Chemistry I

002

15/11/2019
8:30 AM – 11:30 AM

REB
Rwanda Education Board

ORDINARY LEVEL NATIONAL EXAMINATIONS, 2019

SUBJECT: CHEMISTRY

DURATION: 3 HOURS

INSTRUCTIONS:

1) Write your names and index number on the answer booklet as they appear on your registration form and **DO NOT** write your names and index number on additional sheets of paper if provided.
2) Do not open this question paper until you are told to do so.
3) This paper consists of **three** sections: **A**, **B** and **C**.

   Section A: Attempt **all** questions. **(55 marks)**

   Section B: Attempt any **three** questions. **(30 marks)**

   Section C: Attempt **only one** question. **(15 marks)**

4) You do not need the **Periodic Table**.
5) Silent non- programmable calculators may be used.
6) Use only a **blue** or **black** pen.

SECTION A: Attempt all questions (55 marks)

1) a) The atomic number of aluminium is 13.
Draw the structure of aluminium atom (Bohr model) showing electrons on shells. **(1 mark)**

b) Explain why aluminium is used to make electric wires. **(2 marks)**

2) a) Give one example of a mixture having 2 substances that can be separated by decantation. **(1 mark)**

b) In hospitals, blood constituents are separated using centrifuge machines in order to know illnesses of patients.

(i) Explain how the different constituents separate during centrifugation. **(2 marks)**

(ii) State two other mixtures that can be separated by centrifugation in hospitals. **(2 marks)**

3) A sports medal has a total surface area of 150 cm^2 . It was evenly coated with silver by electrolysis. Its mass increased by 0.216g. How many atoms of silver were deposited per cm^2 on the medal surface? **(3 marks)**

(Atomic mass: Ag = 107)
(1 mole = $6.02X10^{23}$ atoms)

4) You want to prepare $ZnSO_4$ using H_2SO_4 and Zn metal:

a) Write the equation of the reaction between Zn and H_2SO_4 solution indicating state symbols. **(2 marks)**
b) Explain the method you would use to obtain $ZnSO_4$ crystals from its aqueous solution. **(2 marks)**

5) An organic compound contains 4.07% hydrogen, 24.27% carbon and 71.65% chlorine by mass. Its molar mass is 99 g/mol.

a) Determine the empirical formula of the compound. **(2 marks)**
b) Determine the molecular formula of the compound. **(2 marks)**

(Atomic mass: C=12, H=1, Cl=35.5)

6) a) Suggest two ways you can use to avoid pollution of water. **(2 marks)**

b) Describe two effects of polluted water to humans. **(2 marks)**

7) Silicon and germanium are metalloids.

a) Give two physical or chemical properties of metalloids. **(2 marks)**
b) State two important uses of silicon on a large scale. **(2 marks)**

8) a) Ethanol is a compound in the homologous series of alcohols.

(i) Write the molecular formula of ethanol. **(1 mark)**

(ii) State one use of ethanol on a large scale. **(1 mark)**

b) Evaluate the social-economic importance of biogas which is produced by the decomposition of cow dung in domestic composts in Rwanda. **(2 marks)**

9) Aluminium is extracted from its ores by means of electrolysis of a solution of Al^{3+}.

a) Write the equation of the reaction which takes place at the cathode during this electrolysis. **(1 mark)**

b) Discuss the economic importance of aluminium to the Rwandan society. **(2 marks)**

10) a) Give two conditions necessary for rusting of iron to take place and hence write the chemical formula of iron rust. **(2 marks)**

b) State two means that can be used to prevent rusting of iron objects. **(2 marks)**

11) Carbon atoms are linked by three (3) covalent bonds in graphite and the fourth electron of every carbon is free and mobile.

a) State one physical properties that results due to the mobility of electrons in graphite. **(1 mark)**

b) Diamond is a carbon allotrope.
State the type of bonding and one of the physical properties of diamond. **(2 marks)**

12) a) Calcium carbonate reacts with hydrochloric acid according to the equation:

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

State two conditions that can be used to obtain the highest rate of production of carbon dioxide at room temperature. **(2 marks)**

b) State one important use of :

(i) calcium carbonate
(ii) calcium oxide. **(2 marks)**

13) In your school laboratory, suppose that some iron debris (pieces) and about 5 ml of water have been accidentally put in a cup half-filled with table salt.
Describe the method you can use to remove the iron and water so that you obtain again the salt in pure form. **(3 marks)**

14) a) Explain why it is dangerous to keep the charcoal stove burning in a house while the doors and windows are closed. **(2 marks)**

b) Explain how biodegradable solid wastes such as remains of plants and animals can be disposed of (dumped) to produce useful products in our homes. **(2 marks)**

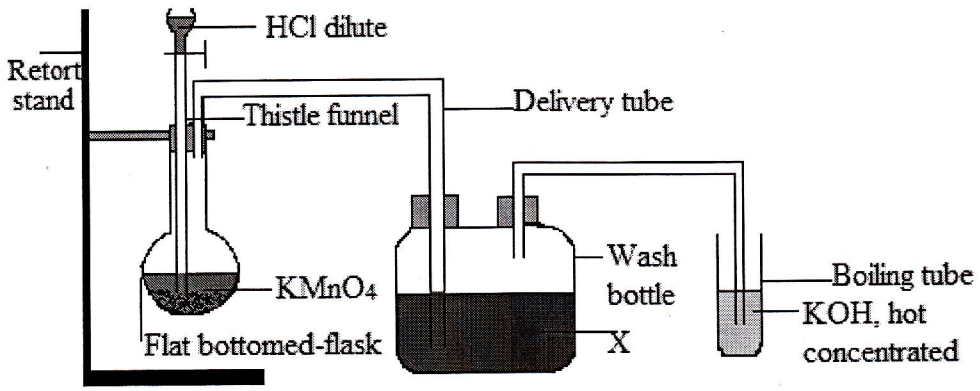
15) Burning magnesium continues to burn when put in pure carbon dioxide.

a) Write the equation of the reaction between Mg and CO_2 **(2 marks)**

b) State two observable changes during the combustion process. **(1 mark)**

SECTION B: Attempt only three questions (30 marks)

16) Study the diagram given below for the production of chlorine gas and answer the questions that follow:



a) Give the name or chemical formula of the substance X present in the bottle. **(1 mark)**

b) Write the equation for the reaction between hydrochloric acid, HCl and cold $KMnO_4$ (potassium permanganate) solution to form chlorine. **(2 marks)**

c) State the colour change in the flat-bottomed flask as the reaction between HCl and $KMnO_4$ proceeds to completion. **(1 mark)**

d) Give a test reagent (substance) for chlorine and describe the observable change for a positive test. **(2 marks)**

e) Suggest one important use of chlorine on a large scale. **(1 mark)**

f) Write the chemical equation for the reaction between Cl_2 and hot, concentrated KOH in the boiling tube. **(2 marks)**

g) State one important use of $KClO_3$. **(1 mark)**

17) During titration, 25 ml of a 0.1 mole/litre Na_2CO_3 solution was poured in a beaker. An appropriate indicator (3 drops of phenolphthalein) was added to the Na_2CO_3 alcaline solution. Titration of $HCl_{(aq)}$ from a burette was done. Neutralisation of the base was reached on addition of 27.50ml of $HCl_{(aq)}$.

Equation:

$$2HCl_{(aq)} + Na_2CO_{3(aq)} \rightarrow 2NaCl_{(aq)} + CO_{2(g)} + H_2O_{(l)}$$

a) State the name of another acid-base indicator that can be used to detect Na_2CO_3 solution and the colour of this indicator in the base. **(2 marks)**

b) Calculate the number of moles of Na_2CO_3 present in 25ml of solution. **(2 marks)**

c) Calculate the number of moles of $HCl_{(aq)}$ in 27.50ml of the solution. **(2 marks)**

d) Calculate the molarity of $HCl_{(aq}$. **(2 marks)**

e) Calculate the mass of anhydrous Na_2CO_3 that was used to prepare 25 ml of the solution. **(2 marks)**

(Atomic mass: Na=23, C=12, O=16)

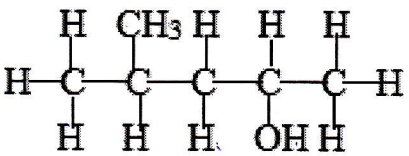
18) a) An organic compound X is constituted of 40% carbon, 6.72% hydrogen and 53.28% oxygen by mass.
(Atomic mass: C=12, H=1, O= 16)

(i) Determine the empirical formula of compound X. **(3 marks)**

(ii) Determine the molecular formula of compound X if its molar mass is 180g/mol . **(2 marks)**

b) Draw the structural formula of the following organic compound:
3,3-dimethyl but-1-ene **(1 mark)**

c) Give the IUPAC name of the following organic compound: **(1 mark)**

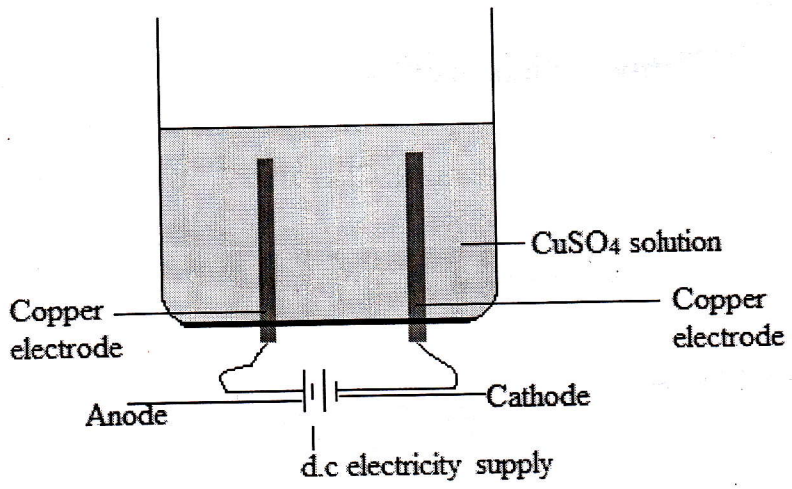


d) Write the structural formula of the organic compound Y obtained in the following reaction:

$$CH_3CH_2OH + K_2Cr_2O_7 + H_2SO_4 \longrightarrow \mathbf{Y}$$ **(1 mark)**

e) State two sources of alcohols. **(2 marks)**

19) Study the diagram for the laboratory electrolysis of copper sulphate solution ($CuSO_4$) using copper electrodes and answer the questions that follow.



a) Write the chemical symbols of all ions present in $CuSO_4$ solution. **(2 marks)**

b) Write the chemical equation of the reaction that takes place at the: **(2 marks)**
   (i) Anode
   (ii) Cathode

c) What will be the product of the reaction at the anode if copper electrodes are replaced with carbon electrodes? **(1 mark)**

d) State two useful applications of electrolysis of copper sulphate on a large scale. **(2 marks)**

e) Two iron nails are put in 20 ml of a 0.05 mole/litre solution of copper sulphate in a boiling tube and are kept there for one week;
   (i) State **two** observable changes in the boiling tube after one week. **(1 mark)**
   (ii) Write the chemical equation for the reaction between iron, Fe and copper ions in the solution (include state symbols). **(2 marks)**

20) Study the table shown below and answer the questions that follow:

Mixture	Reacts or no reaction
$Fe_2O_3 + Zn$	Reacts
$PbO + Fe$	Reacts
$PbO + Zn$	Reacts
$MgO + Zn$	No reaction

a) Arrange the metals Fe, Pb, Mg, and Zn in order of increasing reactivity (start from the least reactive). **(3 marks)**

b) Construct a balanced equation for the reaction of iron oxide, Fe_2O_3 with Zinc, Zn. **(2 marks)**

c) A student prepared zinc sulphate by adding powdered zinc carbonate to a beaker half-filled with dilute sulphuric acid.

Equation:

$$ZnCO_3 + H_2SO_4 \longrightarrow ZnSO_4 + CO_2 + H_2O$$

Describe the method that can be used to show that all the zinc carbonate has reacted. **(2 marks)**

d) Give a reagent or set of reagents that can be used to test for the presence of Zn^{2+} ions in a solution and the observation made. **(2 marks)**

e) Give one reason to explain why aluminium is used in the manufacture of aircrafts. **(1 mark)**

SECTION C: Attempt only one question (15 marks)

21) a) Describe the term "polymerization". **(1 mark)**

b) State two different uses of polymers. **(2 marks)**

c) Describe the technique used during the separation of various fractions of crude oil in the refining process. **(2 marks)**

d) Write the chemical equation between methanoic acid and potassium hydroxide and give the product of the reaction. **(2 marks)**

e) Discuss the economic importance and environmental effects of the deposition of cow dung in domestic composts in Rwanda for the production of methane (biogas). **(3 marks)**

f) Give two reasons to explain why alkanes are preferred for use as fuels instead of alkenes. **(2 marks)**

g) Calculate the volume which is occupied by 4.2g of CH_4 gas at 45^0C and at 1520 mmHg of pressure. **(3 marks)**

(Atomic mass: C = 12, H =1)

(1 mole of a gas occupies 24 dm^3 at 25^0C and 760 mmHg pressure)

22) The relative densities of oxygen O_2 and carbon dioxide CO_2 are 16 and 22 respectively. It is found that 25 cm^3 of carbon dioxide CO_2 diffuses out in 75 seconds.

a) State Graham's law of diffusion of gases. **(2 marks)**

b) Calculate the volume of oxygen that will diffuse in 100 seconds. **(4 marks)**

c) State Charles' law of ideal gases that relates the variation of gas volumes with temperature change. **(1.5 marks)**

d) State Boyle's law of ideal gases that relates the variation of gas volumes with pressure change. **(1.5 marks)**

e) The volume of an ideal gas is 1500 cm^3 at 17 ^0C and 700 mmHg of pressure.

i) Calculate the volume of this gas at 0 ^0C and 760 mmHg. **(2 marks)**

ii) Calculate the number of moles of this gas present in the above volume. **(2 marks)**

f) Discuss the important effects of gases in **either** inflated vehicle tyres, **or** during the process of rotation of engines when combustion of fuel takes place in engine cylinders. **(2 marks)**

(0 ^0C = 273 Kelvins, 1 mole of a gas occupies 22400 cm^3 at 0 ^0C and 760 mmHg pressure)