CHEMISTRY II
014
15 Nov. 2019 08.30 – 11.30 am

REB
Rwanda Education Board

ADVANCED LEVEL NATIONAL EXAMINATIONS 2019

SUBJECT: CHEMISTRY

PAPER II: THEORY

COMBINATIONS: -BIOLOGY-CHEMISTRY-GEOGRAPHY: BCG
- PHYSICS-CHEMISTRY-MATHS: PCM
-PHYSICS-CHEMISTRY-BIOLOGY: PCB
-MATHS-CHEMISTRY-BIOLOGY: MCB

DURATION: 3 HOURS

INSTRUCTIONS:

-Write your names and index number on the answer booklet as written on the registration form, and **DO NOT** write your names and index number on additional answer sheets of paper if provided.

-This paper consists of **two** sections: **A** and **B**.

- Section A: Answer **all** questions. **(70 marks)**
- Section B: Attempt any **three** questions. **(30marks)**

- You do not need the Periodic Table.

- Silent non-programmable Calculators may be used.

-Use a **blue** or **black** pen and a pencil for drawing**.**.

SECTION A: Attempt all questions (70 marks)

1) a) Describe what takes place in the ionization chamber of the mass spectrometer so that positive ions of a sample are produced. **(2 marks)**

b) The percentage abundance of chromium isotopes ^{50}Cr, ^{52}Cr, ^{53}Cr and ^{54}Cr are 4.345% , 83.789%, 9.501% and 2.365% respectively .

i) Calculate the relative atomic mass of chromium. **(2 marks)**

ii) Describe 2 useful applications of isotopes by man. **(2 marks)**

2) Draw diagrams of the shapes of the following molecules and each case state the name of the shape.

a) CO_2 **(1.5 marks)**

b) BCl_3 **(1.5 marks)**

(Atomic number: B = 5 , Cl = 17, C=6, O = 8)

3) a) Describe 2 similarities in terms of chemical properties between beryllium and aluminum elements. **(2 marks)**

(Berryllium and aluminium are in group II of the periodic table)

b) Explain why $PbBr_4$ and PbI_4 do not exist whereas $PbCl_4$ exists. **(2 marks)**

c) Evaluate the social-economic importance of aluminium and boron compounds to the Rwandan society. **(2 marks)**

4) a)Write the equation of the reaction between concetrated H_2SO_4 and HI. **(1 marks)**

b) Explain why HF has a higher boiling point than HCl, HBr and HI despite its lower molecular mass than the rest. **(2 marks)**

c) Evaluate the important uses and hazards of chlorine compounds. **(2 marks)**

5) During the reaction of formation of Al_2O_3 from 5.4g of Al and enough of O2, the heat liberated increased the temperature of 2kg of water by 20oC. **(3 marks)** Find the value of the standard enthalpy of formation of Al_2O_3.

(Atomic mass: Al =27, specific heat capacity of water =4.2J/g/0C)

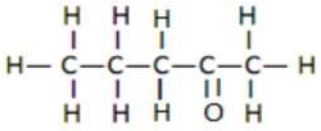
6) Petrol is composed of isomers of C_8H_{18}.

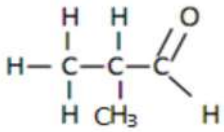
a) Write the structural formula of 2,3,3-Trimethyl pentane. **(1 mark)**

b) Give one reason to explain why 2,3,3-Trimethyl pentane is a better fuel component in vehicle engines than n-octane. **(1 mark)**

c) Explain the reason why unleaded petrol is recommended for use in vehicles in most parts of the world than leaded petrol. **(2 marks)**

7) a) Study the structural formula of the following organic compounds and answer the questions that follow:





i) Write the IUPAC name of compound X and compound Y shown above. **(2 marks)**

ii) Suggest a chemical test reagent that can be used to distinguish between the organic substance X and Y shown above and mention the observable in each case. **(2 marks)**

b) Complete the chemical equation given below writing the semi developed formulae of all organic compounds and molecular formulae of inorganic products.

$CH_3CH_2CH_2\text{-}CO\text{-}CH_3 + I_2 + NaOH \rightarrow$ **(2 marks)**

8) Balance the following reduction –oxidation chemical reaction equations.

a) $Fe^{2+}(aq) + H^+(aq) + Cr_2O_7^{2-}(aq) \rightarrow Cr^{3+}(aq) + Fe^{3+}(aq) + H_2O(l)$ **(2 marks)**

b) $I_2(aq) + NO_3^-(aq) + H^+(aq) \rightarrow NO_2(g) + IO_3^-(aq) + H_2O(l)$ **(2 marks)**

9) Use the data given below to calculate the standard enthalpy of formation ΔH_4 of octane, $C_8H_{18(l)}$:

$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$ $\quad \Delta H_1 = -393.5 kJ\ mol^{-1}$

$H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O(g)$ $\quad \Delta H_2 = -286 kJ\ mol^{-1}$

$C_8H_{18(l)} + 25/2O_{2(g)} \rightarrow 8CO_{2(g)} + 9H_2O_{(g)}$ $\quad \Delta H_3 = -5471 kJ\ mol^{-1}$

$8\ C_{(s)} + 9H_{2(g)} \rightarrow C_8H_{18(l)}$ $\Delta H_4 = ?$ **(4 marks)**

10) The dissociation constant (Kb) of 0.2mole/litre solution of methyl amine is $4.4x10^{-4}$
Calculate:
a) The number of moles of OH^- in 1 litre of the methyl amine solution. **(2 marks)**
b) The pH of 0.2 mole /litre of methyl amine is
Equation: $CH_3NH_2 + H_2O \rightleftarrows CH_3NH_3^+ + OH^-$
(methyl amine is a weak base)

11) Using appropriate steps with equations of reactions , show how you can synthesize $CH_3CH_2NH_2$ from $CH_3CH_2CH_2OH$. **(4 marks)**

12) The solubility product (ksp) of silver chromate VI, Ag_2CrO_4 in water is 3×10^{-12}
$Ag_2CrO_4(s) \rightleftharpoons 2Ag^+(aq) + CrO_4^{2-}(aq)$
a) Calculate the solubility in gdm-3 of silver chromate VI (Ag_2CrO_4) in water. **(2 marks)**
b) Calculate the solubility in moles per litre of Ag_2CrO_4 in 1 litre of a solution of 0.02 mole /litre Na_2CrO_4. **(2 marks)**
(0.02 mole /litre Na_2CrO_4 solution dissolves completely in water)
(Atomic mass , Ag = 107, Cr = 52, O =16)
c) Discuss 2 important applications of solubility in the Rwandan society. **(2 marks)**

13) a) Write the structural formula of 2-bromo-4-methyl pentane. **(1 mark)**
b) Write the equation of reaction of nucleophilic substitution between , 2-bromo-4-methyl pentane and aqueous sodium hydroxide, NaOH.
(use semi-developed formule) **(2 marks)**
c) 2-bromo-4-methyl pentane is made to react with sodium cyanide, NaCN to form product A. The resultant organic product A is reacted with $LiAlH_4$ in presence of H_2O, to give an organic product B.
Give the IUPC name or the structural formula of compounds A and B. **(2 marks)**

14) Nickel- cadmium cells are used to power electrical equipments such as drills and shavers.
The electrode reactions are shown below:
$NiO_2 + 2H_2O + 2e \rightarrow Ni(OH)_2 + 2OH^-$ $E^\theta = +0.52V$
$Cd + 2OH^- \rightarrow Cd(OH)_2 + 2e$ $E^\theta = -0.88V$
a) Calculate the standard e.m.f of a Nickel-cadmium cell. **(1.5 marks)**
b) Deduce the overall equation for the reaction that occurs in the cell when it is used. **(1.5 marks)**
c) Describe the difference between rechargeable cells such as those used in mobile telephones and the non-rechargeable cells. **(2 marks)**

15) a) Describe the term “thermosoftening polymer” and indicate the example of such a polymer. **(2 marks)**
b) Explain how tyres used in vehicles and bicycles are made hard during the process of polymerisation(Synthesis) in industry. **(2 marks)**

SECTION B: Attempt THREE questions (30 marks)

16) a) Glass is essentially made of silicon and boron compounds.
i) Explain the reason why glass is no used to make containers of NaOH solution.
(use chemical equations to support your answer) **(2 marks)**
ii) State 2 similarities between silicon and boron. **(2 marks)**
b) Tin , SnO_2 is mined in some parts of Rwanda.
i) Write the equation of reaction between SnO_2 and hot concentrated H_2SO_4. **(2 marks)**

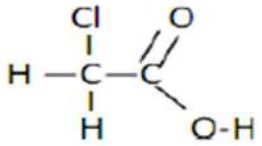
ii) Write the equation of reaction between SnO_2 and NaOH. **(2 marks)**
iii) Describe the important applications of tin on a large scale. **(2 marks)**

17) Organic acid A has the formula $(CH_2)_n(COOH)_2$ and reacts with dilute, NaOH according to the following equation:
$(CH_2)_n(COOH)_2 + 2NaOH \rightarrow (CH_2)_n(COONa)_2 + 2H_2O$
The mass of 2.0g of organic acid X is dissolved in water and the solution made up to $250cm^3$. This organic cid X solution is filled in a burette and $18.40cm^3$ of $(CH_2)_n(COOH)_2$ is required to neutralize $25cm^3$ of a 0.1mol dm^{-3} NaOH.
a) Calculate the number of moles of NaOH in $25cm^3$ solution. **(2 marks)**
b) Determine the number of moles of $(CH_2)_n(COOH)_2$ that reacted with $25cm^3$ of 0.1mol dm^{-3} NaOH solution**. (1 mark)**
c) Calculate the number of moles of $(CH_2)_n(COOH)_2$ present in $250cm^3$ solution. **(2 marks)**
d) Deduce the molecular mass of $(CH_2)_n(COOH)_2$ acid. **(3 marks)**
e) Find the value of n
(Atomic mass: C=12, H=1 and O =16) **(2 marks)**
18) Study the data of the enthalpy changes in the table below and answer the questions that follow:

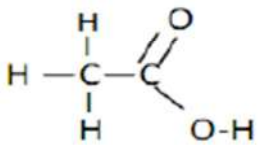
Equations of reactions	**Enthalpy change/kJ mol^{-1}**
$Ag(s) \rightarrow Ag^+(aq) + I^-(aq)$	**ΔH_2 = +112**
$Ag^+(g) \rightarrow Ag^+(aq)$	**ΔH_3 = -464**
$I(g) \rightarrow I^-(aq)$	**ΔH_4 = -293**
$Ag^+(g) + I^-(g) \rightarrow AgI(s)$	**ΔH_1 =**

a) Define the term "**enthalpy of lattice formation**" **(2 marks)**
b)Write the chemical symbol or formula of a reagent that can be used to test for the presence of iodide ions in aqueous solution and describe the observable change. **(2 marks)**
c) Calculate the enthalpy of lattice formation of AgI, ΔH_1. **(2 marks)**
d) Explain why the use of butane alkane is preferred for use in combustion cylinders rather ethane alkane. **(2 marks)**

19) a) Two different organic molecules react to form an amide bond in the resultant molecule.
(i) Write the structural formula of the resultant molecule showing the location of the amide bond. **(1 mark)**
(ii) Explain the reason why the amide bonds are strong. **(2 marks)**
b) Study the diagrams given below and answer the questions that follow:



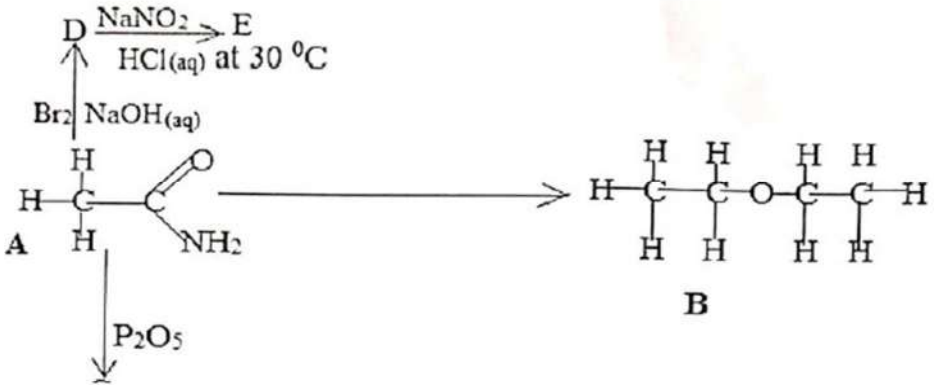
Chloroethanoic acid



ethanoic acid

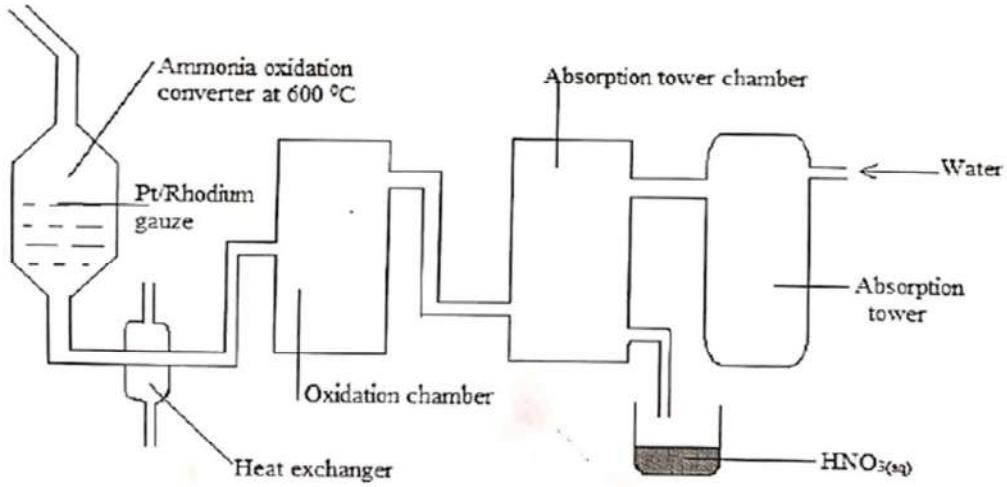
Explain why chloroethanoic acid is a stronger acid than ethanoic acid. **(2 marks)**

c) Study the diagram below and answer the questions that follow:



(i) Write the semi-developed molecular formula of organic substance: C, D and E. **(2 marks)**
(ii) Write different chemical equations of reactions (not more than 5 equations) that can be used to illustrate the conversion of 2 moles of organic substance A into 1 mole of substance B. Include reagents and conditions. **(3 marks)**

20) Study the diagram given below for the production of nitric acid and answer the questions that follow:



Equations:
$4NH_3(g) + 5O_2(g) \rightleftarrows 4NO(g) + 6H_2O(l)$ $\Delta H = -905.2kJmol^{-1}$
$2NO(g) + O2(g) \rightleftarrows 2NO_2(g)$ $\Delta H = -114kJmol^{-1}$
$4NO_2(g) + 2H_2O(l) + O_2(g) \rightleftarrows 4HNO_3(l)$ $\Delta H = -117kJmol^{-1}$
a) Explain the effect of increasing the temperature (in the oxidation converter) on the position of equilibrium when NO is produced from NH_3 in equation1. **(2 marks)**
b) Explain the importance of reduction of temperature of the reacting mixture by the heat exchanger. **(1.5 marks)**
c) State the name of the substance (reagent) that can be used to test for the presence of concentrated nitric acid, HNO_3 and give the observable change. **(2 marks)**
d) Explain the importance of platinum/Rhodium catalyst to the reacting mixture in the oxidation converter. **(1.5 marks)**
e) State 1 physical property of concentrated nitric acid, HNO_3 acid. **(1 mark)**
f) Evaluate the importance of manufacturing of nitric acid, HNO_3 to agricultural farmers in our society. **(2 marks)**