) (2 marks)

17. A student fetched water from a river in a limestone area. He used it for washing and realized that it did not lather easily. (i) Name the two ions that prevent lathering. (1 mark)

(ii) Given that the structure of soap is $C_{17}H_{35}COONa$.
Explain by means of ionic equations how the above ions prevent lathering. (2 marks)

18. A student burnt magnesium ribbon in a gas jar full of sulphur (IV) oxide gas.

(i) State two observations made in the gas jar. (2 marks)

(ii) Write an equation for the reaction that took place. (1 mark)

19. M grams of a radioactive isotope decayed to 5 grams in100 days. The half-life of the isotope is 25 days.

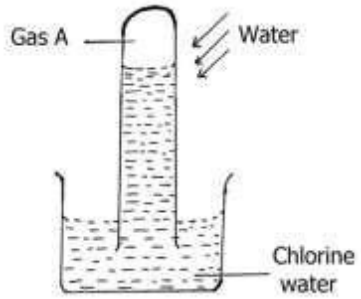
(a) What is meant by half life? (1 Mark)

(b) Calculate the initial mass M of the radioactive isotope. (2 Marks)

20. (i) With the aid of a well labeled diagram, show that the innermost region of a non-luminous flame consist of unburnt gas. (1½ marks)

(ii) Highlight the steps followed when lighting a Bunsen burner. (1½ marks)

21. The diagram below shows an experiment involving chlorine water.

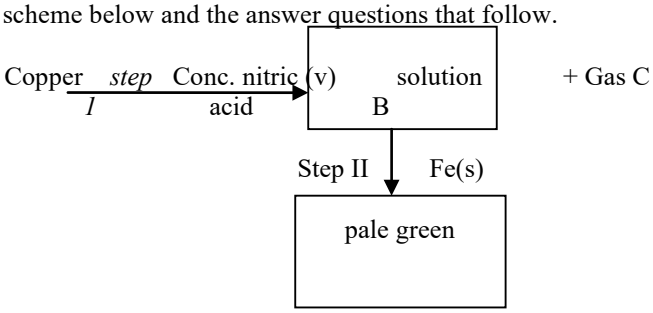


a) State and explain the observations made after 24 hours. (2 marks)

b) Write an equation to show the formation of gas A. (1mark)

c) State one use of chlorine gas. (1mark)

22. Study the reaction scheme below and the answer questions that follow.



solution.

(i) Identify: (2mark)

Solution B

Gas C

(ii) What type of reaction is taking place in step II (1mark)

23. a) Define solubility. (1 mark)

b) In an experiment to determine the solubility in water at 30^{0}c, the following results were obtained.

Mass of empty evaporating dish = 26.2g

Mass of evaporating dish + saturated solution = 42.4g.

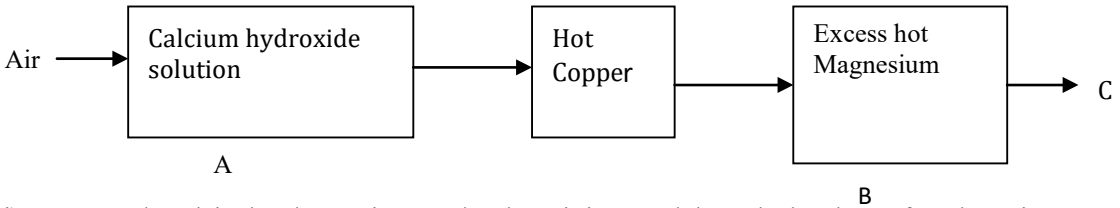
Mass of evaporating dish + dry solid Y = 30.4g

Use this data to calculate the solubility of Y at 30^{0}C. (3 marks)

24. In terms of structure and bonding. Explain why water (H_2O) is a liquid at room temperature while Hydrogen sulphide (H_2S) is a gas. (2 marks)

25. Explain why hard water flowing in lead pipes may be safer for drinking than soft water flowing in the same pipes. (2 marks)

26. Air was passed through reagents as shown below.



i) State and explain the observations made when air is passed through chamber A for a long time. (2 marks)

ii) Name one component in Explain (1 mark)

27. Using dots (·) and crosses (x), draw the dimer structure of aluminum chloride and name the bonds. (Al=13, Cl=17) (2 marks)

28. Iron is extracted from its ore by the blast furnace process.

a) Name the chief ore from which iron is extracted from. (1 mark)

b) An ore is suspected to contain mainly iron. Describe a method that can be used to confirm the presence of iron in the ore. (2 marks)

233/2
CHEMISTRY
Paper 2
(Theory)

1. The figure below represents a section of the periodic table. Study it and answer questions **(a)** to **(h)**. Note that the letters do not represent the actual symbols of the elements.

A							D	
B			G	J		F	H	E
C							I	

(a) Consider elements D, H and I

(i) Give the chemical family of these elements. (1 mk)

(ii) How do their ionic size compare. (1 mk)

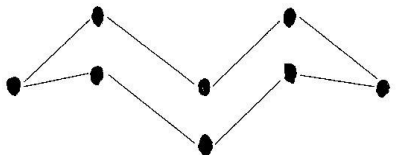
(iii) Compare and explain the reactivity of the three (2 mks)

elements. (b) (i) Write the electronic configuration of:

Element H (1 mk)

(ii) The ion of element G. (1 mk)

(c) A molecule of one of the elements is shown below. (2 mks)



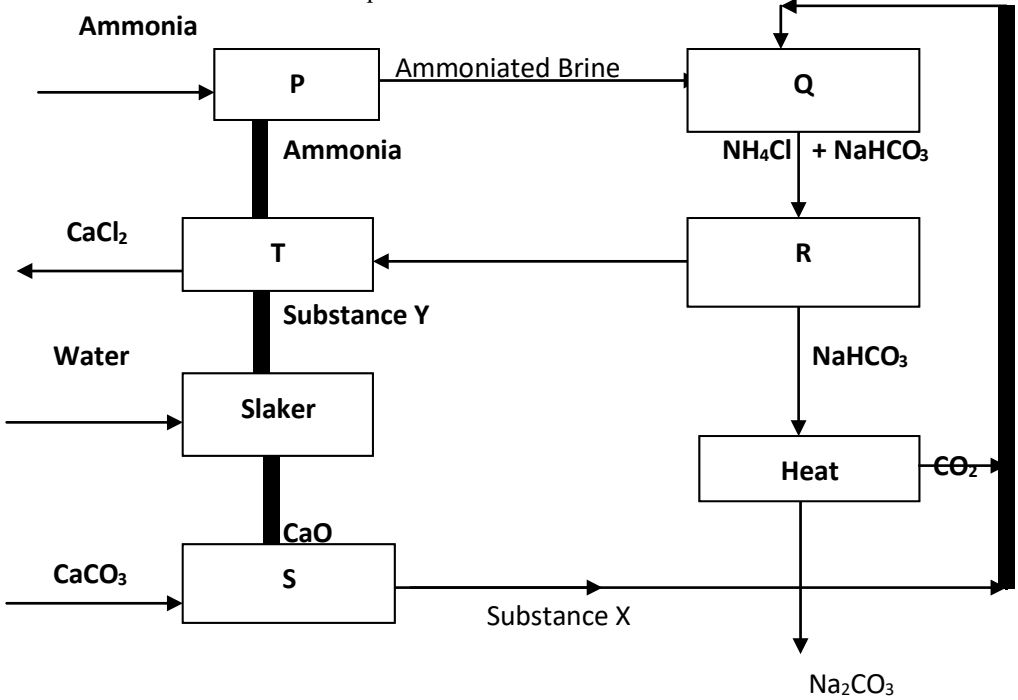
(i) **Identify** this element from the section of the periodic table and give its actual **symbol** and **name.** (2 mks)

(ii) Explain why this element has a higher boiling point compared to that of oxygen. (2 mks)

(iii) Write an equation to show the reaction between the element named above with oxygen. (1 mk)

(iv) Predict the pH of the oxide of the above element when in water. (1 mk)

2. Use the flow chart below to answer the questions that follow.

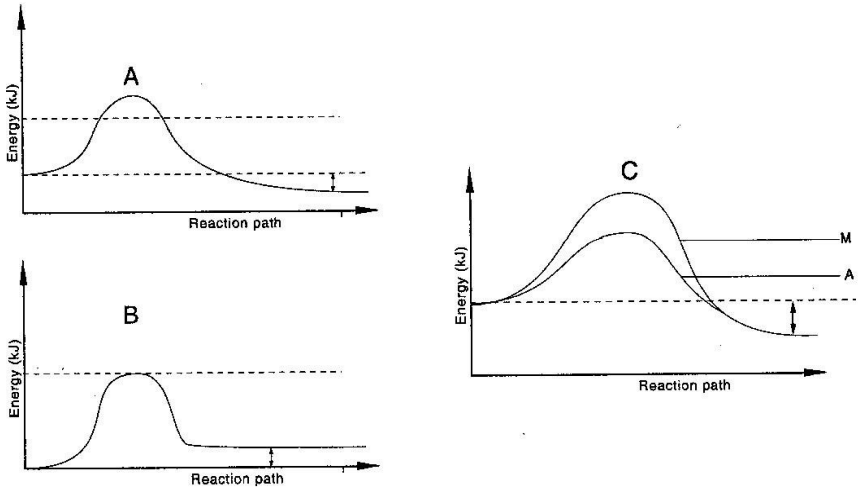


(a) Name the substances labelled: X and Y (2 mks)

(b) Name 2 substances being recycled in the process represented by the flow chart. (2 mks)

(c) Name the process that takes place in: S and R (2 mks)
(d) Give 2 uses of calcium chloride. (1 mk)
(e) Write equations for the reaction that take place in: Q and T (2 mks)
(f) Using ionic equation explain how sodium carbonate can be used to soften hard water. (2mks)
(g) Other than softening of hard water give 2 other uses of sodium carbonate. (1 mk)

3. Consider this group of reaction energy profiles for some dfferent reactions (A, B, C).



(a) Which reaction(s) is: (2 mks)
(i) exothermic
(ii) Endothermic
(b) Explain why the activation energy of A in diagram C is lower than the activation energy of M in the same diagram. (1 mk)
(c) In an experiment to determine the heat of combustion of methanol. CH_3OH, a student set up apparatus as shown in the diagram below. Study the set up and the data and answer the questions that follow.



Volume of water	=	$100cm^3$
Final temperature of water	=	22.0^0c
Initial temperature of water	=	36.0^0c
Final mass of lamp an methanol	=	84.75g
Initial mass of lamp and methanol	=	85.10g
Density of water	=	1 g/cm^3

(S.H.C of water = 4.2 $g^{-1}K^{-1}$)
(i) Write an equation for the combustion of methanol. (1 mk)
(ii) Calculate:
(a) Number of moles of methanol used in this experiment. (1 mk)
(b) The heat change for this experiment. (1 mk)
(c) The heat of combustion per mole of methanol. (1 mk)
(d) Explain why the molar heat of combustion for methanol obtained above is different from the theoretical value. (1 mk)
(e) State two factors to consider when choosing a fuel. (1 mk)
(f) Outline two disadvantages of using hydrogen as a source of fuel. (1 mk)
4. (a) Give the IUPAC names of the following organic compounds. (2 mks)

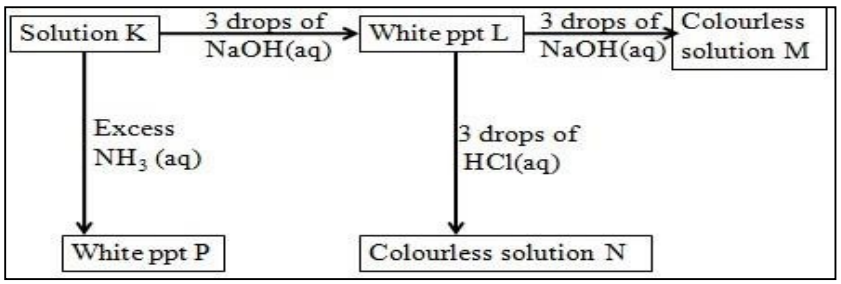
(i) $CH_3 - CH_2 - CH - CH_3$
$\quad\quad\quad

(b) The copper obtained from chamber **N** is not pure. Draw a labeled diagram to show the set up you would use to refine the copper by electrolysis. (3 mks)

(c) Given that the mass of copper obtained from the above extraction was 210kg, determine the percentage purity of the ore (copper pyrites) if 810kg of it was fed to the 1st roasting furnace. (Cu = 63.5, Fe = 56, S = 32.0) (2 mks)

(d) Give 2 effects that this process could have on the environment. (2 mks)

6. Study the scheme below and use it to answer the questions that follow:



(a) Write the formula of:

(i) Cation in solution K (1 mk)

(ii) White precipitate L (1 mk)

(iii) Colorless solution M (1 mk)

(iv) Colorless solution N (1 mk)

(v) White precipitate P (1 mk)

(b) Write the ionic equation for the reaction for the formation of white precipitate L. (1 mk)

(c) What property of **L** is illustrated in the formation of colorless solution M and N. (1 mk)

(d) Electrical conductivity decreases when temporary hard water is heated. Explain. (2 mks)

(e) When excess iron fillings were dissolved in dilute sulphuric (IV) acid, a pale green solution was obtained. The solution was filtered and divided into two portions.

(i) Write an equation for the reaction (1 mk)

(ii) To the first portion aqueous ammonia was added till in excess. State observation made. (1 mk).

(iii) Write an ionic equation for the reaction in (ii) above. (1 mk)

7. a) State the Faraday"s law of electrolysis (1mk)

b) Calculate how long it would take an aqueous gold (III) chloride cell to coat 2.5 g of gold on a bracelet using a current of 2.5 A. The half reaction has been provided for you.

(Au = 197)

(3mks)

$$Au^{3+}_{(aq)} + 3e^- \longrightarrow Au_{(s)}$$

c) Two half-cells are connected under standard conditions to make an electrochemical cell.

The two half-cells are a copper-copper (I) ion (**Cu/Cu^+**) and an aluminum-aluminum ion **(Al/Al^{3+}).** Using your the Standard Reduction Potentials below answer. $Al^{3+}_{(aq)} + 3e^- \rightarrow Al_{(s)}$ **-1.66 V**

$Cu^+_{(aq)} + e^- \rightarrow Cu_{(s)}$ **+ 0.52 V**

(i) Write the cell representation for the cell obtained when the two half cells are connected. (2mks)

(ii) Identify the reaction that takes place at the anode and at the cathode. (2mks)

(iii) Calculate the emf for the above cell (1mk)

(iv) Write the overall balanced redox reaction for the electrochemical cell. (1mk)

d) An excess of copper solid is dropped into a solution which contains $AgNO_3$, $Fe(NO_3)_3$ and $Zn(NO_3)_2$. Write the equations for any reduction **half-reactions** that occur over time under standard conditions. (1mk)

233/3
Paper 3
CHEMISTRY

CONFIDENTIAL

- Solution P ($KMnO_4$)
- Solution Q - (Oxalic acid 0.05m)
- Solution R (Containing 4.9g of $(NH_4)_2SO_4$ $FeSO_4$ $6H_2O$ in 250cm^3 solution).
- 50ml measuring cylinder
- 5 test tubes
- 1 boiling tube
- 250ml glass beaker
- Thermometer
- Stopwatch
- Burette
- Pipette
- Two conical flasks.
- About 1g solid B - ($ZnSO_4$)
- Distilled water
- About 0.5g of solid L. (Oxalic acid)
- Litmus papers
- Metallic spatula
- Means of heating
- Sodium hydroxide solution
- Ammonia solution
- Barium nitrate solution

233/3
CHEMISTRY
PAPER 3
PRACTICAL

1. You are provided with:
- Solution P of Potassium manganate (VII).
- 0.05M solution Q of oxalic acid.
- Solution R containing 4.9g of ammonium iron (II) Sulphate, $(NH_4)_2$ $SO_4.FeSO_4.6H_2O$, in 250cm^3 of water.

You are required to:

i) Determine the rate of reaction between oxalic acid and Potassium manganate (VII).

ii) Standardize the solution P.

PROCEDURE I:

Using a measuring cylinder, place 1 cm^3 of solution P into each of the five (5) test-tubes in a rack. Clean the measuring cylinder and use it to place 19 cm^3 of solution Q into a boiling tube. Prepare a water bath by placing about 200 cm^3 of water into a beaker and start to heat. Place a thermometer into solution Q and place it in the warm water until it attains a temperature of 40^0C. Remove the boiling tube from the water – bath and place it in the test-tube rack. Add the first portion of solution P immediately and at the same time start a stop watch. Record the time taken for solution P to be decolourised in table I below. Repeat the procedure at temperatures of 50^0C, 60^0C, 70^0C and 80^0C to complete the table.

Temperature of solution Q (^{0}C)	40	50	60	70	80
Time taken for decolourisation (tsecs)					
1/t sec^{-1}					

i) Plot a graph of 1/t against temperature (X-axis). (3marks) ii) From the graph determine the time taken for the mixture to decolourise at 65^{0}C (3marks) iii) How does the rate of reaction between oxalic acid and Potassium manganate (VII) vary with temperature? (1mark)

PROCEDURE II

Fill a burette with solution P. Pipette 25cm^3 of solution R into a conical flask and titrate the solution P against solution R until a permanent pink colour just appears. Record your results in table II below and repeat the procedure to fill the table.

	I	II	III
Final burette reading (cm^3)			
Initial burette reading (cm^3)			
Volume of solution P used (cm^3)			

i) Determine the average volume of P used……..cm^3 (1mark)
(Show how you arrive at your answer)

ii) Calculate the concentration of solution R in moles per litre. (Fe=56, S=32, O=16, N=14, H=1). (2marks)

iii) Find the number of moles of solution R used (1mark)

iv) Given the ionic equation for the reaction is

$$5Fe^{2+}(aq) + MnO_4^-(aq) + 8H^+(aq) \longrightarrow 5Fe^{3+}(aq) + Mn^{2+}(aq) + 4H_2O(l);$$

Find the number of moles of solution P used . (1mark)

v) Determine the concentration of the Potassium manganate (VII), solution P in moles per litre. (2 marks)

2. You are provided with solid B. Carry out the tests below and record your observations and inferences in the table below.

i) Place half a Spaluta full of solid B in a clean dry test-tube and heat gently then strongly.

Observations	Inferences
(1mark)	(1mark)

ii) Place the remaining solid B in a boiling tube and add about $5cm^3$ of distilled water and shake well. Divide the resulting mixture into four portions for the tests below.

Observations	Inferences
(1mark)	(1mark)

a) To the first portion add Sodium hydroxide solution dropwise until in excess.

Observations	Inferences
(1mark)	(1mark)

To the second portion add 2-3 drops of dilute Sulphuric (VI) acid

Observations	Inferences
(1mark)	(1mark)

To the third portion add aqueous ammonia dropwise until in excess.

Observations	Inferences
(1mark)	(1mark)

To the fourth portion add 2-3 drops of barium nitrate solution

Observations	Inferences
(1mark)	(1mark)

b)

c)

d)

3. You are provided with solid L. Carry out the tests below on L and record the observations and inferences in the spaces provide.

a) Place half of solid L in a boiling tube and add about 5cm³ of distilled water. Divide the resulting mixture into two portions for the tests below:

i) To the first portion add 2-3 drops of acidified Potassium manganate (VII). [Solution P]

Observations	Inferences
(1mark)	(1mark)

To the second portion dip a piece of blue litmus paper

Observations	Inferences
(1mark)	(1mark)

Place the remaining solid L in a metallic spatula and ignite it.

Observations	Inferences
(1mark)	(1mark)

ii)

b)

1

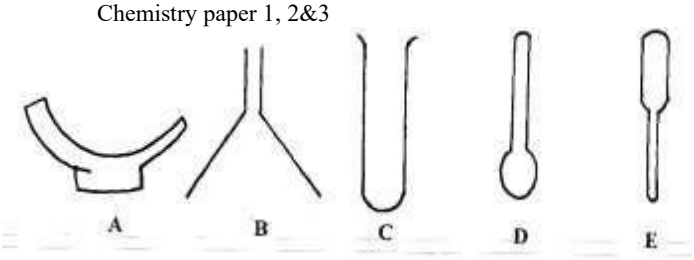
KCSE PREDICTION 10 2022

233/1
CHEMISTRY
PAPER 1

1. Use the information in the table below to determine the relative atomic mass of copper. (2 Marks)

Isotope	Fractional abundance
$^{65}_{29}Cu$	0.31
$^{63}_{29}Cu$	0.69

2. The diagrams below represent a list of apparatus which are commonly used in a chemistry laboratory:-



(a) Give the correct order of the apparatus, using the **letters only,** show the correct arrangement that can be used to prepare and investigate the nature of PH of a sample of onion solution. (2 Marks)

(b) Name one chemical substance and apparatus that is needed in the experiment. (1 Mark)

3. Briefly explain an industrial application of the following processes.
   (a) Crystallization. (1½ Marks)
   (b) Fractional distillation. (1½ Marks)
4. Four solutions of pH 7, 2, 8.5 and 13 respectively were each reacted with calcium turnings. Identify two solutions in which hydrogen gas would be produced. Explain each case. (3 Marks)
5. Study the information in the table below and answer the questions that follow. (3 Marks

Ion	Electronic arrangement	Ionic radius (nm)
Na^+	2.8	0.095
K^+	2.8.8	0.133
Mg^{2+}	2.8	0.065

   (a) Explain why the ionic radius of K^+ is greater than that of Na^+ (1 Mark)
   (b) Account for the difference in ionic radius of Mg^{2+} and Na^+ (2 Marks)
6. In an experiment, a few drops of concentrated nitric acid were added to aqueous iron (II) sulphate in a test-tube. Excess ammonia solution was then added to the mixture. (a)State the observations that were made when:-
   (i) Concentrated nitric acid was added to aqueous iron (II) sulphate (1 Mark)
   (ii) Excess ammonia was added to the mixture. (1 Mark)
   (b) Write an ionic equation for the reaction which occurred in a (ii) above. (1 Mark)
7. Describe how you would prepare a dry sample of zinc carbonate in the laboratory starting with zinc chloride solid. (3 Marks)
8. The solubility of salt Y at 60^0 is 40g/100g of water and 48g/100g of water at 100^0C.
   (i) How much salt Y would saturate 190g of water at 100^0C. (1½ Marks)
   (ii) 150g of saturated solution of Y at 100^0C is cooled to 60^0C. Calculate the mass of Y that crystallizes out. (1½ Marks)
9. Below are the bond dissociation energies of some elements.

Bond	Bond energy $kjmol^{-1}$
C-H	414
Cl-Cl	244
C-Cl	326
H-Cl	431

   Calculate the enthalpy change of the reaction. (3Mrks)

   $CH_{4(g)} + 2Cl_{(g)} \quad CH_2Cl_{2(g)} + 2HCl_{(g)}$
10. An oxide of carbon contains 42.8% by mass of carbon and has R.M.M. of 28. What is its molecular formula? (3 marks) (C=12;O=16)
11. Sulphur (IV) oxide gas was bubbled into acidified potassium chromate (VI) and iron (III) sulphate solutions respectively. Explain the observations made in each case.
(i) With potassium chromate (VI). (1mark)
(ii) With iron (III) sulphate. (1mark)
12. A known volume of ozone diffuses through a small hole in 55 seconds; whereas the same amount of chlorine takes 67 seconds under the same conditions.
    Determine the molecular mass of ozone . (Cl=35.5; O=16) (3 marks)
13. (a) Give the systematic names of the following compound: $CHCH{=}CHCH_2CH_3$. (1 mark)

(b) Ethane and ethene react with bromine according to the equations given below.
   (i) $C_2H_{6(g)} + Br_{2(g)} \quad C_2H_5Br_{(l)} + HBr_{(g)}$ (ii)
   $C_2H_{4(g)} + Br_{2(g)} \quad C_2H_4Br_{2\,(l)}$
   Name the type of reaction that takes place in (i) and (ii) (2 Marks)
14. An organic compound with the formula $C_4H_{10}O$ reacts with potassium metal to give hydrogen gas and a white solid.
   (a) Write structural formula of the compound. (1 Mark)

(b) To which homologous series does the compound belong? (1 Mark)

(c) Write the equation for the reaction between the compound and potassium metal. (1 Mark)

15. In the Haber process, the optimum yield of ammonia is obtained when a temperature of 450^{0}C, a pressure of 200 atmospheres and an iron catalyst are used.

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$ H =-92kJ

(a) How would the yield of ammonia be affected if the temperature was raised to 600^{0}C. (1 Mark)

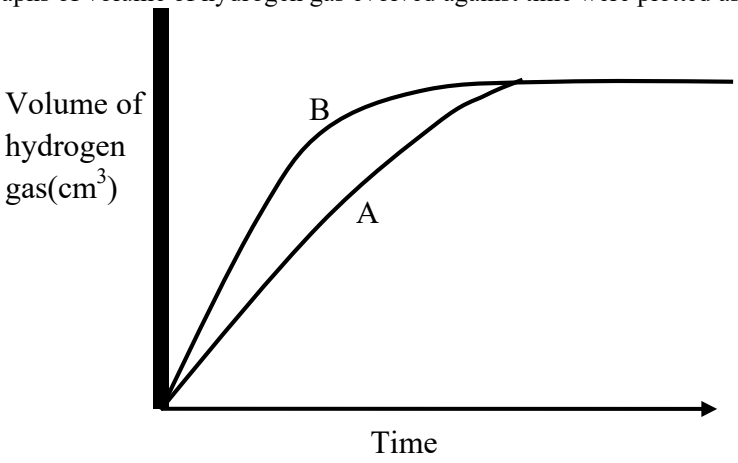
(b) Explain the effect on the yield of lowering the pressure below 200 atmospheres. (1 Mark)

16. Two experiments were carried out as follows and the volume of hydrogen gas evolved measured at intervals of 10 seconds for 100 seconds.

(i) 8cm of magnesium ribbon was added to 1M HCl(aq)

(ii) 8cm of magnesium ribbon was added to 0.5M HCl(aq)

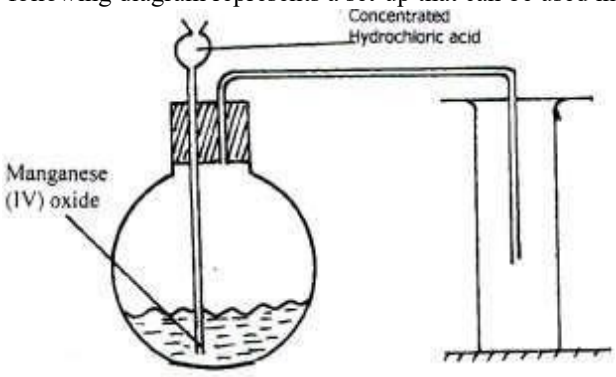
Graphs of volume of hydrogen gas evolved against time were plotted as shown below.



(a) Which of the graphs was obtained for reaction (i). Explain. (2 Marks)

(b) Explain the general shape of the graphs. (1 Mark)

17. The following diagram represents a set-up that can be used in the laboratory to prepare and collect a sample of chlorine gas:



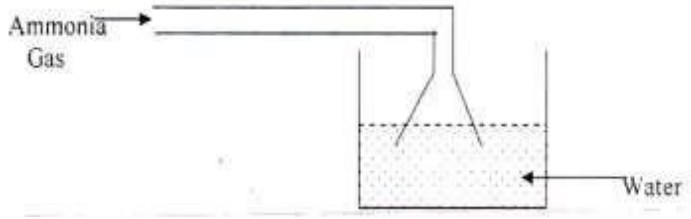
(a) No gas bubbles were produced in the above experiment. Explain the observation. (1 Mark)

(b) Complete the following equation. (1 Mark)

$Cl_{2(g)} + H_20_{(l)}$

(c) Describe the bleaching property of chlorine water (1 Mark)

18. Ammonia gas was passed into water as shown below.

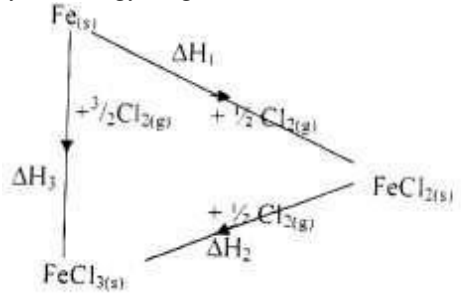


(a) When a red litmus paper was dropped into the resulting solution; it turned blue.

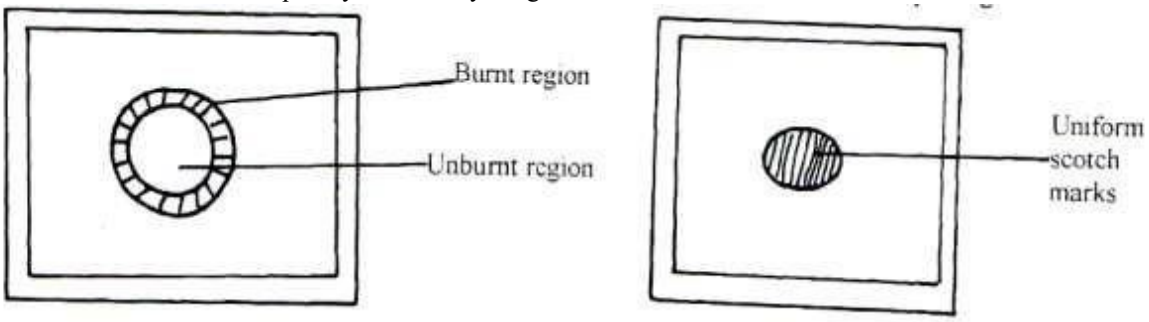
Give a reason to this observation. (1 Mark)

(b) What is the function of the funnel? (1 Mark)

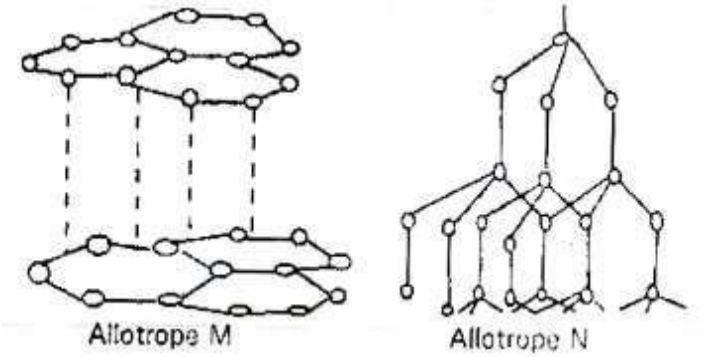
19. During purification of copper by electrolysis, 1.48g of copper were deposited when a current was passed through aqueous copper (II) sulphate for 2 ½ hours. Calculate the amount of current that was passed. (Cu = 63.5; IF = 96500C)
20. Draw a dot (.) and cross (x) diagram to show bonding in carbon (II) oxide. (2 Marks)
21. Write the discharge equations (half equations) for the electrode reactions when molten sodium chloride is electrolyzed using graphite electrodes.
    Anode (1 Mark)
    Cathode (1 Mark)
22. Study the energy diagram and then answer the questions that follow.



    (a) What does H_1 and H_3 represent. (2 Marks)
    (b) Write down the relationship between $H_{1(l)}$, H_2 and H_3 (1 Mark)
23. The isotope $^{24}_{11}$Na decays by Beta, -emission to a stable nuclide. The half-life of the isotope is 15 hours 2.0g of $^{24}_{11}$Na is allowed to decay. Determine the mass left after 90 hours. (3 Marks)
24. The diagram below shows the appearance of two pieces of paper placed in different parts of a non-luminous flame of a Bunsen burner and removed quickly before they caught fire.



    (a) What do the experiments show about the outer region of the flame? (1 Mark)
    (b) From the above experiment, which part of the flame is better to use for heating? Give a reason (2 Marks)
25. The following diagrams show the structure of two allotropes of carbon. Study them and answer the questions that follow.



    (i) Name allotropes M and N (1 Mark)
    (ii) Give one use of N. (1 Mark)
    (iii) Which allotrope conducts electricity? Explain. (1 Mark)
26. The formula below represents the active ingredients in a soap and a detergent respectively.
    (I) $CH_3(CH)_{16}\ COO^-Na^+$ (II)
    $CH_3(CH_2)CHCH_3CH_2SO_3^-Na^+$
    (a) Explain why (I) is suitable for washing using water from a river. (1 Mark)

(b) Give one advantage and one disadvantage of II. (2 Marks)

27. Using the following standard electrode potentials to answer the questions that follow.

$Zn2^{+}_{(aq)} + 2e^{-}$ $Zn_{(s)}$ E V = -0.76 $Cl_{2(g)}$

$+ 2e^{-}$ $2Cl^{-}_{(aq)}$ E V = +1.36

(a) Calculate the e.m.f of the following cell: (2 Marks)

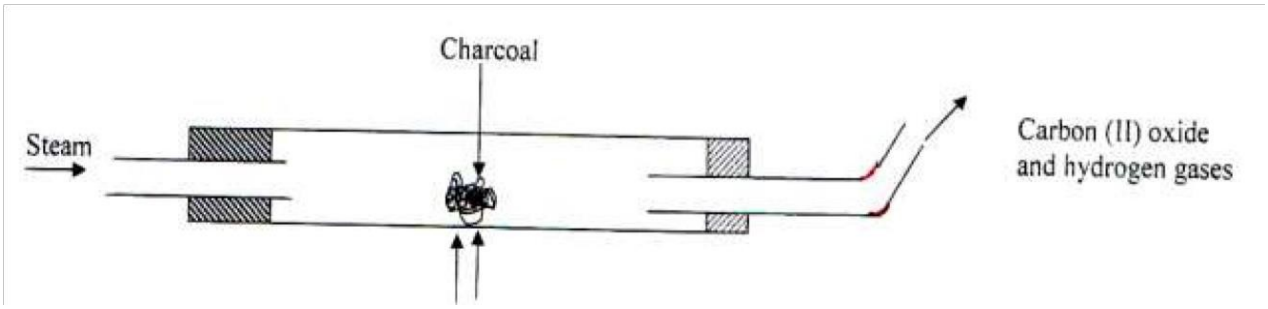
$Zn_{(s)}/Zn2^{+}_{(aq)}//2Cl^{-}_{(aq)}/Cl_{2(g)}$

(b) Write down the equation for the overall cell reaction. (1 Mark)

28. (a) Suppose 180cm3 of a 2.0M solution is diluted to 1.0dm3. What will be the concentration of the resulting solution. (2 Marks)

(b) Why is water not used to put off oil fires? (1 Mark)

29. When steam was passed over heated charcoal as shown in the diagram below hydrogen and carbon (II) oxide gases were formed.



(a) Write the equation for the reaction which takes place. (1 Mark)

(b) Name one use of carbon (II) oxide gas which is also a use of hydrogen gas. (1 Mark)

233/2
CHEMISTRY
PAPER 2

1. (a) The grid given below represents part of the periodic table study it and answer the questions that follow. (The letters do not represent the actual symbols of the elements.)

									A
					B				
	C			D			E		
	F								

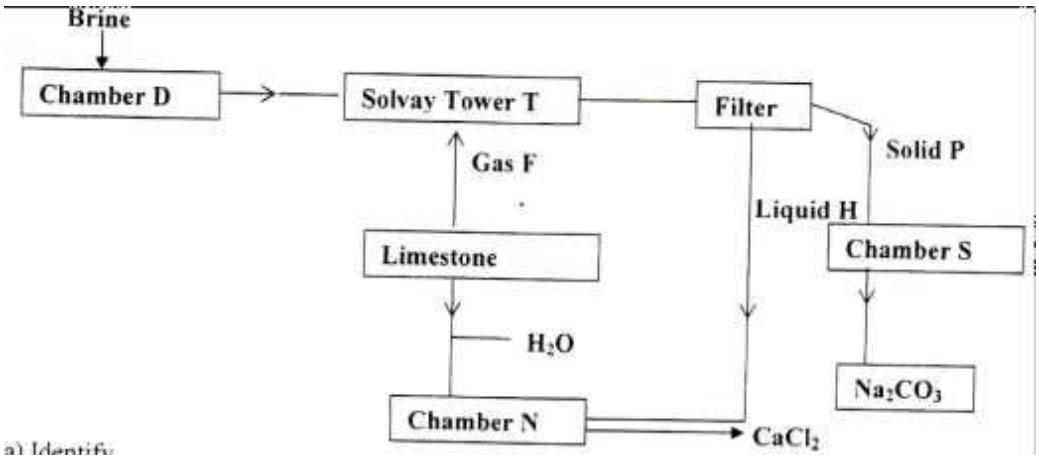
(i) What name is given to the group of elements to which C and F belong? (1 Mark)
(ii) Which letter represents the element that is least reactive? (1 Mark)
(iii) What type of bond is formed when B and E react? Explain (2 Marks)
(iv) Write formula of the compound formed where elements D and oxygen gas react. (1 Mark)
(c) Study the information in the table below and answer the questions that follow. (The letter do no represents the actual symbols of the substance.

Substance	Melting point ^{0}C	Boiling point ^{0}C	Solubility in water	Density at room temp/g/cm^3
H	-117	78.5	Very soluble	0.8
J	-78	-33	Very soluble	0.77 x 1^{-3}
K	-23	77	Insoluble	1.6
K	-219	-183	Slightly soluble	1.33 x 10^{-3}

I. (i) Which substance would dissolve in water and would be separated from the solution by fractional distillation. (1 Mark)

(ii) Which substances is a liquid at room temperature and when mixed with water two layers would be formed? (1 Mark)

II. Which letter represents a substance that is a gas at room temperature and which can be collected by.
(i) Over water? (1 Mark)
(ii) By downward displacement of air? Density of air at room temperature = 1.29 x 10-3 g/C (1 Mark) 2. Study the flow chart below and answer the questions that follow.



(b) Identify
(i) Gas **F**
(ii) Liquid **H**
(iii) Solid P
(c) State one use of calcium chloride. (1Mark)
(d) Give two reasons why such a plant should be cited near a river. (2 Marks)
(e) Write equations for the reactions occurring in chamber: (2 Marks)

(i) **N**

(ii) **S**

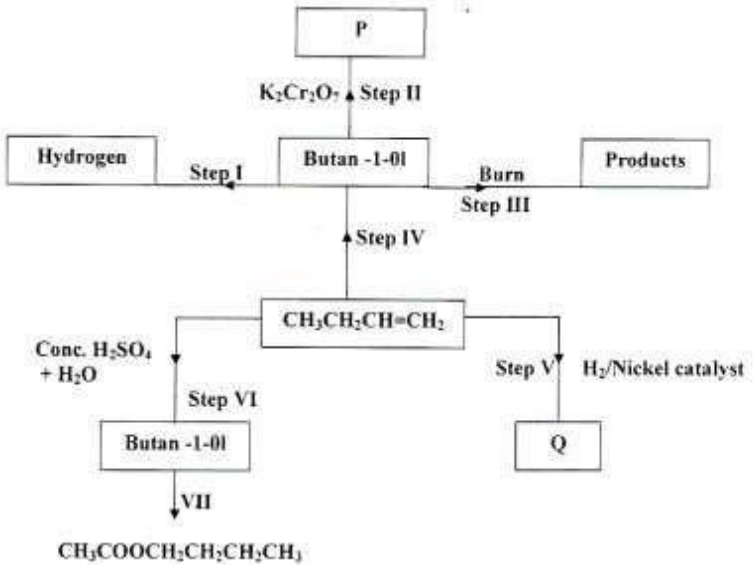
(f) Using an ionic equation, explain how sodium carbonate is used to soften hard water. (1 Mark)

(g) Explain how ammoniacal brine is formed. (1 Mark)

(h) State one use of sodium hydrogen carbonate. (1 Mark)

---

3. Use the information in the scheme below to answer the questions that follow.



(a) Name substance P (1 Mark)

(b) Give the structure and name of compound Q. (1 Mark)

(c) Write the equation for the chemical reaction in steps III (1 Mark)

(d) Name the reagents and conditions necessary for the reaction in

(i) Step IV (1 Mark)

Reagents (1 Mark)

(ii) Step VII

Reagents (1 Mark)

Conditions (1 Mark)

(e) What name is given to the reaction in step VII? (1 Mark)

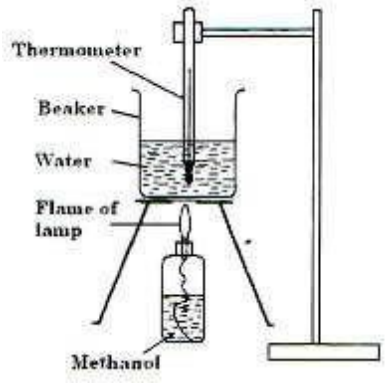
(f) Below are two reactions showing how a long chained alkanoic aci d can be converted into detegernt B.

I. $CH_2 - C_{17}H_{35}COOH$
$CH - C_{17}H_{35}COOH + 3H_2O \longrightarrow 3C_{17}H_{35}COOH + C_3H_8O_3$
$CH_2 - C_{17}H_{35}COOH$

II. $3C_{17}H_{35}COOH + 3NaOH \longrightarrow C_{17}H_{35}COONa + 3H_2O$
(Detergent B)

(i) Name the type of reaction in I and II (2 Marks

4. In an experiment to determine the heat of combustion of Methanol, CH_3OH, a student used a set-up like the one shown in the diagram below. Study the set-up and the data below it and answer the questions that follow.



Volume of water	=	$500cm^3$
Final temperature	=	27.0^0C
Initial temperature of water	=	20.0^0C
Final mass of lamp + Methanol	=	22.11g
Initial mass of lamp + Methanol	=	22.98g
Density of water	=	1.0gcm-1
(Specific heat capacity	=	***$4.2Jg^{-}0C^{1}$)***

(a) Calculate
(i) The number of moles of Methanol used in the experiment. (1 Mark)
(C = 12, O = 16, H = 1)
(ii) The heat change in this experiment. (1 Mark)
(iii) The heat of combustion per mole of Methanol. (2 Marks)

(b) Explain why the value of the molar heat of combustion of Methanol obtained in this experiment is different from the theoretical value. (2 Marks)

(c) On the axis below draw an energy level diagram for the combustion of the Methanol. (2 Marks)



(d) The table below gives factors which affect the rate of the reaction between Zinc and Hydrochloric acid.
(i) Complete the table to show how the factors given affect the rate of reaction between Zinc and Hydrochloric acid. (2 Marks)

Factor	Effect on the rate of reaction	Explanation
Using Zinc powder instead of Zinc granules		
Heating the reactants		

(ii) Name the catalyst that will be added to increase the rate of reaction. (1 Mark)
(iii) Write an equation between the metal and acid above. (1 Mark)

5. The following table shows standard electrode potentials for some half reactions E /Volts

$Ce^{4+(aq)} + e^-$ $Ce^{3+(aq)}$ +1.61
$Fe^{3+(aq)} + e^-$ $Fe^{2+(aq)}$ +0.77
$I_{2(aq)} + 2e^-$ $2I^-$ +0.54
$Fe^{2+(aq)} + 2e^-$ $Fe_{(s)}$ -0.44
$Zn^{2+}_{(aq)} + 2e^-$ $Zn_{(s)}$ -0.76
$J^{3+} + 3e + 3e$ J(s) x

Reference to the above table answer the following questions (Base on the values given) (a) Which is the strongest reducing agent?

(b) Which substance in the table would be used to oxidize iodide to iodine?

(c) Study the cell representation below and answer the questions that follow.
KNO_3
$Zn_{(s)}/Zn^{2+(aq)}$ // $Fe^{2+(aq)}/Fe_{(s)}$
(i) Identify the anode and the cathode
Anode (1 Mark) Cathode (1 Mark)

(ii) If the two electrodes in (i) above are connected externally, what reactions will take place in each half cell? (1 Mark)

(iii) What is the e.m.f of the cell? (1 Mark)

(iv) What is the role of KNO_3? (1 Mark)

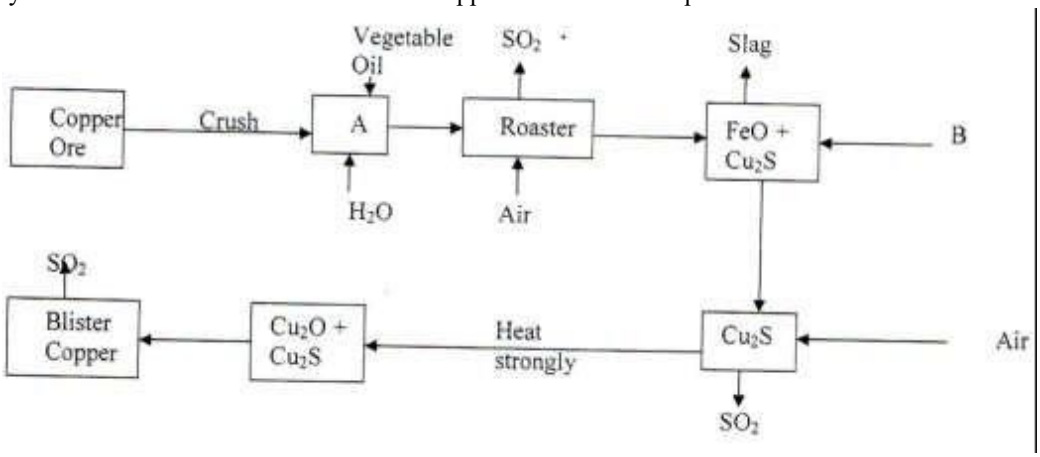
(v) Write an electrochemical equation to show what happens when a Zinc rod is dipped in a solution of iron (II) ions. (1 Mark)

(vi) Explain what happens when KCl is used instead of KNO_3 in a case where $Pb_{(s)}/Pb^{2+}_{(aq)}$ is one of the half cells. (2 Marks)

KNO3

(d) If the e.m.f of the cell $J_{(s)}/J^{3+}_{(aq)}$ // $I_{2(aq)}$ $2I^{-}_{(aq)}$ is 1.32V, calculate the value for $J^{3+}_{(aq)}/J_{(s)}$ (The value of x) (2 Marks)

6. Study the flow chart below on extraction of copper and answer the questions that follow.



(a) Name the chief copper ore used for the extraction of copper. (1 Mark)

(b) The amount of copper in the copper ore is usually very small. State the method used to separate the impurities from the ore in chamber A. (1 Mark)

(c) (i) What substance is fed into the roaster from chamber A. (1 Mark)

(ii) Write an equation for the reaction that takes place in the roaster. (1 Mark)

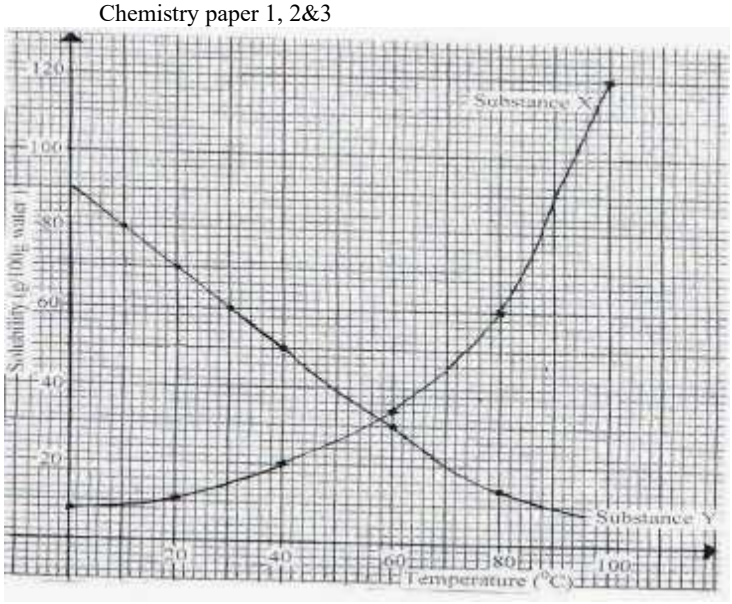
(d) The copper obtained (blister copper) is not pure. Draw a labelled diagram to show the set-up you would use to refine the copper by electrolysis. (2 Marks) (e) Give two side effects that this process would have on the environment. (2 Marks)

(f) Bronze is an alloy of copper and another metal.

(i) Name the other metal. (1 Mark)

(ii) Give one use of bronze. (1 Mark)

7. The solubility curves of substances X and Y are shown on the grid below. Study the curves and answer the questions that follow.



(i) State the effects of temperature on solubility of substance Y. (1 Mark)

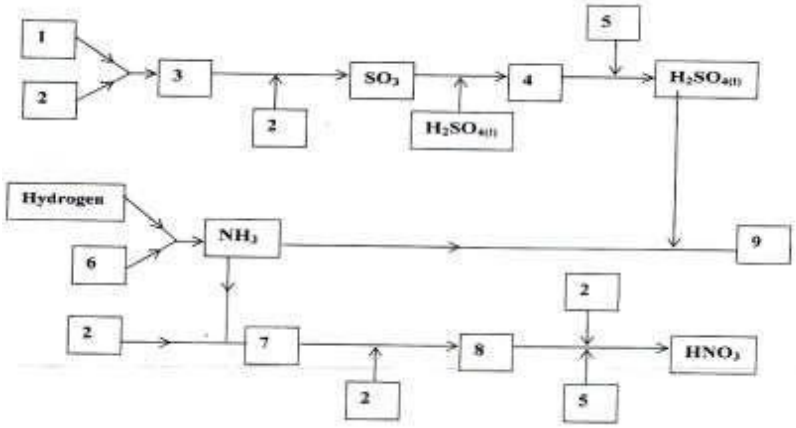
(ii) Calculate the molarity of substance X in a saturated solution of X at 40°C. (Relative formula mass of X = 101) Assume density of the solution is 1.0g/cm^3) (2 Marks)

(iii) At what temperature do the two substances have the same solubility? (1 Mark)

(iv) Which substance is most likely to be oxygen gas? (1 Mark)

(v) If a saturated solution of substances X is cooled from 800C to 200C, determine the mass of crystals that would be obtained. (2 Marks)

8. The chart below shows some of the chemical needed for the production of ammonia gas, nitric acid and ammonia sulphate in the industry.



(a) Name the chemical that should be in chambers **1,2,4,8** and **9**. (3 Marks)

(b) State three conditions required to convert the chemical substance in chamber 3 to SO3(g) (1 ½ Marks)

(c) Write balanced equation with conditions for the reaction that produces the chemical substance in chamber 7 (2 Marks)

Explain the following with the help of equations. When concentrated sulphuric acid is added to copper turnings and the mixture heated, a reaction takes place producing a blue solution as one of the products, when dilute sulphuric acid is added to copper turnings there is no change even after heating.

233/3
CHEMISTRY
PAPER 3

Question 1

You are provided with:

- ✓ Hydrochloric acid, Solution **A**
- ✓ 0.2M Sodium hydroxide, Solution **B**

✓ 0.4g of metal **C**

You are required to determine;

(i) Molar enthalpy change for the reaction between metal **C** and hydrochloric acid. (ii) The molarity of acid A.

Procedure

Using a measuring cylinder, place 100cm^3 of acid A in a 250ml plastic beaker. Record its temperature as t_1. Put metal **C** into the beaker and stir using the thermometer. Record the highest temperature attained as temperature t_2 in table **I** below.

Table I

Final temperature t_2 (^{0}C)	
Final temperature t_1 (^{0}C)	

(a) Determine the temperature change, T^{0}C (1 ½ Marks)

(b) How many moles of **C** were used in the experiment (C = 24.0) (1 Mark)

(c) Calculate the molar enthalpy change for the reaction.

$C_{(s)} + 2H^+_{(aq)} \quad C^{2+}_{(aq)} + H_{2(g)}$ Given $Q = \frac{Mc\Delta T}{1000n}$, where n is the no. of moles of C that reacted.

(s.h.c = 4.2Jg^{-1}k^{-1}, density of solution = 1g/cm^3) (2 Marks)

PROCEDURE II

Fill the burette with solution **F**. Pipette 25cm^3 of solution **B** into a conical flask. Add 3 drops of phenolphthalein indicator. Run the solution in the burette into the conical flask until the pink colour just disappears. Record your readings in the table **II** below. Repeat the above procedure to complete the table.

TABLE II

	I	II	III
Final burette readings (cm^3)			
Initial burette readings (cm^3)			
Volume of solution **F** used (cm^3)			

(a) Find the average volume of solution **F** used (4 Marks)

(b) Calculate

(i) The number of moles of solution **B** used (1 Mark)

(ii) The number of moles of hydrochloric acid in solution **F** that reacted with 25cm3 of solution B. (1 Mark)

(iii) The number of moles of hydrochloric acid in 100cm3 of solution F. (1 Mark)

(iv) The initial number of moles of hydrochloric acid in 100cm3 of solution **A**. (1 Mark)

(v) The molarity of hydrochloric acid, solution **A**. (1 Mark)

Question 2

You are provided with:

(a) Sodium thiosulphate containing 40g/litre, solution **D.**

(b) 2M Hydrochloric acid, solution **E**.

You are required to:

Determine the rate of reaction between sodium thiosulphate and Hydrochloric acid.

Procedure:

Into a 100ml glass beaker, place 20cm^3, of D. Using a pencil, Mark a cross (X) on a white paper. Place a beaker containing solution **D** on the cross X. Add 20cm^3 of solution **E** into solution **E** into solution **D** and at the same time start a stop watch. Shake the beaker and immediately place it on the cross. Observe the cross (X) through the solution (from the top) and record the time (t) in seconds taken for the cross to be longer visible.

Repeat the procedure using the other solutions of **E** diluted with water as indicated in the table III below.

TABLE III

Experiment	1	2	3	4	5
Volume of solution **D** (cm^3)					
Volume of solution **E** (cm^3)					

Volume of water (cm^3)					
Time taken for X to disappear					
1/time					

(3 Marks) (a) Plot a graph of 1/time (y-axis) against volume of solution **E.**

(4 Marks)

(b) (i) From the graph, determine the time taken for the cross (X) to be invisible at 16.5cm3 of solution **E**.

(ii) If the volume of solution **E** in b (i) above was diluted using 3.5cm^3 of water, what would be the concentration of **E** in the mixture in moles/litre. (1 Mark)

(c) Explain the shape of the graph. (1 Mark)

Question 3

Procedure:

You are provided with solid **G** and **H.** Carry out the tests and record your observation and inferences in spaces provided.

(a) Place all solid **G** in a clean boiling tube. Add about 10cm3 of distilled water and shake well.

Observations	**Inferences**
(½ Mk)	(½ Mk)

Divide the solution into 4 portions

(i) To the first portion add 2-3 drops of sodium hydroxide until in excess.

Observations	**Inferences**
(1 Mk)	(1 Mk)

(ii) To second portion add 2-3 drops of aqueous ammonia until excess.

Observations	**Inferences**
(1 Mk)	(1 Mk)

(iii) To the third portion add 3 drops of dilute hydrochloric acid, solution E.

Observations	**Inferences**
(½ Mk)	(½ Mk)

(iv) To the fourth portion, add 3 drops of Lead (ii) nitrate solution followed by dilute nitric acid.

Observations	**Inferences**
(1 Mk)	(1 Mk)

(b) I. Using a clean metallic spatula, heat about one third of solid **H** in a Bunsen burner flame.

Observations	**Inferences**
(1Mk)	(1 Mk)

II. Put the remaining solid **H** in clean test tube. Add distilled water and shake well. Add more water to about ¾ full. Divide the solution into three portions.

(i) Determine the pH of the solution using universal indicator solution.

Observations	**Inferences**
(1 Mk)	(1 Mk)

(ii) To the second portion, add 2 drops of acidified Potassium Manganate (VII) solution.

Observations	**Inferences**
(1 Mk)	(1 Mk)

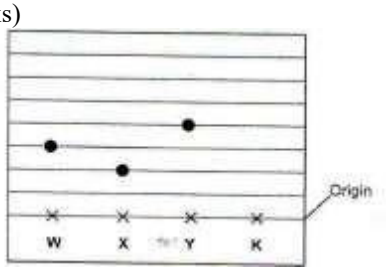
(iii) To the third portion add sodium hydrogen carbonate solid.

Observations	**Inferences**
(1 Mk)	(1 Mk)

KCSE PREDICTION 11 2022
233/1
CHEMISTRY
THEORY
PAPER 1
2 HOURS

Answer all Questions

1. a) The diagram below represents a paper chromatogram of pure W, X and Y. A mixture K contains W and Y only. Indicate on the diagram the chromatogram of K. (2 marks)



b) Show the solvent front. (1 mark)

2. Ammonia is produced in large scale by Haber process.

i) Write an equation for the formation of ammonia gas. (1 mark)

ii) State two optimum conditions for obtaining a high yield of ammonia in the process. (2 marks)

3. The table below gives elements represented by letters which are not the actual symbols.

Element	U	V	W	X	Y	Z
Atomic No.	8	12	13	15	17	20

i) Select an element that can form divalent anion. (1 mark) ii) What is the structure of the oxide of W? (1 mark)

4. A compound has an empirical formula C_3H_6O and relative formula mass of 116.

a) Determine its molecular formula.
(H=1.0, C=12.0, 0=16.0) (2 marks)

b) Calculate the percentage composition of carbon by mass in the compound. (1 mark)

5. In the laboratory, hydrogen sulphide gas is prepared by action of dilute hydrocholoc acid on metal sulphides.

a) Name the metal sulphide that can be used in preparing the gas. (1 mark)

b) Write down the equation for the reaction in (a) above. (1 mark)

c) Give one chemical test for hydrogen sulphide gas. (1 mark)

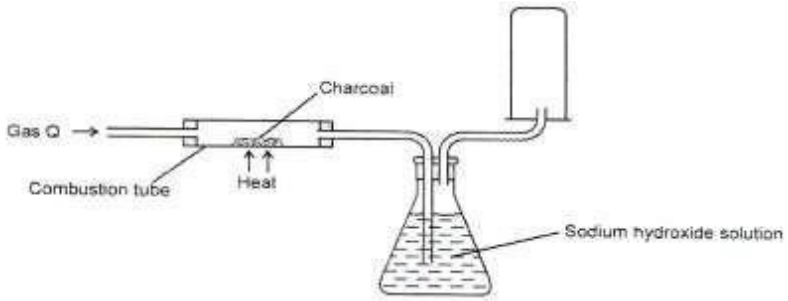
6. The table below gives the solubilities of Potassium Bromide and Potassium Sulphate at 0c at 40^0c.

Substance	Solubility/100g water	
Potassium Bromide	55	75
Potassium Sulphate	10	12

When aqueous mixture containing 60g of KBr and 7g of K_2SO_4 in 100g water at 80^0C was cooled to 0^0C, some crystals were formed:

i) Identify the crystals. (1 mark) ii) Determine the mass of the crystals formed. (1 mark) c) Name the method used to obtain the crystals. (1 mark)

7. The diagram below shows an experimental set up for preparing Carbon (II) oxide. Study it and answer the questions that follow.



a) Identify gas Q. (1 mark)

b) State the reason why Carbon (II) Oxide is collected in the manner illustrated. (1 mark)

c) Describe a simple test that can be used to distinguish between Carbon (II) Oxide and Carbon (IV) Oxide. (1 mark)

8. a) Phosphorous is situated immediately below nitrogen in the periodic table. Give two physical differences between the two elements. (2 marks)

b) Write the chemical symbols of Boron and Silver. (2 marks)

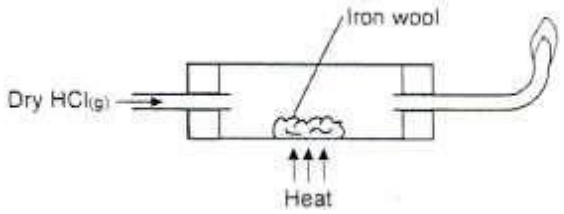
---

9. Swimming pools are neutralized by adding calcium hypochlorite, $Ca(OCl)_2$ or Sodium hypochlorite, NaOCl. The equilibrium involved is

$$OCl^-_{(aq)} + H_2O_{(L)} \rightleftharpoons HOCl_{(aq)} + OH^-_{(aq)}$$

The species that is best at destroying bacteria and resisting decomposition by sunlight in HOCl. Explain any two reaction conditions that will favour formation of $HOCl_{(aq)}$. (2 marks)

10. Dry hydrogen chloride gas was passed over heated iron wood as shown below.



a) State the observation made in the combustion tube at the end of the experiment. (1 mark)

b) Write an equation for the reaction that gave the blue flame. (1 mark)

11. Some crystals of sugar cane were placed in a test-tube and a few drops of concentrated sulphuric (VI) acid added to it.

i) State what was observed. (1 mark)

ii) What name is given to the property of concentrated sulphuric (VI) acid in (i) above. (1 mark) iii) Write an equation for the reaction between glucose, $C_6H_{12}O_6$ and $H_2SO_{4(l)}$. (1 mark)

12. 4.333g of element Q, valency 2, reacts completely with 2.14dm^3 of chlorine gas at s.t.p (Molar gas volume at s.p=22.4dm^3)

i) Write a balanced equation for the reaction that occurs. (1 mark) ii) Find the relative atomic mass of Q. (2 marks)

13. a) Define the term „half-life". (1 mark)

b) W grams of a radioisotope take 100 days to decay to 20g. If the half-life of the element is 25 days, calculate the initial mass W of the radioisotope. (2 marks)

14. The equation for the reaction between hydrogen and bromine is:

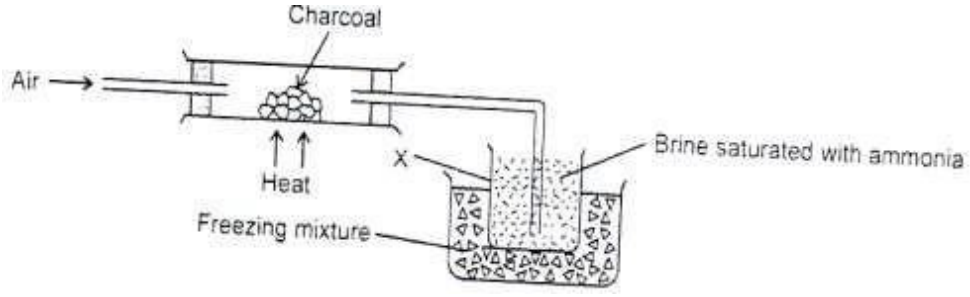
$$H_{2(s)} + Br_{2(g)} \longrightarrow 2HBr_{(g)}$$

Given the following bond energies

Bond	Energy (kJ)
H-H	+435
Br-Br	+224
H-Br	+336

Calculate the energy change for the above reaction. (2 marks)

15. Study the diagram below and use it to answer the questions that follow.



a) Write two equations for the reactions taking place in the apparatus labeled X. (2 marks)

b) Name one of the salts formed at the end of the reaction. How can the salt be obtained from the mixture? (2 marks)

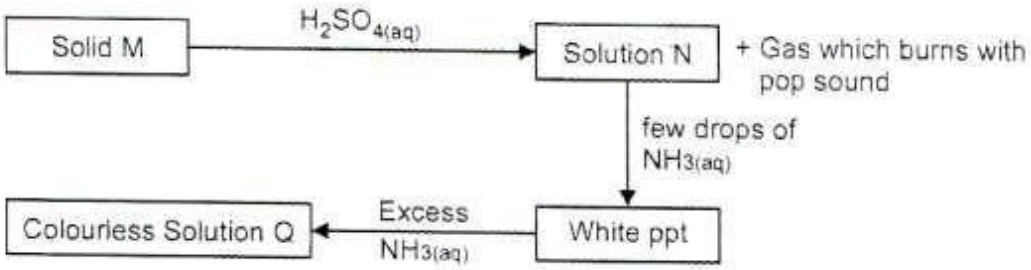
16. 3.22 of hydrated sodium sulphate, Na_2SO_4,XH_2O were heated to a constant mass of 1.42g. Determine the value of X in the formula. ***(Na=23.0, S=32.0, O=16.0, H=1.0)*** (3 marks)

17. Describe how a mixture of sodium carbonate and lead (II) carbonate can be separated. (3 marks)

18. Giving reasons, identify the acid and bases in both forward and backward reactions in the equation below.

$NH_{4(aq)}^{+} + H_2O_{(L)} \rightleftharpoons NH_{3aq} + H_3O_{(aq)}^{+}$

19. The scheme below shows some reaction sequence starting with solid M.



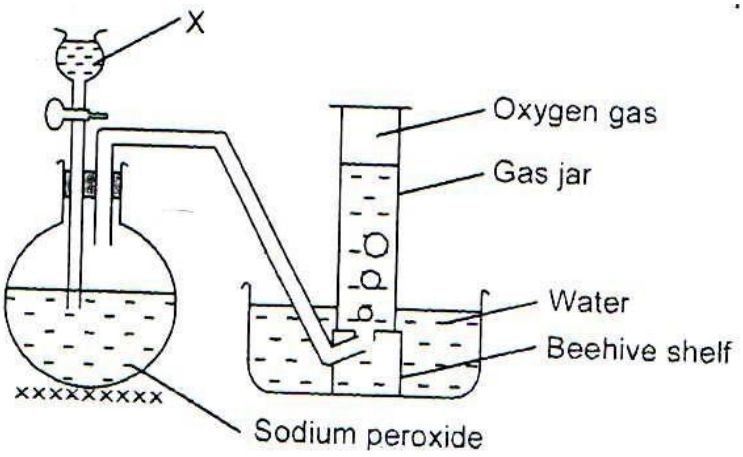
i) Name solid M. (1 mark)

ii) Write the formula of complex ion present in solution Q. (1 mark)

iii) Write ionic equation of reaction between barium nitrate and solution N. (1 mark)

20. Describe an experimental procedure that can be sued to extract oil from nut seeds. (3 marks)

21. The set up below can be used to prepare oxygen gas. Study it and answer the questions that follow.



a) Identify X. (1 mark)

b) What property of oxygen makes it possible for it to be collected as shown above set-up? (1 mark)

c) Write a chemical equation for taking place in the round-bottomed flask. (1 mark)

22. a) Name two ores from which copper is extracted. (2 marks)

b) During an extraction of copper metal, the ore is subjected to froth floatation. Give a reason why this process is necessary. (1 mark) c) Name one alloy of copper and state its use.

Alloy (1 mark)

Use (1 mark)

23. By using aqueous sodium chloride, describe how a student can distinguish calcium ions from lead ions. (2 marks)

24. The table below shows the test carried out on a sample of water and the results obtained.

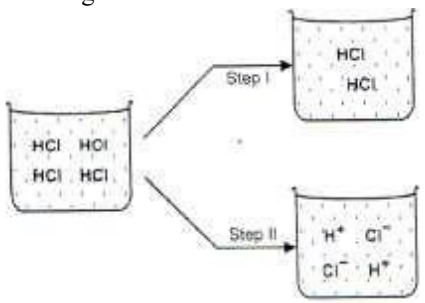
Sample	Tests	Observation
A	Addition of sodium hydroxide solution in excess	White precipitate which dissolves
B	Addition of excess ammonia	White precipitate
C	Addition of HNO_3 then Barium chloride	White precipitate

a) Identify the anion in water. (1 mark)

b) Write the ionic equation for the reaction in C. (1 mark)

c) Write the formula for the complex ion in A. (1 mark)

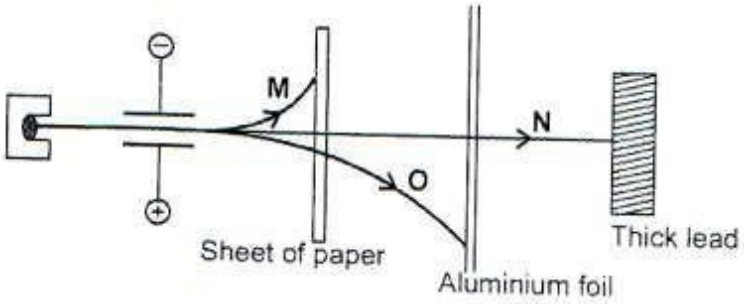
25. Study the diagram below and use it to answer the questions that follow.



a) Identify the solvent used in Step I and Step II.

b) Spatula –endful of sodium hydrogen carbonate was poured into solution B. What observations were made? Explain. (2 marks)

26. Study the diagram below and use it to answer the questions that follow.



Name the radiations: M,N,O

27. Graphite is one of the allotropes of Carbon.

a) Name one other element which exhibits allotropy. (1 mark)

b) Explain why graphite is used in making of pencil leads. (1 mark)

c) Diamond is the hardest known substance by man. Name one use of diamond. (1 mark)

28. a) A dry red litmus paper was dropped onto a gas jar of dry chlorine gas.

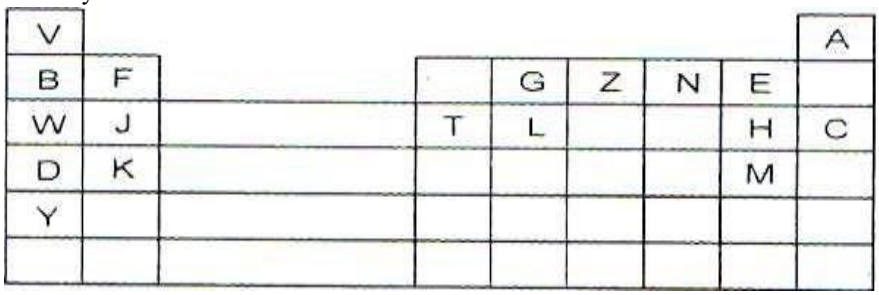
i) State the observation made. (1 mark) ii) Explain your observations for (i) above. (1 mark) b) Write an equation for bleaching of a dye by use of chloric II) acid. (1 mark)

29. A solution was made by dissolving 8.2g of calcium nitrate to give 2 litres of solution. (Ca=40.0, N=14.0, 0=16.0) Determine the concentration of nitrate ion in moles per litre. (3 marks)

233/2
CHEMISTRY
THEORY
PAPER 2
2 HOURS

Answer all Questions

1. The grid below represents part of the periodic table. Study it and answer the questions that follow. The letters do not represent the actual symbols of the elements.



(a) What name is given to the family to which:
i) Element E, H and M belong? (1 mark) ii) Elements F, J and K belong? (1 mark)

(b) Write the chemical formula of the;

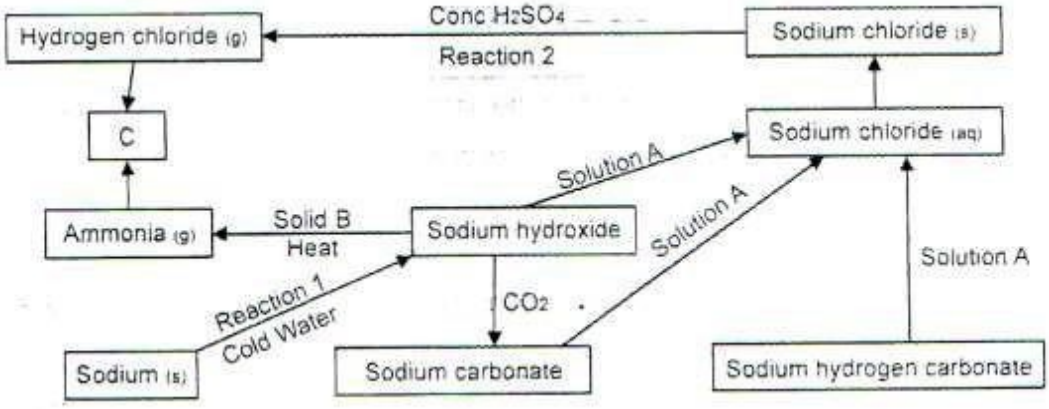
(c) Name the type of bond and structure formed between reactions of: i) D and N
Bond (1 mark)
Structure (1 mark) ii) T and H
Bond (1 mark)
Structure (1 mark)

(d) i) Ionic radius of element E is bigger than its atomic radius. Explain. (2 marks) ii) The oxide of G has a lower melting point than the oxide of L. Explain. (2 marks)

iii) Explain in terms of bonding and structure the following observation. There is an increase in melting and boiling points from W to T. (1 mark)

(e) Using dot (.0) and cross (x) diagram show bonding in ZV_4. (2 marks)

2. The flow chart summarizes a series of chemical reaction of sodium and its compounds.



(a) Which of the chemicals in the flowchart is used;

i) To make soap. (1 mark) ii) In the manufacture of glass (1 mark) iii) For deicing roads (1 mark) iv) In cake-baking (1 mark)

(b) Briefly describe what would be observed in reaction 1 in the flow chart. (3 marks)

(c) Name (i) solution A. (1 mark) ii)

Write a balanced chemical equation for the reaction between solution A and sodium carbonate. (2 marks)

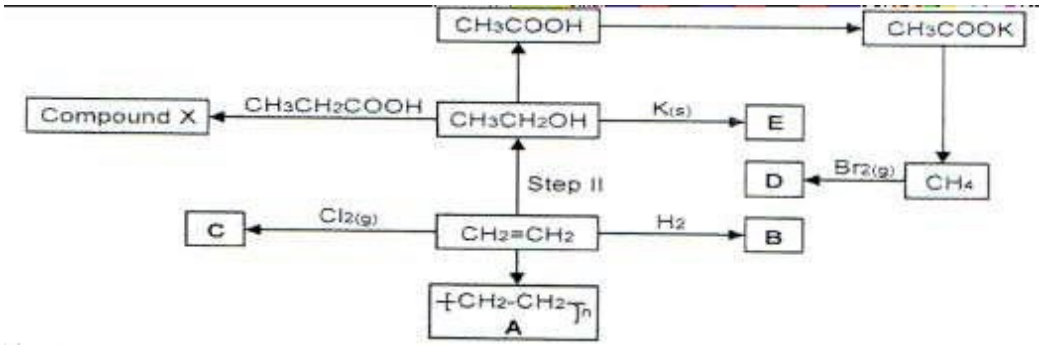
iii) What type of reaction takes place between solution A and sodium hydroxide solution. (1 mark)

(d) Identify; Solid B (½ mark)

Solid C (½ mark)

---

3. The flow chart below shows some chemical reactions.



a) Write the name and formula of the organic compounds;

i) Name Formula (1 mark) ii) C

Name Formula (1 mark) iii) B

Name Formula (1 mark)

a) Write the name of the process that leads to the formation of substance (s).

D

(1 mark)

A (1 mark)

C

1 mark

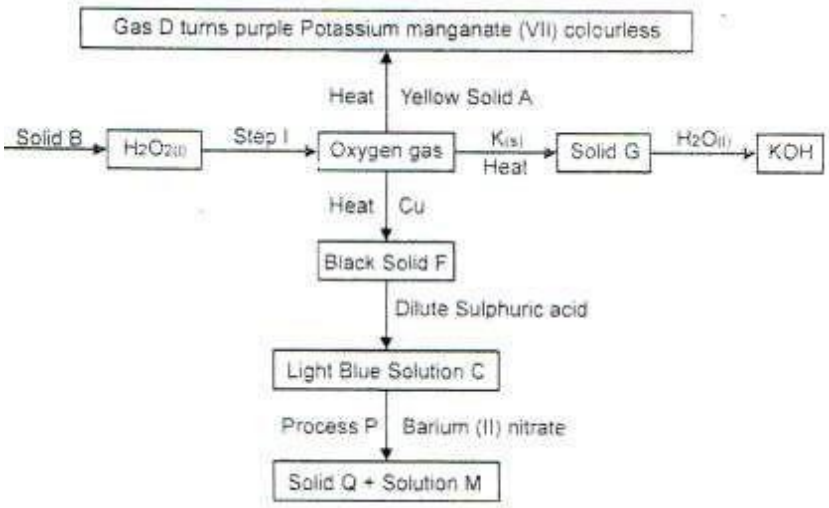
b) Give one necessary condition for the formation of compound X. (1 mark)

c) If the relative molecular mass of compound A is 84,000 units, determine the value of n. (C=12, O=1.0)

d) Write an equation for the reaction leading to the formation of substance E. (1 mark)

e) State and explain the observation made when substances „B" and C2H4 are burnt in excess air. (2marks) **4.**

The flow chart represents preparation and properties of oxygen gas. Study it and answer the questions that follow.



i) Identify the following substances. (2 marks) a) Solid A
b) Gas D
c) Solid Q
d) Solution M

ii) Write a chemical equation for the reaction in step I. (1 mark)

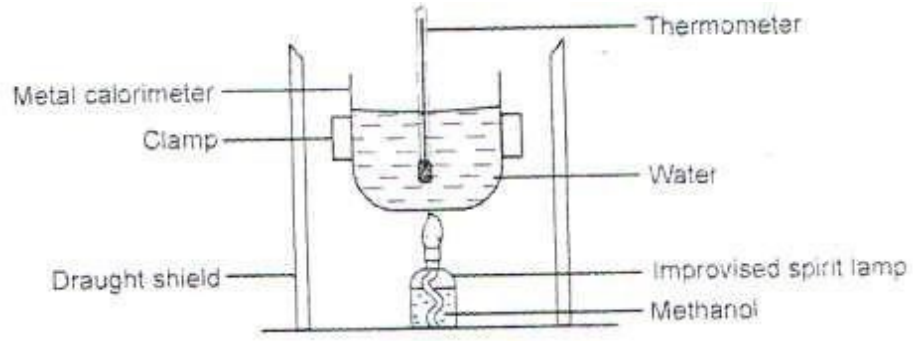
iii) Write the chemical equations for the formation of the following compounds. (3 marks) a) Solid G
b) Gas D
c) Light blue solution C

iv) State the confirmation test for oxygen gas. (1 mark) v)
Write the ionic equation for reaction taking place in process P. (1 mark)

vi) State one industrial use of oxygen. (1 mark)

---

5. The diagram below shows a set-up that was used to determine the molar heat of combustion of methanol.

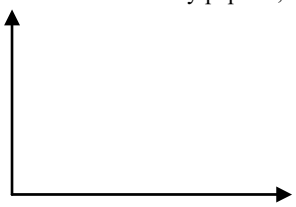


During the experiment, the information below was recorded.
Volume of water=300cm^3
Initial volume of water =24^{0}C
Final temperature of water=47.5^{0}C
Mass of methanol+lamp before burning=142.8g
Mass of methanol+lamp after burning=141.8g
Calculate the;

a) Heat evolved (2 marks)
(Density of water=1g/cm^3, specific heat capacity of water=4.25J/g/k)

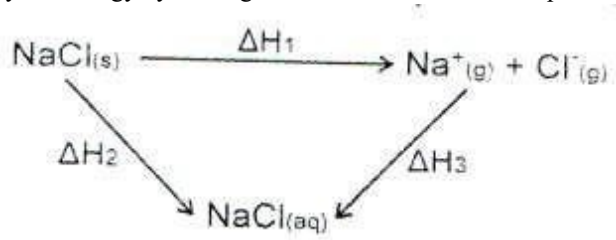
b) Molar heat of combustion of methanol. (3 marks)
(Mass of methanol=32g)

c) i) Write the thermo chemical equation for the combustion of methanol. (1 mark)
ii) Draw an energy level diagram for the reaction in c (i) above. (2 marks)



d) The value of molar heat of combustion of methanol in (b) above obtained is less than the theoretical value. State two sources of error in this experiment. (2 marks)

e) Study the energy cycle diagram below and answer the questions that follow.



i) What does H_1 and H_2 represent? (2 marks)

H_1 H_2 ii) Show the relationship between H_1 H_2 and H_3. (1 mark)

6. Use the standard electrode potential given below to answer the questions that follow.

			E^0 (volts)
$A_{2(aq)}+2e^-$	⟶	$A_{(s)}$	-2.90
$B_{2(aq)}+2^-$	⟶	$B_{(s)}$	-2.38
$C_{2(aq)}+2e^-$	⟶	$C_{(s)}$	0.00
$D^{2+}{}_{(aq)}+2e^-$	⟶	$D_{(s)}$	+0.34
$\frac{1}{2}F_{2(g)}+e^-$	⟶	$F_{-(aq)}$	+2.87

a) i) Which element is likely to be hydrogen? Give a reason for your answer. (2 marks)

ii) What is the E^0 value of the strongest reducing agent? (2 marks)

iii) In the space provided, draw a labeled diagram of electrochemical cell that would be obtained when the half-cells of elements B and D are combined. (2 marks)

iv) Calculate the E^0 value of the electrochemical cell constructed in (iii) above. (1 mark)

b) During the electrolysis of aqueous copper (II) sulphate using copper electrodes, a current of 0.2A was passed through the cell for 5 hours.

i) Write an ionic equation for the reaction that took place at the anode. (1 mark)

ii) Determine the change in mass of the anode which occurred as a result of the electrolysis process. (Cu=63.5, IF=96,500C) (2 marks)

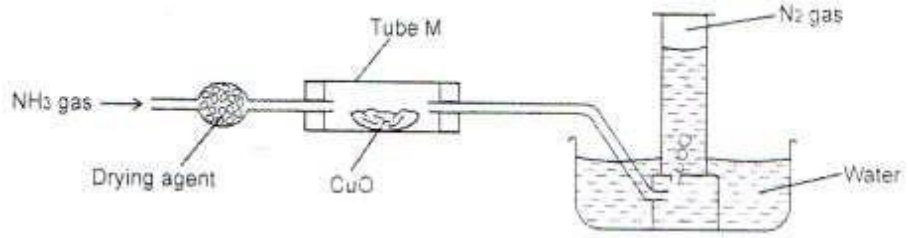
7. a) In the Harbour process, ammonia is produced by the reaction between hydrogen and nitrogen according to the equation.

$N_{2(g)}+3H_{2(g)} \longrightarrow 2NH_3(g)$ H=-ve

Explain how the following would affect the yield of ammonia.

i) Increase in temperature. (1 ½ marks) ii) Increase in pressure. (1 ½ marks)

b) The set up below was used by a student to pass dry ammonia gas over heated copper (II) oxide.



i) Give two observations made in the combustion tube M. (1 mark) ii) Name a suitable drying agent. (1 mark)

c) In the experiment the student passed dry ammonia over 477g of copper (II) oxide until the reaction was complete.

i) Write an equation for the reaction that took place. (1 mark) ii) What property of ammonia is shown by the experiment? (1 mark) iii)

Calculate the mass of the copper produced. (Cu=63.5, O=16) (2 marks) iv)
Calculate the volume of the gas produced at s.t.p. (2 marks)
(Molar gas volume at s.t.p 22.4dm^3)

d) Name one another gas that has this property shown by ammonia. (1 mark)

e) Name the catalyst used in preparation of ammonia and state how it can be made more effective. (1 mark)

233/3
CHEMISTRY
THEORY
PAPER 3
2 HOURS

---

1. You are provided with:

- ✓ Solution E, 0.99M hydrochloric acid
- ✓ Solution F containing 15.3g per litre of a basic compound G_2X, $10H_2O$

You are required to

- ✓ Place solution E in a burette.
- ✓ Pipette 25cm3 of solution F into a 250cm3 conical flask. Add two drops of methyl orange indicator and titrate. Record your results in the table below. Repeat the procedure two more tiems and complete table 1.

a (i) **Table I**

	I	II	III
Final burette reading, (cm^3)			
Initial burette reading, (cm^3)			
Volume of solution E used, (cm^3)			

ii) What is the average volume of solution E? (1 mark)

b) Given that one mole of F reacts with 2 moles of E, calculate the

i) Number of moles of the basic compound, G_2X, $10H_2O$ in the volume of solution F used. (2 marks)

ii) Concentration of solution F in the moles per litre. (2 marks)

iii) Relative formula mass of the basic compound G_2X, $10H_2O$. (2 marks)

iv) Relative atomic mass of G. (Relating formula mass of X=156, atomic masses of H=1.0, O=16.0). (2 marks) **2.**

You are provided with:

- ✓ Magnesium ribbon labeled solid K.
- ✓ 2.0M hydrochloric acid labeled solution L.
- ✓ Stop watch

You are required to determine the rate of reaction between Magnesium and hydrochloric acid at different concentrations.

Procedure

I Place first test tubes on a test-tube and label them 1, 2, 3, 4 and 5. Using a 10cm^3 measuring cylinder, measure out the volumes of 2.0M hydrochloric acid, solution L as shown in table II and pour them into the corresponding test-tubes. Wash the measuring cylinder and use it to measure the volumes of water as indicated in the table and pour into the corresponding test-tubes.

II Cut out five pieces of each of exactly 1cm length of Magnesium ribbon.

III Transfer all of the solution in test-tube 1 into a clean 100cm^3 beaker. Place one piece of Magnesium into the beaker continuously ensuring that the magnesium is always inside the solution. Record in the table the time taken for the magnesium ribbon to disappear. Wash the beaker each time.

IV Repeat procedure III for each of the solutions in the test-tubes 2, 3, 4 and 5 and complete the table.

Test tube number	1	2	3	4	5
Volume of solution L (cm^3)	10	9	8	7	6
Volume of water (cm^3)	0	1	2	3	4
Time taken (sec)					
Rate of reaction=$^1/_{time}$					

(5 marks) b) i) Plot a graph of rate of reaction against $^1/_t$ $(y-axis)$volume of solution L. (3 marks) ii) Use the graph to determine the time that would be taken for a 1cm length of magnesium ribbon to disappear if the

volume of the acid, solution L used was 7.5cm^3. (2 marks) iii) In terms of rate of reaction, explain the shape of your graph. (2 marks)

3. a) You are provided with Solid C. You are required to:

i) Carry out the tests described below on this solid.

ii) Record all your observations and inferences accordingly.

Procedure

i) Place a little amount of solid C in a dry boiling tube and heat it gently.

Observation	Inference
(½ mark)	(½ mark)

ii) Add 10cm^3 of distilled water to the remaining amount of solid C and shake well. Divide the resulting solution into two portions.

Observation	Inference
(1 mark)	(1mark)

iii) Add 3-4 drops of lead (II) nitrate solution to the first portion.

Observation	Inference
(1 mark)	(1 mark)

iv) Add 2M sodium hydroxide, followed by three drops of hydrogen peroxide to the second portion.

Observation	Inference
(1 mark)	(1 mark)

b) You are provided with substance J. You are required to:

i) Carry out the tests described below on the substance J. ii) Record all observations and inferences accordingly. iii) Describe the appearance of J.

Procedure

i) Place a little of substance J in a metallic spatula. Ignite it in a blue Bunsen burner flame.

Observation	Inference
(1 mark)	(1 mark)

ii) Place a little of substance J in a boiling tube. Add some distilled water and shake the mixture well. Test the solution with full range pH paper (universal indicator paper).

Observation	Inference
(1 mark)	(1mark)

iii) Place about 1cm^3 of substance J in a test tube. Add a small piece of sodium hydrogen peroxide.

Observation	Inference
(1 mark)	(1 mark)

iv) To about 3cm^3 of J in a boiling tube, add acidified potassium dichromate (VI) and warm the mixture.

Observation	Inference
(1 mark)	(1 mark)

KCSE PREDICTION 12 2022
233/1
CHEMISTRY (THEORY) PAPER
FORM FOUR
TIME: 2HOURS
JULY EDITION 2022

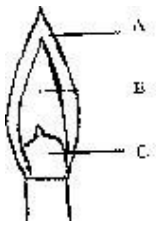
SECTION A
Answer ALL questions.

1. Use the following half cell standard electrode potentials to answer the questions that follow.

Reduction Equation	Electrode Potentials (Volts)
$A^{2+}(aq) + 2e^-$	-0.76
$B^{+}(aq) + 2e^-$	-0.13
$C^{+}(aq) + 2e^-$	+0.84
$D^{+}(aq) + 2e^-$	+0.34

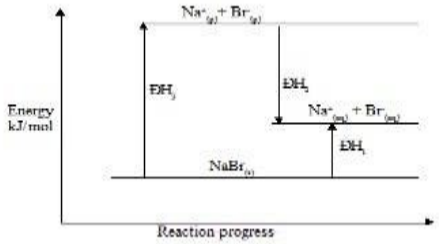
i) Select two half cells which give you the largest e.m.f when combined. (1mark)
ii) Calculate the e.m.f of the cell formed in (i) above (2marks)

2. i) The diagram below represents a non luminous flame of a Bunsen burner. Name the parts labelled A, and C. (1mark)



ii) A luminous flame preferred for lighting. Explain. (1mark)

3. Study the energy level diagram below and answer the questions that follow it.



(1mark)

a) What name is given to the energy changes labelled.
ĐH1

ĐH2

b) Given the following energy values

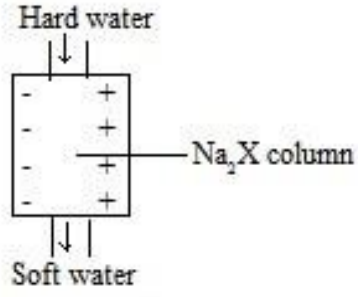
$H_1 = +4kjmol^{-1}$

$H_3 = -741$ kj/mol

Calculate the value of ĐH2 (1mark)

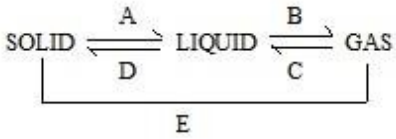
4. Explain how you would obtain lead carbonate from a mixture of lead carbonate and sodium carbonate. (2marks)
5. Hardness in water is caused by dissolved salts.
a) Which cations cause water hardness. (1mark)

b) Explain how the following apparatus soften hard water. (2marks)



6. The flow chart below shows the physical changes of matter. Study it and answer the questions that follow.

a) Name the processes A - E (2mks)



b) Give two examples of substances that undergo process E. (1mk)

7. The table below gives the pH values of solution A - D.

Solution	A	B	C	D
pH	5.0	7	6.5	8.0

Which solution is likely to be

i) Wood ash (½mk) ii) Common salt (½ mk) iii) Rain water (½ mk) iv) Lemon juice (½ mk)

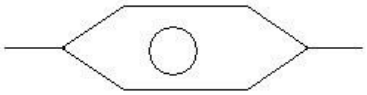
8. A dynamic equilibrium between chromate (VI) ions and chromium ions is as shown below

$$Cr_2O_7^{2-}(aq) + 14H^+(aq) \rightleftharpoons 2Cr^{3+}(aq) + 7\,H_2O(l)$$

Orange Green

State and explain the observations made when dilute sodium hydroxide solutions are added to the equilibrium (2mks)

9. The following is a structure of a cleansing agent



i) State the type of cleansing agent dawn above. (1mk) ii) State one disadvantage of using the cleaning agent drawn above. (1mk) b) State one use of polychloroethene (1mk)

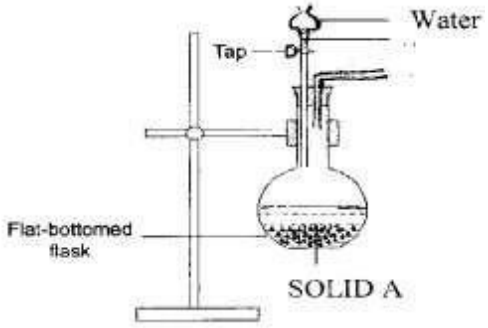
10. The setup below was used to prepare a sample of oxygen gas.

a) Complete the set up. (1mk)

b) Name solid A. (1mk)

c) Write a balanced chemical equation for the reaction that took place. (1mk)

11. Draw the structure and name isomers of butane. (2mks)



12. Use the information in the table below to answer the questions that follow. The letters do not represent the actual symbols of the elements.

Elements	A	B	C	D	E
Atomic numbers	12	6	4	6	15
Mass numbers	24	12	9	13	31

a) Which two letters represent the same element. Give a reason. (2mks)

b) Calculate the number of neutrons in Element C. (1mk)

c) What is the role of neutrons in the nucleus. (1mk)

13. Explain the following observations

a) Atomic radius decreases across period three. (1mk)

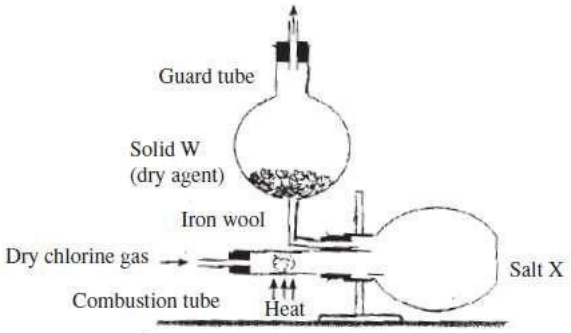
b) Sodium is more reactive than magnesium (1mk)

14. a) Name the process by which butene gas molecules are converted to into a giant molecule. (1mk) b) Draw the structure of the giant molecule formed by butene molecules in (a) above (1mk)

15. Using dots (•) and crosses (X) diagrams, show how the following compounds form .

i) Ammonia (1mk) ii) Nitrogen molecule (1mk)

16. The diagram below shows a setup for preparation of anhydrous salt X. Study it and answer the questions that follow.

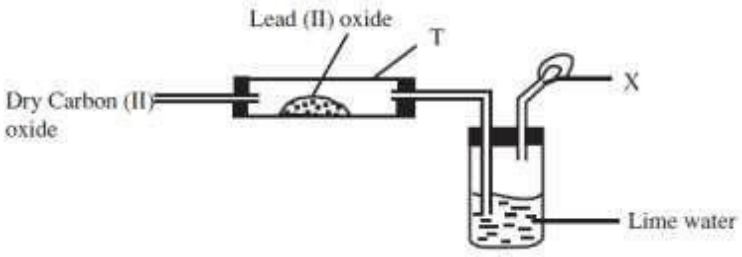


a) Identify the method of preparing salts. (½ mk)

b) Give the name of salt X (½ mk)

c) Why is it not possible to collect salt Z in the combustion tube. (1mk)

17. The diagram below shows a reaction of carbon (II) oxide on lead (II) oxide.



a) Identify the missing condition for this reaction to take place. (½ mk)

b) State the observation made in the combustion tube T at the end of the experiment. (1mk)

c) State two uses of carbon (IV) oxide. (1mk)

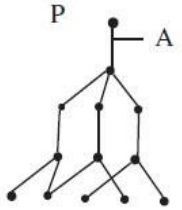
18. Calculate the solubility of glucose in water at 40^0C from the following information. (2mks) Mass of evaporating dish = 23.0g

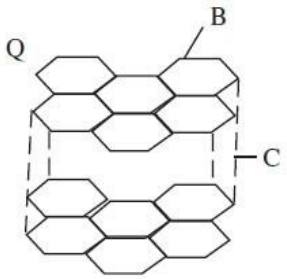
Mass of evaporating dish + saturated solution = 192.0g

Mass of evaporating dish + dish after evaporation = 142.0g

19. The diagram below shows the allotropes of carbon. Study them and answer the questions that follow.

i) Name the bonds feel. Explain. conductor of





allotropes P and Q. (1mk) ii) State the types of labelled A and C. (1mk) iii) Q has a greasy (1mk) iv) Which of the allotropes is a good electricity? Explain. (1mk)

20. Study the reaction below and answer the equations that follow

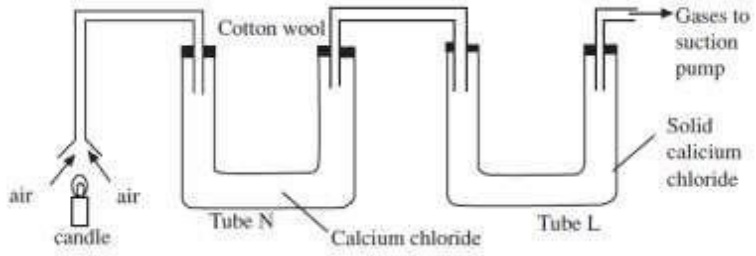
NH3(g) + H2O(l) $NH_4^+(aq) + OH^-(aq)$

a) Define an acid. (½ mk)

b) Identify an acid in the above reaction. Explain your answer. (1mk)

21. a) Candle wax is normally a compound consisting of two elements. Name the elements. (1mk)

b) The set up below was used to investigate the burning of a candle. Study it and answer the questions that follow.



i) What would happen to the burning candle if the pump was put off. Give reasons. (1mk)

ii) State and explain the changes in mass that are likely to occur in tube N by the end of the experiment. (2mks) iv) When the candle was burnt completely, the total mass of the product was found to be greater than the original mass of the candle. Explain. (1mk)

iv) Name another substance that can be used instead of calcium chloride in tube L. (1mk)

22. A radioactive decay series can be represented as below

A → B → C

State the mass number and atomic number of elements B and C. (2mks)

23. Use the grid below to answer the questions that follow.

I	II		III	IV	V	VI	VII	VIII
F								
				Q				
O			B	P		R	S	A
T	E		C				U	
V							Z	

a) Which element forms an ion with a charge of -2. Explain. (1mk)

b) Give the family name of S, U, Z. (½ mk)

c) How do the reactivity of the following compare T and V. (1mk)

d) Select an element with the largest atomic radius. Give a reason. (1mk)

e) Which type of bond exists between B and S. Give a reason? (1½mk)

24. $100cm^3$ of a sample of ethane gas diffuses through a porous pot in 100 seconds. What is the molecular mass of gas Q if $10cm^3$ of the same gas diffuses through the same porous pot in 121 seconds.

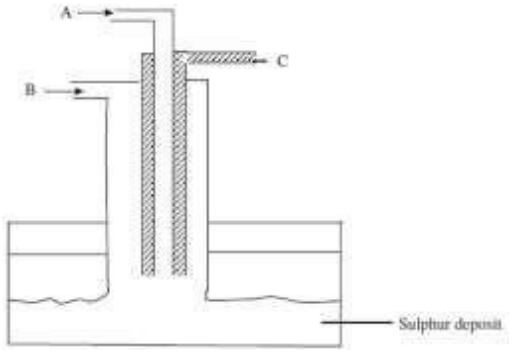
(C = 12.0, H = 1.0) (2mks)

25. During purification copper by electrolysis, 1.48 of copper were deposited when a current was passed through aqueous copper

(II) sulphate for 2 ½ hours. Calculate the amount of current that was passed. (Cu = 63.5, 1F = 96500C) (3mks) 26. A substance contains 57.5% sodium, 40% oxygen and the rest is hydrogen.

(Na = 23, H = 1.0, O = 16.0). Calculate its simplest formular. (3mks)

27. The diagram below shows extraction of sulphur by frasch process. Study it and answer the questions that follow.



a) Identify the substances that pass through pipes A, B and C. (1½ mks)

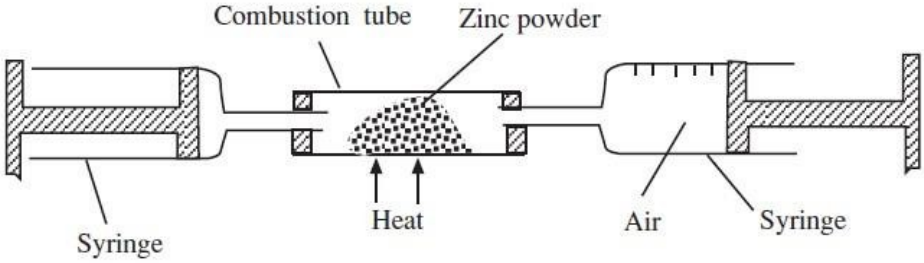
b) Name two allotropes of sulphur. (1mk)

28. Bronze is an alloy of copper and another metal.

i) Name the other metal (½ mk)

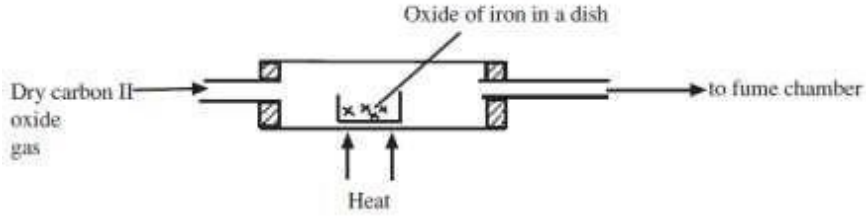
ii) Give one use of bronze (1mk)

29. In an experiment a certain volume of air was passed repeatedly from syringe over heated zinc powder as shown in the diagram below.



The experiment was repeated using excess magnesium powder. In which one of the two experiments was the change in volume of air greatest. Give reasons. (3mks)

30. Excess carbon (II) oxide was passed over heated of an oxide of iron as shown below.



The data obtained was recorded as shown below.

Mass of empty dish = 10.98g

Mass of empty dish + oxide of iron =

Mass of empty dish + residue = 12.66g

i) Write an equation for the reaction which took place in the dish. (1mk)

ii) Determine the formula of the oxide of iron.

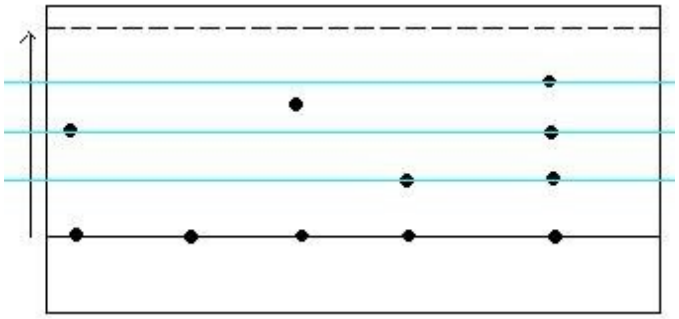
(Relative formula mass of the oxide of iron is 232 , Fe = 56.0, O = 16.0) (3mks)

233/2
CHEMISTRY
(THEORY) PAPER 2
FORMFOUR
TIME: 2HOURS

1. The grid below represents a section of the periodic table. Study it and answer the questions that follow.

							L
A				D	M	G	I
B	C		E		F	H	J
N							K

a) Give the formular of the compound formed between C and M. (1mk)
b) Which element form a stable trivalent cation? (1mk)
c) Identify the least reactive element. (1mk)
d) Which element exist as a mono-atomic gas? (1mk) e) Write the electron arrangement of the following ions;
i) N^{+}
ii) C^{2+} (2mks) f) How do atomic radius of C and J compare? Explain. (2mks)
g) Explain how the melting point of J and K compare. (2mks)
h) Identify an element which: (2mks) i) Is the most electronegative ii) Is the strongest reducing agent
2. The diagram below shows chromatograms for five different dyes



a) Name the technique used to separate the dyes. (1mk)

b) What is meant by the term solvent front?
Indicate its position in the diagram. (2mks)

c) Which letters represent? (2mks)

i) Baseline (origin)

ii) Solvent path

d) Which chromatograms were present in dye E? (2mks)

e) Which dye is pure? Explain (2mks)

f) Which dye is

i) Insoluble (Does not move) (1mk)

ii) Most soluble (Moves fastest) (1mk)

g) Give one condition required to separate the chromatograms present in a dye? (1mk)

3. a) What name is give to a compound that contains carbon and hydrogen only? (½ mk)

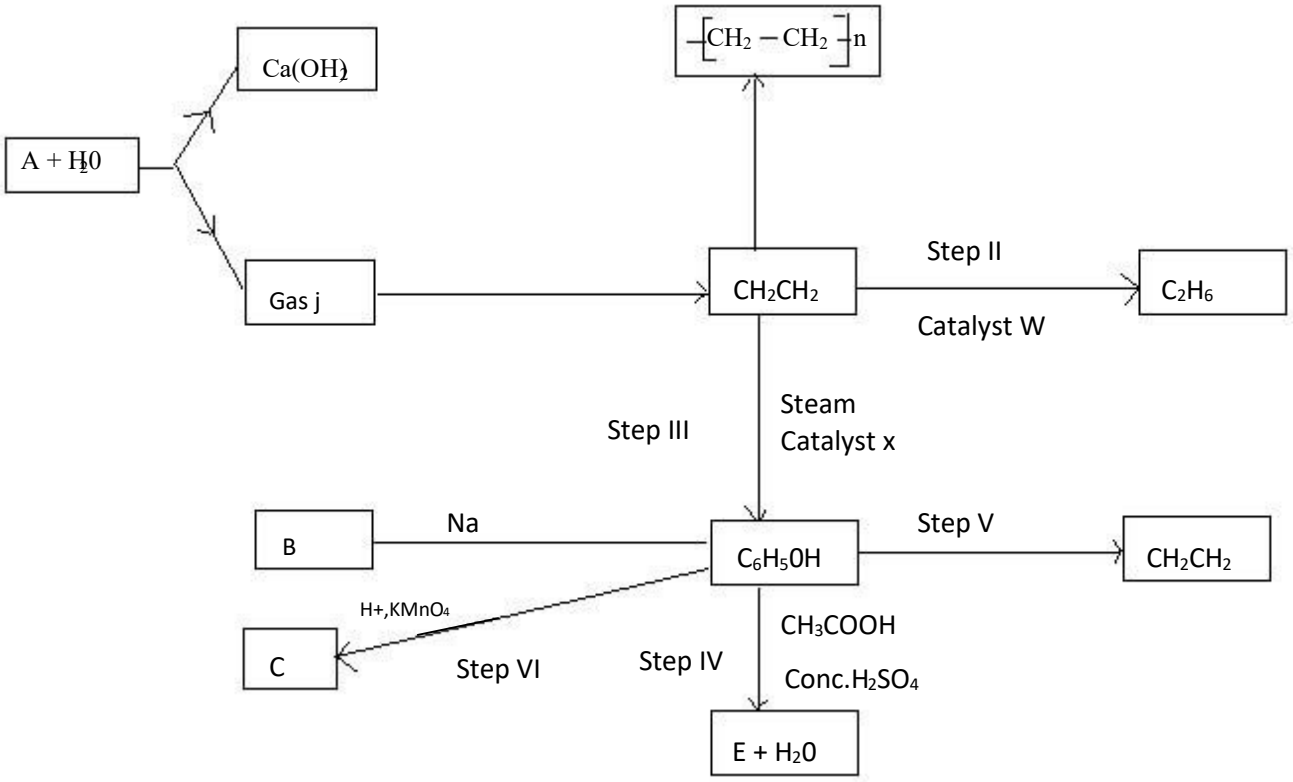
b) Hexane is a compound containing carbon and hydrogen

i) What method is used to obtain hexane from crude oil? (1mk)

ii) State one use of hexane. (1mk)

---

c) Study the flow chart below and answer the questions that follow.



i) Identify substances; A , B ,C and gas J (2 mks)

ii) Name steps I , III, IV and V (2mks)

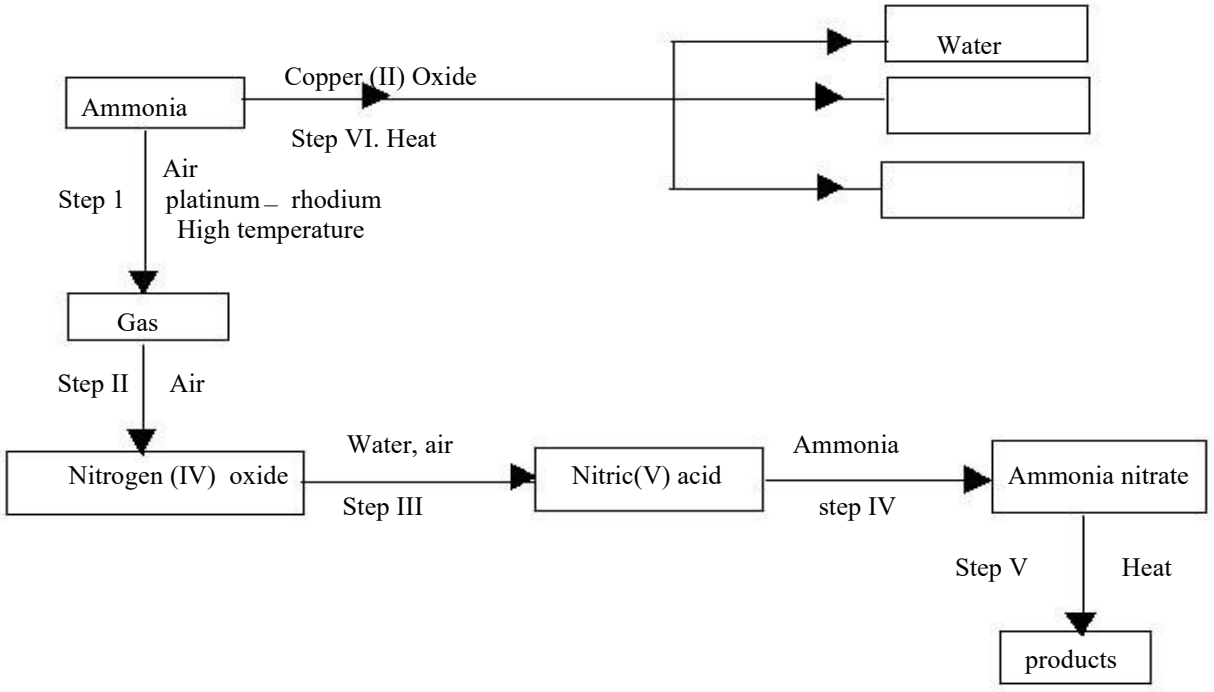
iii) What is the industrial importance of process represented by Step II (1mk)

iv) Name the catalysts W and X (1mk)

v) Draw the structural formula of product E in Step IV. (1mk) vi) Write a correct chemical equation for the reaction that leads to formation of substance B. (1mk) vi) Explain why the reaction between 1g Sodium carbonate and 2M hydrochloric acid is faster than the reaction between 1g Sodium Carbonate and 2M ethanoic acid. (2mks)

4. a) Describe the process by which nitrogen is obtained from air on a large scale. (3mks)

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



i) Identify gas J. (1 mk)

ii) Using oxidation numbers, show that ammonia is the reducing agent is step VI. (2mks) iii) Write an equation for the reaction that occurs in Step (IV). (1mk

iv) Give one use of ammonium nitrate. (1mk)

c) The table below shows the observations made when aqueous ammonia was added to cations of elements E,F and G until excess.

Cation of	Addition of few drops of NH_4OH solution	Addition of excess NH_4OH solution
E	White precipitate	Insoluble
F	No precipitate	No precipitate
G	White precipitate	Dissolves

i) Select the cation that is likely to be;
Zn2+ (1mk)
Ca2+ (1mk)

ii) Given the formula of the cation of element E is $E^{3+}(aq)$, write the ionic equation for the reaction between E^{3+} and aqueous NH4OH solution. (1mk)

5. a) The table below shows the standard reduction potential for half-cells. Study it and answer the questions that follow. (Letters are not the actual symbols of the elements)

E^{θ}(Volts)

$F_2(aq) + 2e \rightarrow 2F^-(aq)$; +0.54

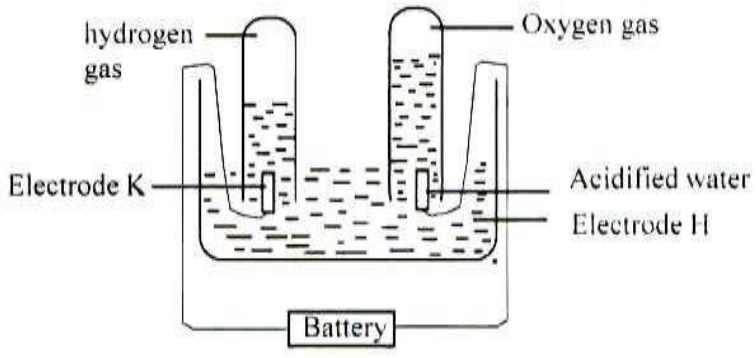
$G^{2+}(aq) + 2e \rightarrow G(s)$; - 0.44

$H^{2+}(aq) + 2e \rightarrow H(s)$; +0.34

$2J^-(aq) + 2e \rightarrow J$; 0.00

i) Identify the strongest reducing agent. (1mk) ii) Write the equation for the reaction which takes place When solid G is added to a solution containing H^{2+} ions. (1mk) iii) Calculate the E^0 value for the reaction in (ii) above. (1mk) iv) Construct an electrochemical cell for (ii) above. (3mks)

b) The diagram below shows the apparatus that can be used to electrolyte acidified water to obtain hydrogen and oxygen gases. Study it and answer the questions that follow.



i) Identify the electrode at which oxidation takes place. (1mk) ii) Give a reason why it is necessary to acidify the water. (1mk) iii) Explain why hydrochloric acid is not used to acidify the water. (1mk)

c) During electrolysis of aqueous Copper (II) Sulphate 144,750 coulombs of electricity were used. Calculate the mass of copper metal that obtained. (3mks)
(Cu = 64, I Faraday = 96500 coulombs)

6. Sodium thiosulphate solution reacts with dilute hydrochloric acid according to the following equation.

$S_2O_3^{2-}(aq) + 2H^+(aq) \rightarrow H_2O(l) + SO_2(g) + S(s)$

In an experiment to study how the rate of reaction varies with concentration. $10cm^3$ of 0.4M Sodium thiosulphate was mixed with $10cm^3$ of 2M hydrochloric acid in a flask. The flask was placed in a white paper marked with a cross X. The time taken for the cross X to be come invisible when view from above was noted and recorded in the table below. The experiment was repeated three items as the temperature using volumes in the table and the results recorded as shown in the table below.

Experiment	Volume of 0.4m thiosulphate (cm^3)	Volume of water (cm^3)	Volume of 2MHCl(cm^3)	Time
1	10	0	10	16
2	7.5	2.5	10	23
3	5.0	5.0	10	32
4	2.5	7.5	10	72

a) i) On the grid provided , plot a graph of the volume of thiosulphate (vertical axis) against time taken for the cross (X) to become invisible. (3mks) ii) From the graph determine how long it would take for the cross (X) to become invisible if the experiment was done.

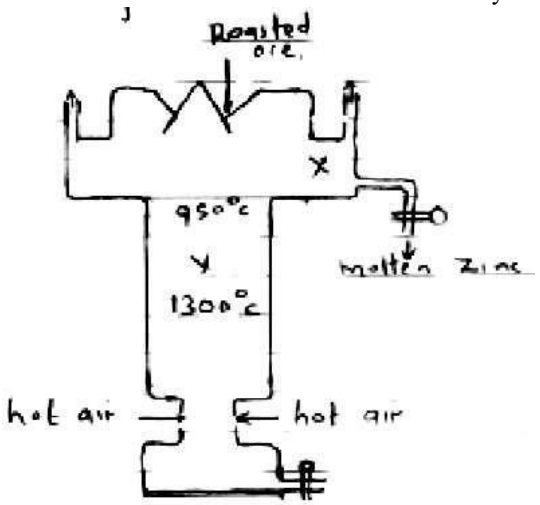
I Using $6cm^3$ of the 0.4M thiosulphate (1mk)

II Using $6cm^3$ of 0.2M thiosulphate solution (1mk) b) i) Using values of experiment I. Calculate

I moles of thiosulphate used. (1mk) II Moles of hydrochloric acid used. (1mk) ii) Explain which of the two reactants in experiment I controlled the rate of the reaction? Explain. (1mk) c) Give two precautions which should be taken in experiments above to ensure that consistent results are obtained. (2mks)

7. The melting and boiling points of zinc are 419^0C and 907^0C respectively. One of the ores of Zinc i) Zinc blende.To extract Zinc, the ore is first roasted in air before introducing it into the furnace.

a) i) Write the formula of the main Zinc compound in Zinc blende (1mk) ii) Explain using an equation why it is necessary to roast the ore in air before introducing it into the furnace. (2mks) b) The diagram below shows a simplified furnace used in the extraction of Zinc. Study it and answer the questions that follow:



i) Name two other substances that are also introduced into the furnace together with roasted ore. (1mk) ii) The main reducing agent in the furnace is carbon (II) oxide. Write two equations showing how it is formed. (2mks) iii) In which physical state is Zinc at point Y in the furnace? Give a reason. (1mk) iv) Suggest a value for the temperature at point X in the furnace. Give a reason. (1mk) v) State and explain one environmental effect that may arise from the extraction of Zinc from Zincblende. (2mks) vi) Give two industrial uses of Zinc. (1mk)

CONFIDENTIAL

This document must not be seen by the candidates whatsoever.

CONFIDENTIAL INSTRUCTION TO SCHOOLS

In addition to the apparatus and fitting found in the laboratory, each candidate will require the following.

1. 2g Solid D
2. 3 boiling tubes (Pyre recommended)
3. 10ml measuring cylinder
4. Distilled water
5. Filter funnel
6. Filter paper
7. 6 test tubes
8. 10ml liquid F (absolute propan-2-ol)
9. Watch glass
10. Wooden splint
12. Burette
11. 2g sodium carbonate
13. Pipette and pipette filler
14. Thermometer
15. 250ml volumetric flask
16. 1 label
17. 3 conical flasks 250ml
18. 4.5g of solid P (accurately weighted) Oxalic acid

In addition the student should have access to:

19. Water bath (maintained at about 80°C)
20. 2M Sodium hydroxide
21. 2M Sulphuric (VI) acid
22. 2M Hydrochloric acid
23. 2M Barium nitrate
24. 2M Potassium dichromate
25. 2M Ammonium hydroxide
26. 2M Nitric acid
27. Bromine water

NOTES

1. Solid D is prepared by mixing small amounts of Zinc sulphate and Zinc carbonate
2. Potassium dichromate VII is prepared by dissolving 20gm in 400cm³ of 2M H_2SO_4 acid and then topping up to one litre solution.
3. Water bath should be maintained at about 80°C using a low flame to avoid breakage of beaker.

233/3
CHEMISTRY (PRACTICAL)
FORMFOUR

TIME: $2\frac{1}{4}$ HOURS

---

1. You are provided with:

- 4.5g of solid **P** in a boiling tube.
- Solution W, 0.2M sodium hydroxide
- Phenolphthalein indicator

You are required to determine: i) The solubility of solid **P** at different temperatures ii) The value of **n** in the formula $(HX)n \cdot H_2O$ of solid **P**.

PROCEDURE 1

i) a) Fill the burette with distilled water. Using the burette, add 4.0cm^3 of distilled water to solid **P** in a boiling tube. Heat the mixture in a water bath while stirring with a thermometer to about 70^{0}C until all the solid dissolves.

b) Allow the solution to cool while stirring with the thermometer and note the temperature at which crystals of solid **P** start to appear. Record this temperature in table 1.

c) Using the burette, add 2.0cm^3 of distilled water to the contents of the be boiling tube. Heat the mixture while stirring with the thermometer until all the solid dissolves while in the water bath.

d) Allow the mixture to cool while stirring and note the temperature at which crystals of solid **P** start to appear.

e) Repeat the procedure (c) and (d) three more times, heating the solution in a water bath and record the temperature in the table. **Retain the contents of the boiling tube for use in procedure II.**

ii) Complete the table by calculating the solubility of solid P at the different temperatures. (the solubility of a substance is the mass of the substance that dissolves in 100cm^3 (100gm) of water at a particular temperature.

Table 1

Volume of water in the boiling tube (cm^3)	Temperature at which crystals of solid P first appear (^{0}C)	Solubility of solid P (g/100g) of water
4		
6		
8		
10		
12		

(6mks) i) On a grid plot a graph of the solubility of solid **P** against temperature. (3mks)

ii) Using the graph determine the temperature at which 100g of solid P would dissolve in 100cm^3 of water. (1mk) iii) Determine the solubility of solid P at 55^{0}C (1mk)

PROCEDURE II

1. Transfer the contents of the boiling tube into a 250ml volumetric flask. Rinse the boiling tube with the thermometer with distilled water and add to the volumetric flask. Add more distilled water to make up to the mark. Label this solution P.

Fill the burette with solution P using a pipette and pipette filler place 25.0cm^3 of solution Q into a conical flask. Titrate solution Q with solution P. Using Phenolphthalein indicator.

Table II

(4mks)

Calculate the;

	I	II	III
Final burette reading cm^3			
Initial burette reading cm^3			
Volume of solution P used cm^3			

i) Average volume of solution P used in the experiment (1mk) ii) Number of moles of sodium hydroxide used in solution Q. (2mks) iii) Number of moles of solution P given that the relative formula mass P, $(HX)_n \cdot 2H_2O$ is 126. (2mks)

iv) The number of moles of sodium hydroxide required to react with one mole of P. Hence find the value of n in formula $(HX)_n \cdot 2H_2O$. (2mks)

2. You are provided with a solid labelled D. Carry out the following test, record the observation and make the correct inferences.

a) Place solid D in a boiling tube and add about $40cm^3$ of distilled water while shaking. Filter the mixture and divide the filtrate into four portions, keep the residue for part (b)

i) To the first portion, add sodium hydroxide dropwise till in excess

Observation Inferences
1mk 1mk

ii) To the second portion, add a few drops of dilute sulphuric (VI) acid.

Observation Inferences
1mk 1mk

iii) To the third portion, add few drops of barium nitrate solution. Followed by few drops of dilute hydrochloric acid.

Observation Inferences
1mk 1mk

b) Place the residue in (a) above in a boiling tube. Add dilute nitric (V) acid while shaking till the solid just dissolves. Divide the solution into two portions.

Observation Inferences
(½ mk) (½ mk)

i) To the first portion, add a few drops of sodium hydroxide solution dropwise till in excess.

Observation Inferences
1mk 1mk ii) To the second portion, add a few drops of ammonia solution then in excess.

Observation Inferences
(½ mk) (½ mk)

3. You are provided with liquid F. Carry out the following tests. Write your observations and inferences in the spaces provided.

a) Place about 1cm3 of solution F on a watch glass. Place a burning splint to the solution on the watch glass.

Observation Inferences
1mk 1mk

b) Place about $2cm^3$ of solution F in test tube and add drops of potassium dichromate.

Observation Inferences

c) Place about $2cm^3$ of solution F in a 2nd test tube and add bromine water.

Observation Inferences
1mk 1mk

d) To the 3rd portion of $2cm^3$ of solution F add a spatula of sodium carbonate provided

Observation Inferences
1mk 1mk