P525/2
CHEMISTRY
Paper 2
July/August 2023
2 ½ hours

ASSHU ANKOLE REGIONAL JOINT MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

CHEMISTRY

Paper 2

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES

*Answer **five** questions including **three** questions from section A and any **two** from section B*

Write the answers in the answer booklets provided

Begin each question on a fresh page

Mathematical tables and graph papers are provided

Non – programmable scientific electronic calculators may be used.

Use equations where necessary to illustrate your answer.

Where necessary use (H = 1, C = 12, O = 16, Na = 23)

SECTION A (60MARKS)

Answer three questions from this section.

1. (a) Define the terms
   i) Enthalpy of solution **(1mark)**
   ii) Enthalpy of hydration **(1mark)**

   (b) The dissolution of anhydrous sodium carbonate in water takes place according to the following equation.

$$Na_2CO_{3\,(s)} + aq \longrightarrow 2Na^+_{(aq)} + CO_3^{2-}(aq) \;\; \triangle H = -ve$$

   Briefly describe an experiment that can be carried out to determine the enthalpy change associated with the above process. **(6 ½ marks)**

   (c) In an experiment to determine the enthalpy of hydration of anhydrous sodium carbonate, 5.0g of the anhydrous sodium carbonate was added to 50.0g of water and the temperature of water rose by 5.5^0C. When 5.0g of the hydrated salt was added to 50 g of water, the temperature of water dropped by 4.5^0C.
   (Specific heat capacity of solution = $4.2Jg^{-1}C^{o-1}$, Na = 23, C = 12, O = 16, H = 1). Calculate the enthalpy of solution of
   i) anhydrous sodium carbonate **(3marks)**
   ii) hydrated sodium carbonate – 10 – water **(3marks)**

   (d) Explain the effect of increasing temperature on the solubility in water of each sodium salt in (c) above **(3marks)**

   (e) Determine the enthalpy of hydration of anhydrous sodium carbonate. **(2 ½ marks)**

2. *3.0g of an organic compound P, containing carbon, hydrogen and oxygen only, was burnt in excess air, 4.4g of carbon dioxide and 1.8g of water was produced.*
   a) *Calculate the empirical formula of P* **(3marks)**
   b) *When 0.6g of P was vaporized, it occupied a volume of 750cm³ at 27^0C and 249.3mmHg. Determine the molecular formula of P (R = $8.31JK^{-1}mol^{-1}$)* **(3marks)**
   c) *P burns with a non – sooty flame and its aqueous solution reacts with magnesium ribbon with effervescence of hydrogen gas.*
      i) Name the functional group present in P **(½ mark)**
      ii) Write the structural formula and IUPAC name of P. **(1mark)**
   d) Describe the reactions of P leading to:
      i) Cleavage of the carbon to oxygen single bond **(5 ½ marks)**
      ii) Cleavage of the carbon to carbon bond (Your answer should include mechanism for the reactions if applicable) **(2marks)**
   e) With equations to show how P can be:

i) Prepared from methanol **(2 ½ marks)**

ii) Converted to propanone oxime, $CH_3C(CH_3)=N-HO$

(2 ½ marks)

3. The elements carbon, silicon, tin and lead belong to group(IV) of the Periodic Table

a) Describe the reactions of the elements with:

i) Sulphuric acid **(5 ½ marks)**

ii) Concentrated nitric acid **(3 ½ marks)**

b) The table below shows the boiling points and molecular masses of the hydrides of group (IV) elements.

Hydride	CH_4	SiH_4	GeH_4	SnH_4	PbH_4
Molecular mass (g)	16	32	77	123	211
Boiling point (^0C)	-162	-112	-88	-152	-13

i) Plot a graph of boiling point against molecular mass of the hydrides **(3marks)**

ii) Explain the shape of the graph you have drawn **(3marks)**

c) Explain the reactivity of the hydrides of carbon and silicon with hot concentrated sodium hydroxide solution **(5marks)**

4. The Haber process involves catalytic hydrogenation of nitrogen to form ammonia according to the following equation.

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

a) Name:

i) The catalyst used in the Haber process **(½ mark)**

ii) One source of nitrogen and one source of hydrogen for use in the Haber process. **(1mark)**

b) Nitrogen and hydrogen were mixed in the mole ratio of 1: 3 in a one litre container at different temperatures. At equilibrium, the percentages of ammonia in the mixture of gases were 25% at 400^0C and 15% at 600^0C.

i) Calculate the values of equilibrium constant K_c at 400^0C and 600^0C **(7marks)**

ii) Explain whether the reaction between nitrogen and hydrogen to form ammonia is endothermic or exothermic. **(2 ½ marks)**

c) Describe how ammonia can be converted to nitric acid. **(5 marks)**

d) Concentrated nitric is 70% W/W and has a density of $1.42gcm^{-3}$. Calculate the volume of concentrated nitric acid required to prepare one litre of 2M dilute solution (H = 1, N = 14, O = 16) **(4marks)**

SECTION B (40MARKS)

Attempt any two questions from this section.

5. (a) The molecular structure of compound Q is $CH_2=CHCHO$
Write the acceptable mechanism for the reaction between Q and the following reagents.

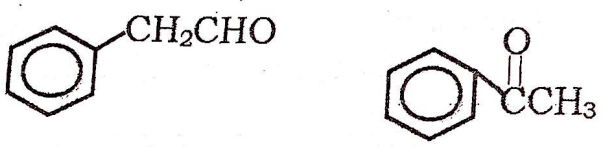
i) 2, 4 – dinitrophenyl/hydrazine solution **(4marks)**

ii) Bromine water **(3marks)**

iii) Sodium hydrogen sulphite **(3marks)**

(b) Write equations to show how the following conversions can be effected. Indicate the conditions and reagents for the reactions

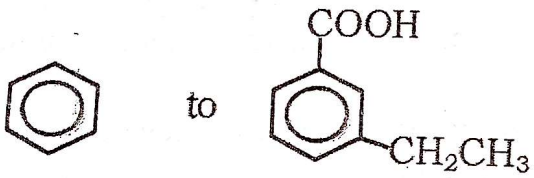
i)



(3 ½ marks)

ii) $CH_3CH_2CH_2OH$ to $CH_3CH_2NH_2$ **(3 ½ marks)**

iii)



(3marks)

6. (a) State what is meant by the term salt hydrolysis **(1mark)**

(b) Calculate the pH of the solution made by mixing 100 cm^3 of 2M ethanoic acid and an equal volume of 2M sodium hydroxide solution
($Kw = 1.0 \times 10^{-14}\ mol^2dm^{-6}$ at 25^0C)
(Ka of ethanoic and $= 1.8 \times 10^{-5}\ moldm^{-3}$ at 25^0C)

(c) Explain what happens when the resultant solution in (b) above is treated with the following substances:

i) Aluminium powder and the mixture warned **(2 ½ marks)**

ii) Magnesium chloride solution **(1 ½ marks)**

(d) The table below shows the pH of a solution obtained when different volumes of sodium hydroxide solution were added to $25cm^3$ of 0.1M solution of an ethanoic acid.

Volume of NaOH (cm^3)	0	15.0	35.0	48.0	50.0	53.0	57.5	70.0
pH of solution	2.8	3.8	5.0	6.0	7.0	11.5	12.0	12.5

i) Plot a graph of pH against volume of sodium hydroxide solution **(3marks)**

ii) Explain the shape of the graph you have drawn **(3marks)**

(e) From the graph determine the:

i) Molar concentration of sodium hydroxide solution **(2marks)**

ii) Acid ionization constant, Ka for ethanoic acid **(2marks)**

7. (a)(i) Write the electronic configuration of Iron. (Atomic number = 26) **(1mark)**

(ii) State the common oxidation states shown by iron in its compounds. **(1mark)**

(b) One of the ores from which Iron can be extracted is iron pyrites.

i) Write the formula of Iron pyrites **(1mark)**

ii) Describe the reactions that take place during extraction of iron from iron pyrites **(8marks)**

(c) Describe the reactions of iron with;

i) water **(2mark)**

ii) sulphuric acid **(4mark)**

(d) Dilute sodium hydroxide solution was added drop wise until in excess to iron (II) nitrate solution. State what was observed and write equation(s) for the reaction(s) that took place **(3marks)**

8. Explain the following observation. Illustrate your answers with equations where applicable.

a) When a solution of sodium hydrogen carbonate is added to zinc chloride solution, a white precipitate is formed with evolution of bubbles of a colourless gas. When magnesium chloride used instead of zinc chloride there is no observable change **(5marks)**

b) A solution of iodine and sodium hydroxide gives a pale yellow precipitate when reacted with ethanol, but gives no observable change with methanol **(5marks)**

c) The molar ionic conductivities of sodium ions and Rubidium ions are 50.1 and 78.3 $\Omega^{-1}cm^2mol^{-1}$ respectively. **(3marks)**

d) When nickel (II) ethanoate was heated and the gaseous product passed through a solution of 2, 4 – diminitrophanyl hydrazine in sulphuric acid, a yellow precipitate was formed. **(4 ½ marks)**

e) The melting point of calcium is 842^0C. While that of manganese is 1246^0C. **(2 ½ marks)**

END