P525/2

CHEMISTRY   <u>**S.5**</u>

(Theory)

 Paper 2

AUGUST/ SEPT. 2024

$2\frac{1}{2}$ hours

<div align="center">

UGANDA ADVANCED CERTIFICATE OF EDUCATION

CHEMISTRY

(THEORY)

Paper 2

SENIOR FIVE

END OF TERM 2

2hours:30minutes

</div>

INSTRUCTION TO CANDIDATES

*Attempt **five** questions including **three** questions in section **A** and **two** questions in section **B**.*

Answers must be written on the answer sheets (booklets) provided.

Begin each question on a fresh page.

Mathematical tables and squared paper are provided.

Silent non-programmable scientific electronic calculators may be used.

Write equations where necessary to illustrate your answers

Where necessary, use the following

*1 mole of gas occupies $22.4dm^3$ at STP; molar gas constant (**R**) is 0.0821 atm dm^3K^{-1}. **C=12**, O=16, H=1*

---

*Answer **three** questions from this section.*

1. (a) What is meant by the following terms.

(i) Half-life of a radioactive atom. **(01 mark)**

(ii) Relative Atomic mass. **(01 mark)**

(iii) Isotopes. **(01 mark)**

(b) Describe how in a mass spectrometer thee ions are;

(i) Deflected **(02 marks)**

(ii) Accelerated **(02 marks)**

(iv) Produced. **(02 marks)**

(c) The relative atomic mass of magnesium with isotopes $^{24}_{12}Mg$, $^{25}_{12}Mg$ and $^{26}_{12}Mg$ is 24.3. If the percentage abundances of $^{25}_{12}Mg$ and $^{26}_{12}Mg$ and are equal;

(i) Calculate the percentage abundance of each isotope of magnesium and hence sketch the mass spectrum of magnesium. **(04 marks)**

(ii) State two advantages of using a mass spectrometer in measuring relative atomic mass. **(01 mark)**

(d) The table below shows how the mass of radioactive protactinium, $^{234}_{91}Pa$ varies with time.

Mass of protactinium (g)	60.0	38.5	26.0	17.2	11.1
Time (s)	0	40	80	120	160

(i) Plot a graph of mass of protactinium against time. **(03marks)**

(ii) Use your graph to determine the half-life of protactinium. **(01mark)**

(iii) Determine the time taken for 8g of protactinium to decay to 1g. **(02marks)**

2. Beryllium, Magnesium, calcium, strontium and barium belong to group (II) of the periodic table.

(a) Write the general outermost electronic configuration of group (II) elements in the periodic table. **(01 mark)**

(b) Compare the reaction of,

(i) Beryllium and magnesium with water. **($3\frac{1}{2}$ marks)**

(ii) Calcium and beryllium with sodium hydroxide solution. **($3\frac{1}{2}$ marks)**

(iii) Magnesium carbonate and calcium carbonate with dilute sulphuric acid. **($3\frac{1}{2}$ marks)**

(c) Explain why;

(i) The second and third ionization energies of magnesium are $1451 KJmol^{-1}$ and

$7733 KJmol^{-1}$ respectively. **(03 marks)**

(ii) The solubility of Sulphates of group (II) elements decreases from beryllium suplhate to barium sulphate. **($2\frac{1}{2}$ marks)**

(iii) Properties of beryllium differ from those of group (II) elements but resemble those of aluminum. **(03 marks)**

3.   An organic compound Q has structural formula as shown below.

(a) Write the;

(i) I.U.P.A.C name of compound   Q. **(01 mark)**

(ii) Name the homologous series to which Q belongs and give a reason for your answer. **(01 mark)**

(b) When compound Q was heated with acidified potassium manganate (VII) solution, compound **W** was formed.

(i) Write the structural formula and IUPAC name of compound **W** $(1\frac{1}{2}$ **marks)**

(ii) Write an equation for the reaction that occurs in (b) above. $(1\frac{1}{2}$ **marks**

(c) (i) Describe how the distribution coefficient for compound W between water and ethoxyethane can be determined.   **(06 marks)**

(ii) State two advantages of using ethoxyethane as a solvent in the above determination.   **(02 marks)**

(d) An aqueous solution contains 10g of compound W per liter. When 100cm^3 of this solution was shaken with 20cm^3 of ethoxyethane, the ethoxyethane layer extracted 0.8g of compound W. Calculate the mass of compound W extracted when 500cm^3 of the aqueous layer was shaken with;

(i) 50cm^3 of ethoxyethane.   **(02 marks)**

(ii) Two successive 25cm^3 portion of the ethoxyethane.   **(04 marks)**

(e) Comment on the results in (d) above.   **(01 mark)**

4. An organic compound R contains **64.9%, 13.5**% hydrogen and the rest being oxygen. **1.85g** of R in the vapour form occupied **969.8** cm^3 at **101325 Nm^{-2}** and **200^{0}C**.

(a) (i) Determine the molecular formula of R.   **(05 marks)**

(ii) Write the I.U.P.A.C names of all the possible isomers of compound R. **(03 marks)**

(b) When compound R was heated with concentrated sulphuric acid, **compound N** was formed. When N was ozonolysed followed by hydrolysis with water in presence of zinc and ethanoic acid, **propanone** and **compound Z** were formed.

Write the structural formulae of compounds R, N and Z. $(1\frac{1}{2}$ **marks)**

(c) Write an equation and a mechanism for reaction that;

(i) Led to formation of compound N. **(03 marks)**

(ii) Occurs when compound N is reacted with bromine water. **($2\frac{1}{2}$ marks)**

(iii) Occurs when compound N is converted to 1-Bromo-2-methylpropane. **($2\frac{1}{2}$ marks)**

(d) Show how propanone can be converted to 2-ChloroPropane. **($2\frac{1}{2}$ marks)**

SECTION B. (40 MARKS)

*Attempt any **two** questions from this section.*

5. (a) (i) Explain what is meant by;

(i) **Azeotropic mixture** **(02 marks)**

(ii) **Non ideal solutions.** **(02 marks)**

(b) The boiling points and percentage composition by mass of methanol in the liquid mixture and in the vapour above the mixture of ethanol and water are given in the table below.
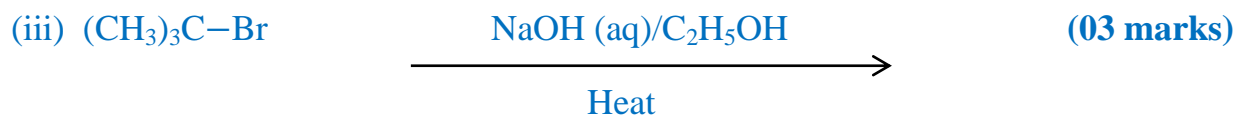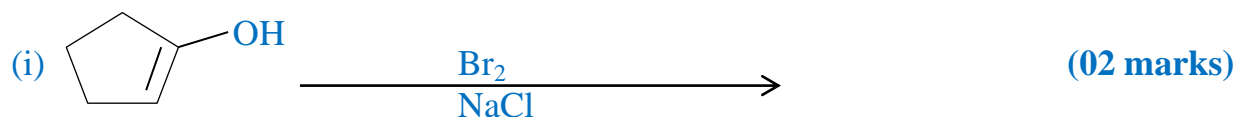
Boiling point of mixture (^{0}C)	70	60	55	57	61
Percentage composition of ethanol in liquid mixture	12	13	50	82	94
Percentage composition of ethanol in vapour above the mixture	27	47	56	69	83

(i)   Use the data to plot a boiling point-composition diagram for solutions of ethanol in water (Boiling points of pure ethanol pure water are 78^0C and 100^0C respectively)   **(05 marks)**

(ii)   Use your graph to determine the composition of the azeotropic mixture and Azeotropic temperature.   **(02 marks)**

(iii)   Explain the type of deviation from Raoult's law shown by the mixture of ethanol and water.   **(03 marks)**

(c) $100cm^3$ of the azeotropic mixture above was shaken with two successive volumes $50cm^3$ ether. Calculate the mass of ethanol extracted from the azeotropic mixture (partition coefficient of ethanol between ether and water is 0.48)   **(06 marks)**

6. (a) State what is observed and write an equation for the reaction that occurs when;

(i) Ethanoic acid is heated with sodium carbonate solution.   **(02 marks)**

(ii) 2- methylbut-2-ene is reacted with bromine water.   **(02 marks)**

(iii) Cyclohexene is reacted with alkaline potassium manganate (VII) solution.

.   **(02 marks)**

(b) Complete the following equations and write a mechanism for the reaction that occurs.

(i) $\xrightarrow[\text{NaCl}]{\text{Br}_2}$ **(02 marks)**

(ii) $CH_3CH_2C{\equiv}CH \xrightarrow{2HI}$ **(03 marks)**

(iii) $(CH_3)_3C{-}Br \xrightarrow[\text{Heat}]{\text{NaOH (aq)/C}_2\text{H}_5\text{OH}}$ **(03 marks)**

(c) Write equations to show how the following conversions can be effected. In each case, give the appropriate conditions for the reaction.

(i) $(CH_3)_2C=CH_2$ to $CH_3CH=CH_2$ **(03 marks)**

(ii) 2-Hydroxybutanoic acid to Propan-2-ol.   **(03 marks)**

7. (a) The osmotic pressure of a solution containing 1.5% of a polymer **Q** is 3.6 x 10^{-4} atmospheres at 25^0C.

    (i)   What is meant by the term **osmotic pressure?**   **(01 mark)**
    (ii)   Determine the molecular mass of the polymer.   **(02 marks)**
    (iii)   Briefly explain why the determination of molecular mass of polymer Q is more efficient when using osmotic pressure than ebullioscopy. **(03 marks)**

(b) Describe an experiment that can be carried out to determine the molecular mass of a substance by osmotic pressure method.   **(05 marks)**

(c) The osmotic pressure of various concentrations of a polysaccharide Y dissolved in water at 25^0C is shown below.

Concentration (g/dm^3)	1.0	2.0	3.0	3.0	4.0	5.0
Osmotic pressure (Nm^{-2})	23	37	53	75	92	109

    (i)   Plot a graph of osmotic pressure against concentration.   **(02 marks)**
    (ii)   Determine the molecular mass of the polysaccharide Y. Given that
            $R=8.314JK^{-1} mol^{-1}$ **(03 marks)**

 (d)   The vapour pressure of carbon disulphide at certain temperature is $53330Nm^{-2}$.

At the same temperature, 5g of sulphur in 63cm^3 of carbon disulphide at ha a vapour

pressure of $52320Nm^{-2}$. Calculate the relative molecular mass of sulphur and hence

deduce the molecular formula of sulphur in carbon disulphide solution. **(04 marks)**

8. Sodium, aluminium, magnesium, silicon, phosphorous, sulphur and chlorine are elements of period 3 of the periodic table.

(a) Write the electronic configuration of Al^{3+} ions and phosphorus.   **(02 marks)**

(b) The table below shows the variation of the different physical properties of elements of period 3 of the periodic table.

Element	Na	Mg	Al	Si	P	S	Cl
Atomic number	11	12	13	14	15	16	17
Melting point (^{0}C)	97.8	650	660.3	1414	44.2	115.2	-101.5
Atomic radius (nm)	0.156	0.136	0.125	0.117	0.110	0.104	0.09
First ionization energy (Kjmol^{-1})	496	738	578	786	1012	1000	1251

State and explain the trend in the;

    (i)   Atomic radius of the above elements.   **(03 marks)**

    (ii)   Ionization energy of the elements.   **(05 marks)**

(c) Plot a graph of melting point against atomic number of the elements of period 3 of the periodic table.   **(03 marks)**

(d) Explain the shape of the graph.   **(07 marks)**

END

WE WISH YOU SUCCESS ANDD NICE HOLIDAYS.