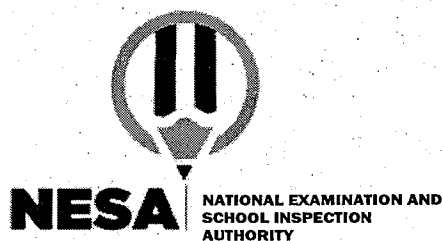


Chemistry I

002

23/07/2021 08.30 AM - 11.30 AM



ORDINARY LEVEL NATIONAL EXAMINATIONS, 2020-2021

SUBJECT: CHEMISTRY I

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 answer sheets 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 in this section (55 marks)

1) Hydrated iron sulphate, $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ undergoes decomposition when heated to form iron sulphate and water. When heated further, the FeSO_4 decomposes to form Fe_2O_3 , sulphur dioxide and sulphur trioxide.

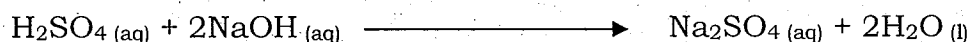
a) Write a balanced chemical equation for the thermal decomposition of FeSO_4 . **(2 marks)**

b) State the colour changes that occur when $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ decomposes to FeSO_4 then to Fe_2O_3 . **(3 marks)**

2) A student uses 100 cm^3 of a 0.2 mol dm^{-3} sodium hydroxide solution to react with excess sulphuric acid.

a) Calculate the number of moles of NaOH contained in 100 cm^3 of solution. **(2 marks)**

b) Calculate the mass of sodium sulphate crystals that are formed after evaporation of the resultant solution. **(2 marks)**
Equation:



(Atomic mass $\text{Na}=23$, $\text{S}=32$, $\text{O}=16$ $\text{H}=1$)

3) a) Sodium sulphate crystals are obtained by reacting $\text{H}_2\text{SO}_4(\text{aq})$, with $2\text{NaOH}(\text{aq})$. Using appropriate reagents or other means, describe a method that can be used to test (identify) the sulphate ions in Na_2SO_4 indicating the observations for a positive test. **(3 marks)**

b) Pure oxygen for industrial use can be obtained from atmospheric air. State one use of oxygen in industry and one of its uses for medical purposes. **(2 marks)**

4) In the upper atmosphere, there is a layer of ozone surrounding the earth.
a) Explain the importance of this layer in terms of human health. **(2 marks)**

b) State the type of chemical substances that destroy the ozone layer. **(1 mark)**

5) Aluminium is a metal of group IIIa of the periodic table.

a) Using Bohr model of the representation of electrons on shells, draw the structure of aluminium atom. **(2 marks)**

b) Write a balanced chemical equation of the reaction that takes place when aluminium reacts with sulphur (S). **(2 marks)**
(Atomic number: $\text{Al}=13$, $\text{S}=16$).

- 6) Sodium atom loses 1 electron and sulphur accepts 2 electrons to form ions.
- a) Deduce the chemical formula of the compound formed between sodium and sulphur. **(2 marks)**
 - b) Discuss the socio-economic importance of sodium compounds in our society. **(2 marks)**
(Atomic number: Na=11, S=16)
- 7) When calcium reacts with water, hydrogen gas is evolved and an alkaline solution is formed.
- a) Write a chemical equation of the reaction between calcium and water; include state symbols. **(2 marks)**
 - b) Explain effects of acid rain to buildings and monuments which are constructed in calcium carbonate compound. **(2 marks)**
- 8) Magnesium is an alkaline earth metal; copper is a transition element.
- a) Explain why copper is preferred to be used in coating (cover) monetary coins rather than magnesium. **(2 marks)**
 - b) Write a balanced chemical equation of combustion of magnesium in oxygen gas. **(1 mark)**
- 9) In an experiment, CO₂ gas was dissolved in a test tube of cold water; blue and red litmus papers were put in the resultant mixture.
- a) Indicate the litmus paper that changed its colour. **(1 mark)**
 - b) State 2 uses of CO₂ gas by man on a large scale. **(2 marks)**
- 10) State a reagent that you would use to differentiate between each of the pair of compounds and give an observable change for a positive test:
- a) Sodium nitrate, NaNO₃ and sodium chloride, NaCl. **(2 marks)**
 - b) Zinc II nitrate Zn (NO₃)₂ and aluminium III nitrate Al(NO₃)₃. **(2 marks)**
- 11) Alkanes are members of a homologous series of saturated hydrocarbons with the general formula C_nH_{2n+2}.
- a) Write a balanced chemical equation of the reaction of combustion of an alkane with 5 carbon atoms. **(2 marks)**
 - b) Write a chemical equation for the combustion of C₃H₈ in excess oxygen. **(2 marks)**
- 12) Silicon dioxide has a similar structure to diamond.
- a) Suggest the reason why silicon dioxide does not conduct electricity. **(2 marks)**
 - b) Give 2 uses of diamond on a large scale. **(2 marks)**

- 13) A gas of known identity as X diffuses at a rate of 83.3 ml/ second in a diffusion apparatus in which carbon dioxide diffuses at a rate of 102 ml/ second. Calculate the molecular mass of gas X. **(4 marks)**
(Molar mass: $\text{CO}_2 = 44 \text{ g/mole}$)
- 14) a) Write two uses of strong acids. **(2 marks)**
 b) Give the difference between a strong base and a weak base. **(2 marks)**

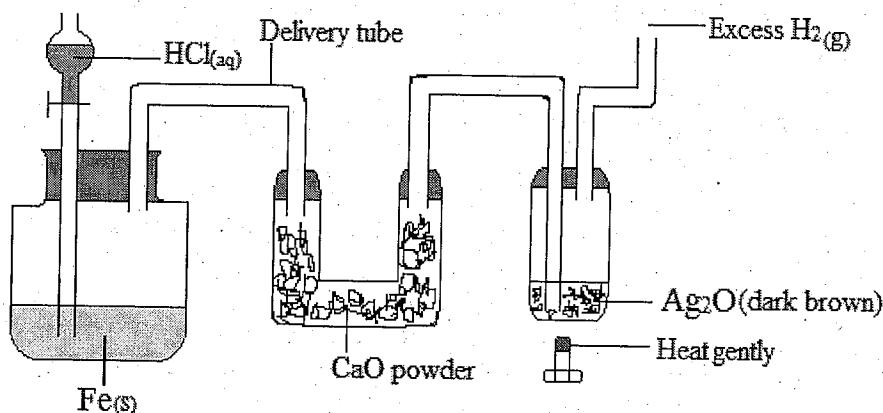
SECTION B: Attempt any three questions in this section (30 marks)

- 15) a) It takes 243 seconds for 4.46×10^{-5} mole of Xenon (Xe) to diffuse through a tiny hole. What time will it take 4.46×10^{-5} mole of Neon (Ne) to diffuse through the hole under the same conditions? **(4 marks)**
 b) Two cotton plugs, one moistened with NH_3 and another with HCl are simultaneously inserted into opposite ends of a glass tube that is 87dm length, a white ring of NH_4Cl forms where gaseous NH_3 and gaseous HCl first meet (come into contact). It takes 80 seconds for NH_3 gas to move distance Y, HCl gas moves in this distance Y in 117.2 seconds.
(Molar mass: $\text{NH}_3 = 17 \text{ g/mole}$, $\text{HCl} = 36.5 \text{ g/mole}$)
 (i) Determine how much faster NH_3 diffuses than HCl (percentage rate of NH_3 to the rate of HCl). **(1 mark)**
 (ii) Calculate the distance travelled by NH_3 gas to meet HCl gas. **(5 marks)**
- 16) A student added 8.0 g of magnesium to an excess of a 0.5 mol dm^{-3} sulphuric acid solution to react in a container.
 a) Calculate the number of moles contained in 8.0 g of magnesium. **(2 marks)**
 b) Calculate the maximum volume of sulphuric acid that reacted with all the 8.0 g magnesium. **(2 marks)**
(Atomic mass, $\text{Mg} = 24$).
Equation of reaction: $\text{Mg}_{(\text{s})} + \text{H}_2\text{SO}_{4(\text{aq})} \rightarrow \text{MgSO}_{4(\text{aq})} + \text{H}_{2(\text{g})}$
 c) A hydrated zinc sulphate; $\text{ZnSO}_4 \cdot \text{XH}_2\text{O}$ contained 56.09% of ZnSO_4 by mass. Determine the value of X in the equation (X=number of moles of water of crystallization). **(4 marks)**
(Atomic mass: $\text{Zn}=65$, $\text{S}=32$, $\text{O}=16$, $\text{H}=1$)
 d) Write a chemical ionic equation for the reaction between Zn^{2+} ions and OH^- ions in aqueous solution using:
 (i) Little of OH^- solution. **(1 mark)**
 (ii) Excess of OH^- solution. **(1 mark)**

- 17) a) Write a chemical equation of the reaction between aluminium and water. **(2marks)**
- b) Explain why aluminium metal is used to make overhead electric cables on streets. **(2 marks)**
- c) Aluminium reacts with chlorine according to the following equation:

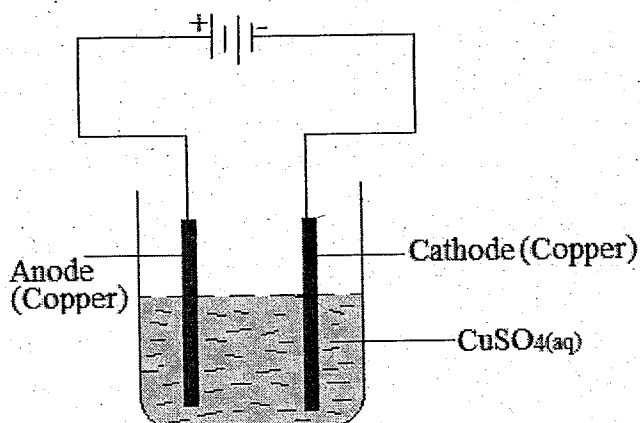
$$2\text{Al} + 3\text{Cl}_2 \rightarrow 2\text{AlCl}_3$$
- (i) Calculate the mass of AlCl_3 produced when 5.4g of aluminium reacts completely with excess chlorine. **(3 marks)**
 - (ii) Calculate the volume of Cl_2 gas required to react with 5.4g of aluminium at room temperature and pressure. **(3 marks)**
- (1 mole of a gas occupies 24dm^3 at room temperature and pressure, atomic mass of Al=27. Atomic mass of Cl=35.5 g/mol)*

- 18) Silver oxide, Ag_2O can be reduced by hydrogen gas H_2 ; study the set up diagram below and answer the questions that follow:



- a) Write a chemical equation of the reaction that takes place when Silver oxide reacts with hydrogen gas. **(2 marks)**
- b) Explain why hydrogen gas reduces silver oxide but cannot reduce zinc oxide. **(2 marks)**
- c) State the role of CaO powder in the tube. **(1 mark)**
- d) Fe reacts with dilute HCl to produce H_2 .
 - (i) State the method of collection of H_2 gas in the above apparatus set up. **(1 mark)**
 - (ii) Indicate one test for the excess H_2 gas and give the observation for a positive test. **(2 marks)**
- e) Zinc oxide can be reduced by carbon on heating.
 Write a chemical equation of the reaction between ZnO and C . **(2 marks)**

- 19) Study the set-up diagram below for the electrolysis of aqueous copper sulphate solution and answer the questions that follow:



- a) Write a chemical equation for the reaction that takes place at the:
- (i) Anode **(1.5 marks)**
 - (ii) Cathode. **(1.5 marks)**
- b) Describe the observable changes on the volume of both electrodes as the reaction proceeds. **(2 marks)**
- c) Indicate the direction of flow of electrons in the external circuit. **(1 mark)**
- d) Suggest one application of copper sulphate electrolysis on a large scale. **(1 mark)**
- e) Describe what would happen to the reactions in the beaker of CuSO_4 electrolyte if copper electrodes were replaced by carbon electrodes. **(3 marks)**

SECTION C: Attempt only One question in this section (15 marks)

20) A 0.095 g impure sample of K_2CO_3 is dissolved in enough water to make 20 ml of solution **X**. The 20.0 ml of solution **X** is put into an Erlenmeyer flask and 20 ml of a 0.17 mole/litre HCl is added.

The resulting solution is titrated against a 0.1048 mole/litre NaOH solution using phenolphthalein indicator.

The volume of NaOH required to neutralize excess HCl is 24.16 ml.

Equations:

Preparation of solution **X**: $K_2CO_{3(aq)} + 2HCl_{(aq)} \rightarrow 2KCl_{(aq)} + CO_{2(g)} + H_2O_{(l)}$

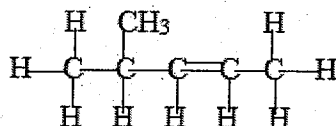
During titration: $HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$

- a) State the colour change of phenolphthalein indicator in the flask solution when the end-point of titration is reached. **(1 mark)**
- b) Calculate the number of moles of NaOH in 24.16 ml. **(2 marks)**
- c) Calculate the number of moles of HCl that react with NaOH in the flask. **(2 marks)**
- d) Calculate the number of moles of HCl (0.17 mole/litre) in 20.0 ml. **(2 marks)**
- e) Deduce the number of moles of HCl that react with K_2CO_3 . **(1 mark)**
- f) Calculate the number of moles of K_2CO_3 present in 0.048 g sample. **(2 marks)**
- g) Calculate the actual mass of K_2CO_3 in 0.095g of its impure sample. **(2 marks)**
- h) Calculate the percentage composition by mass of K_2CO_3 in 0.095 g impure sample. **(3 marks)**
(Atomic mass: $K=39$, $C=12$, $O=16$)

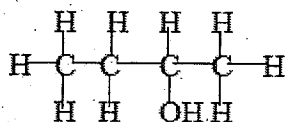
21) a) Give the names of the following compounds:

(2 marks)

(i)



(ii)



b) State 2 physical properties of alcohols.

(1 mark)

c) Write a balanced chemical equation for:

(i) Combustion of $CH_3CH_2CH_2OH$ in enough oxygen.

(2 marks)

- (ii) Oxidation of $\text{CH}_3\text{CH}_2\text{OH}$ by $\text{K}_2\text{Cr}_2\text{O}_7$ in acidic (H_2SO_4) medium. **(2 marks)**
- d) State two uses of alcohols on a large scale. **(2 marks)**
- e) Describe two health hazards caused by drinking too much alcohol. **(4 marks)**
- f) Explain why alcohols are not used so often as fuel in vehicle engines as much as alkanes. **(2 marks)**