THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATIONS COUNCIL OF TANZANIA
ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

132/2 **CHEMISTRY 2**
(For Both School and Private Candidates)

Time: 3 Hours   **Year: 2024**

Instructions

1. This paper consists of a total of **six (6)** questions.

2. Answer a total of **five (5)** questions.

3. Each question carries **twenty (20)** marks.

4. Mathematical tables and non-programmable calculators may be used.

5. All writing must be in **blue** or **black** ink, **except** drawings which must be in pencil.

6. Communication devices and any unauthorised materials are **not** allowed in the examination room.

7. Write your **Examination Number** on every page of your answer booklet(s).

8. For calculations you may use the following constants:

   Gas constant, $R = 8.31$ J mol^{-1} K^{-1} or 0.082 atm mol^{-1} K^{-1} dm^3
   GMV = 22.4 dm^3
   Standard temperature = 273 K
   Standard pressure = 760 mm Hg = 1 atm = 1.0×10^{-5} N m^{-2}
   Atomic masses: H = 1, C = 12, O = 16, Na = 23, Cl = 35.5, Cr = 52, Ag = 108

1. (a) (i) How does the dilution with water affects the pH of a buffer solution? Briefly, explain.

    (ii) Briefly, explain the role of hydrocyanic acid (HCN) in the mixture of sodium cyanide (NaCN) and hydrocyanic acid when sodium hydroxide is added.
    (04 marks)

    (b) Calculate the mass of hydrochloric acid required to be added in a mixture of equal volumes of 0.5 M CH_3COONa and 0.5 M CH_3COOH to make 250 cm^3 of a solution with a pH of 4. (K_a of CH_3COOH is 1.77×10^{-5}).
    (06 marks)

    (c) (i) Briefly, comment on the solubility of CuS(s) and AgCl(s) when added in acidic solution.

    (ii) At 25 °C the solubility product of Ag_2CrO_4 is 1.9×10^{-12} mol^3 dm^{-9}. What would be the concentration of silver ions in g/dm^3?
    (10 marks)

2. (a) (i) Components of a binary mixture of liquid **A** and **B** were separated by distillation. After a certain amount of time, the separation of the components stopped and the composition of the vapour phase became the same as that of the liquid phase. Why this happened? Explain briefly.

    (ii) When alcohols and water are mixed together, the resulting solution deviates positively from the ideal behaviour. Justify this statement.
    (04 marks)

    (b) The vapour pressure of chloroform ($CHCl_3$) and dichloromethane (CH_2Cl_2) at 298 K are 200 mm Hg and 415 mm Hg, respectively. Determine:
    (i) the vapour pressure of the solution prepared by mixing 25.5 g of $CHCl_3$ and 40 g of CH_2Cl_2 at 290 K.
    (ii) the mole fraction of each component in the vapour phase.
    (08 marks)

    (c) (i) Briefly, comment on the statement that, "The boiling point of an immiscible solution is less than the boiling point of either of its pure components."

    (ii) An aromatic compound **Z** was steam distilled at 98.6 °C and 1 atm pressure. The distillate was found to contain 25.5 g of water and 7.4 g of the aromatic compound **Z**. Given that the saturated vapour pressure of water at 98.6 °C is 720 mmHg, determine the molecular mass of the aromatic compound **Z**.
    (08 marks)

3. (a) An alcohol **H** has the structure $CH_3CH_2CH_2CH(OH)CH_3$.
        (i)   What is the name of the compound **H** according to IUPAC rules?

        (ii) What type of the reaction would be involved if compound **H** reacted with concentrated H_2SO_4 at 170 °C ?

        (iii) Write the chemical equation for the reaction between compound **H** and I_2 in alkaline medium of NaOH. **(04 marks)**

    (b) A Chemist visited a chemical store to collect some hydroxyl compounds and found that all the chemicals had lost their actual labels though the store register book showed that phenol, n-propanol, benzyl alcohol and ethanol were in the stock. Due to this, the bottles were re-labelled as **I, II, III** and **IV** and placed into two groups as follow;
        (i)   **A (I and II)**
        (ii) **B (III and IV)**

        OH

        I $CH_3CH_2CH_2OH$ CH_2OH CH_3CH_2OH
                                II   **III**   **IV**
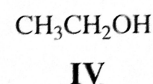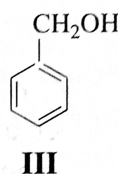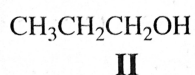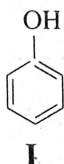
        How can you differentiate the chemicals in each group? Explain briefly while supporting your answer with appropriate chemical equations in each case.
        (02 marks)

    (c) An organic compound **L** contains 60% carbon, 13.33% hydrogen and 26.67% oxygen. A $1.12 \, dm^3$ volume of the gaseous organic compound **L** at s.t.p has a mass of 3 g. When reacted with iodine under dry ether, compound **L** gave a yellow compound and when reacted with PCl_5, it gave a colourless gas which on treatment with ammonia, gave white dense fumes.
        (i)   Determine the molecular formula of compound **L**.
        (ii) Give the structure of compound **L**. **(05 marks)**

    (d) (i)   Classify polymers based on their structures. Give one example for each type.
        (ii) Briefly, describe how branching and cross linking affect the physical properties of polymers.
        (iii) Why rubber is an elastomer? Briefly, explain.

        (iv) Addition polymerization is highly used in industrial production of plastics. How can you increase the rate of production of plastics if monomers, temperature and pressure are to be altered? **(09 marks)**

4. (a) Write the structural formula of the following organic compounds:
   (i) 4-Methylpentan-2-one.
   (ii) Pent-3-en-2-one. **(04 marks)**

   (b) Briefly, account for each of the following observations:
   (i) Although propanal and acetone have the same molar mass, the boiling point of acetone is higher than that of propanal.
   (ii) Ethanol is more reactive than propanone towards nucleophilic addition reactions.
   (iii) Ethanal gives a positive silver mirror test while butan-2-one does not. **(06 marks)**

   (c) Compounds **H** and **I** have the same molecular formula, C_4H_8O. When compound **H** and **I** were treated with PCl_5, they gave an acidic gas. Compound **H** gives a positive iodoform test while compound **I** does not.
   (i) What are the possible structures of **H** and **I**?
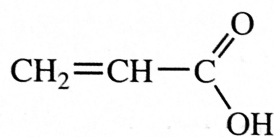   (ii) If compound **H** reacts with iodoform; what will be the chemical equation for the reaction? **(04 marks)**

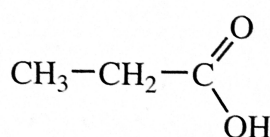   (d) Briefly, explain the following observations:
   (i) Methanoic acid has a larger value of K_a than ethanoic acid.
   (ii) 4-Hydroxybenzoic acid is less acidic than 4-nitrobenzoic acid.
   (iii) Acrylic acid is more acidic than propionic acid.

   $$CH_2{=}CH{-}\overset{\displaystyle O}{\underset{\displaystyle OH}{C}} \qquad\qquad CH_3{-}CH_2{-}\overset{\displaystyle O}{\underset{\displaystyle OH}{C}}$$

   Acrylic acid   Propionic acid

   (06 marks)

5. (a) You are given a reaction which exhibits a second order with respect to a reactant. Find out how its rate of reaction could be affected if the concentration of the reactant is;
   (i) doubled.
   (ii) reduced to half. **(02 marks)**

   (b) 0.25 g of a radioactive element remained after 5 years decomposition. If its initial weight was 10 g, calculate;
   (i) The rate constant for the decay of the radioactive element.
   (ii) The amount left after one year.
   (iii) The time required for half of the element to decay.
   (iv) The average life of the element. **(08 marks)**

(c) It is observed that the rate of a chemical reaction doubles with every 10 °C rise in temperature. Assume that this generalization holds true for a reaction in the temperature range 298 to 308 K, compute the value of activation energy for this reaction. **(05 marks)**

(d) The decomposition of N_2O_5 at 318 K according to the following equation, obeys first order reaction:

$$N_2O_5(g) \longrightarrow 2NO_2(g) + \frac{1}{2}O_2(g)$$
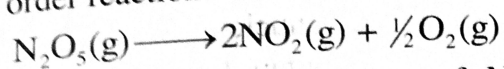
If the initial concentration of N_2O_5 was 1.24×10^{-2} mol dm^{-3}, calculate the concentration of N_2O_5 after 60 minutes, given that the rate constant of the reaction at 318 K is 0.0304/minute. **(05 marks)**

6. (a) (i) Differentiate between electron affinity and electronegativity.
   (ii) The first ionization enthalpy of magnesium is higher than that of sodium. On the other hand, the second ionization energy of sodium is higher than that of magnesium. Explain briefly. **(04 marks)**

(b) Describe how the position of an element in the periodic table is located. **(05 marks)**

(c) (i) All the s-block elements form ionic compounds except lithium and beryllium. Briefly, justify this statement.
   (ii) Differentiate effective nuclear charge from ionic radius. **(04 marks)**

(d) (i) Write the possible chemical equations representing the reduction of copper in the reverberator furnace.
   (ii) Describe the process of obtaining pure copper from blister copper. **(07 marks)**