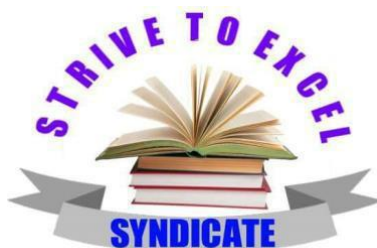**THE UNITED REPUBLIC OF TANZANIA
PRESIDENT 'S OFFICE
REGIONAL ADMINISTRATION AND LOCAL
GOVERNMENT**

FORM SIX SPECIAL SCHOOL JOINTS EXAMINATION

CODE:132/1   **CHEMISTRY 1**

TIME: 3HRS   **Tuesday, 18-February-2025PM**

INSTRUCTIONS:

1. This paper consists of ten (10) questions in sections A and B.

2. Answer all questions from section A and any two (2) from section B.

3. Mathematical table and non-programmable calculators may be used.

4. Cellular phones are not allowed in the examination room.

5. Write your examination number on every page of your answer booklet(s)

6. For your calculations the following constants may be used:

- Rydberg constant, R_H = 1.09678×10^7 M^{-1}
- Gas constant, R = 8.314 $Jmol^{-1}K^{-1}$ or 0.0821 atm $mol^{-1}K^{-1}dm^3$
- Planck's constant, h = 6.63×10^{-34} Js
- Velocity of light, c = 3.0×10^8m/s
- Avogadro's constant, N_A = 6.022×$10^{23}mol^{-1}$
- Atomic masses H=1, C= 12, N=14, O= 16, Na=23, Cl=35.5, K=39, Br=80.

SECTION A (70 MARKS)
Answer **all** questions from this section

1. (a) (i)   Explain any three (3) postulates and (3) shortcomings of Bohr's hydrogen model.

   (ii) Why do the spacing between lines in the hydrogen spectrum decrease as one goes away from the nucleus?   (4 marks)

   (b) An electron moves from infinity to a lower energy levels in Paschen series. Calculate the:
   (i)   Frequency of radiations emitted
   (ii)   Energy possessed by the electron in the new energy level and energy emitted during transition.

                                                                (3 marks)
   (c) Identify the geometrical structure and one example of the molecule

   formed from the following types of hybridized atomic orbitals.

   (i)   Sp hybridized orbitals
   (ii) Sp^2 hybridized orbitals
   (iii) Sp^3 hybridized orbitals   (3 marks)

2.   Explain the following terms as related to environmental chemistry
   (i) Soil pollutant
   (ii) Greenhouse effect
   (iii) Contaminant   (03 marks)
   (b)   With the aid of chemical reactions, explain how;
   (i) Ozone layer is formed
   (ii) Ozone layer is depleted by CFCs   (04 marks)
   (c)   Explain any three (3) harmful effects of acidic rain and three methods to reduce acidic rain   (03 marks)

3.   (a) State the conditions under which the following laws are valid
   (i) Ideal gas law
   (ii) Boyle's law
   (iii) Dalton's law of partial pressure   (03 marks)
   (b)   State the two faults assumptions in kinetic theory of gases
                                                                02 marks)

   (c)   The circulation of blood in the human body supplied oxygen and removes carbon dioxide. The concentration of oxygen and carbon dioxide is variable but on an average of 100 ml of blood contains 0.02g of oxygen and 0.08g of carbon dioxide. Calculate the volume of oxygen and carbon dioxide at 1 atm and body temperature (37°C) assuming that there 10 liters of blood in the human body   (05 marks)

4. (a) Differentiate between the following terms as used in chemistry;

(i) Cryoscopic constant from ebullioscopic constant.
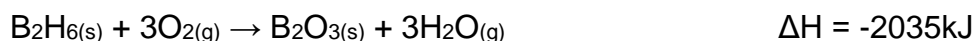
(ii) Boiling point from vapour pressure.

(iii) Briefly, explain the effect of degree of dissociation of a solute on the boiling point of solution. **(3 marks)**

(b) What mass of ethylene glycol, $C_2H_6O_2$, the main component of anti-freezing agent, which is added to 10L of water to produce a solution for use in a car radiator, that freezes at -23.3°C. Assume that the density of water is exactly 1g/ml and cryoscopic constant is 1.86oCkg/mol. **(4 marks)**

(c) 0.120g of hemoglobin, the protein which carries oxygen in the blood was dissolved to 200cm3 of benzene at 20oC. The solution exerted an osmotic pressure of 25.6Pa. Find the relative molecular mass of hemoglobin. **(3 marks)**

5. (a) Diborane, (B_2H_6) is very reactive such that it was once considered as a possible rocket fuel for U.S space programs. The overall equation for the synthesis of diborane is: $2B(s) + 3H_2(g) \rightarrow B_2H_6(g)$

Use the following data to calculate the enthalpy change of formation of B_2H_6 from its elements:

$2B_{(s)} + 3/2O_{2\,(g)} \rightarrow B_2\,O_{3(s)}$	$\Delta H = -1273kJ$
$B_2H_{6(s)} + 3O_{2(g)} \rightarrow B_2O_{3(s)} + 3H_2O_{(g)}$	$\Delta H = -2035kJ$
$H_{2(g)} + .O_{2(g)} \rightarrow H_2O_{(l)}$	$\Delta H = -286\ kJ$
$H_2O_{(l)} \rightarrow H_2O_{(g)}$	$\Delta H = 44\ kJ$ **(5 marks)**

(b) The enthalpies of solution of anhydrous $CuSO_4$ and hydrated $CuSO_4.5H_2O$ are -66.5 and 11.7 kJmol^{-1} respectively. Using thermochemical cycle, calculate the enthalpy of hydration of $CuSO_4$ to $CuSO_4.5H_2O$ **(5 marks)**

6. (a) Explain the three (3) classes of metal oxides **(03 marks)**

(b) With examples, explain each of the following

(i) A chemical test to distinguish soluble Metal Carbonates from metal hydrogen carbonates

(ii) Preparation of insoluble metal sulphates

(iii) Strong heating Iron (II) sulphate

(iv) Acidity property of aqueous aluminum Chloride **(04 marks)**

(c) Describe any three differences between aluminum chloride and sodium chloride **(03 marks)**

7. (a) Give reasons for the following observations:

(i) The boiling point of water, ethanol and ethoxyethane (diethyl-ether) are in the reverse order of their relative molecular masses unlike those of their analogous sulphur compounds, H2S,

C2H5SH, C2H5SC2H5.

(ii) BF3 is non-polar but NF3 is polar.

(iii) Aluminium fluoride has a much higher melting point than aluminium chloride. (3 marks)

(b) X, Y and Z represent elements of atomic number 9, 19 and 34.

(i) Write the electronic configuration of X, Y and Z.

(ii) Predict the type of bonding which would expect to occur between X and Y, X and Z and Y and Z.

(iii) Predict by giving reasons for relative volatility, electrical conductance and Solubility in water of the compounds formed between X and Y compared to that formed between X and Z. (4 marks)

(c) What is the effect of hydrogen bonding on the boiling point and solubility of a compound? **(3 marks)**

SECTION B (30 MARKS)

Answer only two (2 questions) from this section.

8. (a) State the Le-Chatellier's principle **(01 mark)**

(b) In Tanzania, we have two industries that produces ammonia by using the following chemical equation;
$$3H_2 (g) + N_2 (g) \rightleftharpoons 2NH_3 (g) \quad \Delta H = -93.8 \text{ kJ.}$$
The ammonia produced are being exported to china for manufacture of fertilizers, but currently the need of ammonia by china has increased compared to last year. As a chemistry expert, work out the conditions for maximum yield ammonia so as to meet the demand of the market?
(04 marks)

(c) A mixture of SO_2, O_2 and SO_3 gases are maintained in a 10L flask at a temperature of at which $K_c = 100$ for the reaction,
$$SO_2 (g) + O_2 (g) \rightleftharpoons SO_3 (g)$$
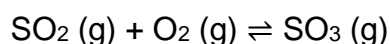
(i) If the moles of SO_2 and SO_3 are equal in the flask, how much O_2 is present at equilibrium?

(ii) If the number of moles of SO_3 in the flask is twice the number of moles of SO_2, how much O_2 is present at equilibrium? **(06 marks)**

(b) Explain the following
  (i)   The law of mass action
  (ii)   Equilibrium law
  (iii) Reaction quotient
  (iv)   Equilibrium concentration   **(4 marks)**

9. (a) What are the two effects of substituents groups on the reactivity of benzene ring. Briefly explain   **(4marks)**

(b) By giving example in each case briefly justify the statement that " Despite the fact that both benzene and alkene are unsaturated hydrocarbons, benzene undergoes electrophilic substitution reaction whereas akene undergoes electrophilic addition reaction"   **(2marks)**

(c) Why do activators attached to the benzene ring directs the incoming electrophile to Ortho and para positions? Briefly explain

(d) A unsaturated compound **H** reacts with ozone oxygen followed by hydrolysis in the presence of Zn to give compound **K (C_3H_6O)** which lacks replaceable hydrogen at the functional group and **L (C_3H_6O)** which has replaceable hydrogen at the functional group. If the compound **H** decolorizes acidified $KMnO_4$, then

i.   Write the structure of compound **K and L**   **(2marks)**
ii.   Show how to deduce the structure of compound **H**   **(1mark)**
iii. Write the mechanism of ozonolysis of compound H in the presence of zinc.   (**3marks)**

10. (a) Explain the following

Molal elevation constant

Molal depression constant

Vapour pressure

Colligative properties   **(04 marks)**

In a Cottrell determination, 22g of benzene was used as solvent. The reading on the differential thermometer before and after adding 0.586g of naphthalene (molar mass = 128) were 1.262°C and 1.799°C respectively. In a separate experiment, using the same amount of benzene but this time adding 0.627g of organic compound X, the temperature readings were 1.269°C and 1.963°C. Calculate the molecular mass of X

arks)

Phenol (C_6H_6O) associates in water to double molecules. When 0.6677g of phenol is dissolved in 35.5g of water, it depresses the freezing point by 0.215°C. Calculate the van't hoff factor and the degree of association of phenol. Molal depression constant of water = 1.85°Cmol⁻¹   **(05 marks)**

Explain each of the following as related to colligative properties

   A high blood pressure victim is advised by a doctor to take in less salt content food

   During heavy winter season, water in car radiator is mixed with ethylene glycol

   Salt is not applied at the start of cooking beans

   Osmotic pressure   **(02 marks)**