

**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: 2023

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** drawing which must be in pencil.
6. Cellular phones 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, $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$ or $0.082 \text{ atm mol}^{-1} \text{ K}^{-1} \text{ dm}^3$

GMV = $22.4 \text{ dm}^3 = 22,400 \text{ cm}^3$

Standard temperature = 273 K

Standard pressure = $760 \text{ mm Hg} = 1 \text{ atm} = 1.0 \times 10^5 \text{ N m}^{-2}$

Velocity of light, $c = 3.0 \times 10^8 \text{ m/s}$

1 Faraday = $96,500 \text{ C mol}^{-1}$

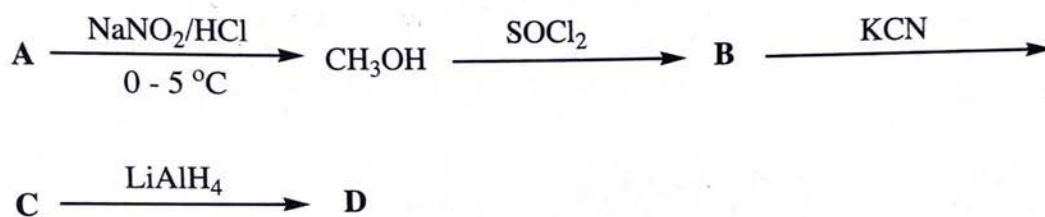


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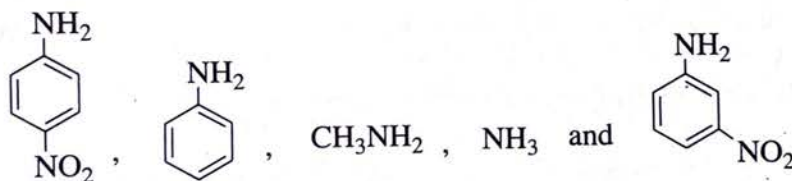
Answer a total of **five (5)** questions.

1. (a) (i) Can azeotropic mixtures be separated by distillation? Briefly, explain.
(ii) Mixing of acetone with chloroform takes place with reduction in volume. Identify the type of deviation from Raoult's law. **(04 marks)**
- (b) Two liquids **M** and **N** are mixed to form an ideal solution. The vapour pressure of the solution containing 3 moles of **M** and 1 mole of **N** is 550 mm Hg. When 4 moles of **M** and 1 mole of **N** are mixed, the vapour pressure of the solution formed is 560 mm Hg. What will be the vapour pressure of the pure **M** and pure **N** at this temperature? **(06 marks)**
- (c) (i) Briefly, explain five conditions that govern the distribution law.
(ii) The experiment was set to assess the solubility of succinic acid in water and ether at 15 °C. It was found that, 20 cm³ of the ether layer contained 0.092 g of the acid. If the distribution coefficient for succinic acid between ether and water is 5.2, find the weight of the acid which was present in 50 cm³ of the aqueous solution when the experiment was left at equilibrium. **(10 marks)**
2. (a) Comment briefly on the following statements:
(i) Lewis concept of acids and bases overruled Arrhenius concepts of acids and bases.
(ii) HSO₄⁻, is an amphiprotic.
(iii) When rain is accompanied by a thunderstorm, the collected rain water will have a pH value slightly lower than that of rain water without thunderstorm. **(06 marks)**
- (b) (i) Calculate the pH of a mixture when 1 cm³ of a 0.5 M H₂SO₄ is mixed with 2 cm³ of 0.1 M HCl, provided that no reaction occurs in the mixture.
(ii) A 0.1 M ethanoic acid solution contains 0.001 M H₃O⁺. What would be the K_a for this acid? **(08 marks)**
- (c) How much volume of a 0.1 M HCN should be added to a 50 cm³ of 0.2 M NaCN solution to prepare a buffer solution with a pH value of 4.91? (pK_a of HCN is 4.76). **(06 marks)**
3. (a) Write the IUPAC name of each of the following organic compounds:
(i) $\text{CH}_3-\underset{\text{CH}_3}{\text{CH}}-\text{CO}-\underset{\text{CH}_3}{\text{CH}}-\text{CH}_3$
(ii) $\underset{\text{C}_6\text{H}_5}{\text{CH}}=\text{CH}-\text{CHO}$ **(02 marks)**
- (b) (i) An organic compound **E** with molecular formula C₉H₁₀O forms 2,4-dinitrophenylhydrazine (2, 4-DNP) derivative. Also, it reduces Tollen's reagent and undergoes Cannizzaro's reaction. Upon vigorous oxidation, compound **E** gives 1,4-benzene dicarboxylic acid. Determine the chemical structure of compound **E**.

- (ii) Why aldehydes and ketones have lower boiling points than their corresponding alcohols and carboxylic acids? Explain briefly.
- (iii) A compound **B** (C_2H_4O) on oxidation gives compound **C** ($C_2H_4O_2$). Compound **B** undergoes haloform reaction. On treatment with HCN , compound **B** forms a product **Z** which on hydrolysis, gives 2-hydroxypropanoic acid. Write the equations for all the reactions involved. **(08 marks)**
- (c) Briefly explain the following observations:
- (i) Methylamine has lower boiling point than methanol.
- (ii) Aniline does not undergo Friedel-Crafts alkylation. **(04 marks)**
- (d) (i) Identify the structures of compounds **A**, **B**, **C** and **D** in the following sequential conversions:



- (ii) Giving reasons, arrange the following organic compounds in decreasing order of basic strengths.



- (iii) How ethylamine can be prepared from propionic acid? Give two steps. **(06 marks)**

4. (a) Given the following complex compound $K_3[Fe(NH_3)_6]$;

- (i) Give the IUPAC name of the compound.
- (ii) What is the number of electrons in the d -orbital in the central metal atom?
- (iii) Give the geometric structure and hybridization of the complex.
- (iv) Is the complex cationic, anionic or neutral? Briefly, explain. **(04 marks)**

- (b) Briefly, comment on the following statements:

- (i) Silver nitrate can react with $[Cu(NH_3)_5Cl]Cl$ but not with $[Cu(NH_3)_4Cl_2]$
- (ii) The complex compounds of cobalt have different colours; $[Co(CN)_6]^{3-}$ is Yellow, $[Co(NH_3)_6]^{3+}$ is orange while $[Co(H_2O)_6]^{3+}$ is blue. **(05 marks)**

Calculate;

(i) The rate constant at the given temperature without using graph.

(10 marks)

(ii) The concentration of N_2O_5 after 10 minutes.

(b) In the Arrhenius equation for a certain reaction, the values of A and E_a are $4 \times 10^{13} / \text{s}$ and 98.6 kJ mol^{-1} , respectively. If the reaction is of first order, calculate the temperature at which its half-life period will be 10 min. (05 marks)

(c) The following data were obtained during the first order thermal decomposition of SO_2Cl_2 at constant volume, $\text{SO}_2\text{Cl}_2 \xrightarrow{\Delta} \text{SO}_2(\text{g}) + \text{Cl}_2(\text{g})$.

Experiment	Time (s^{-1})	Total pressure/atom
1	0	0.5
2	100	0.6

Calculate the rate of the reaction when total pressure is 0.65 atmosphere.

(05 marks)