

**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 $0.082 \text{ atm mol}^{-1} \text{ K}^{-1} \text{ dm}^3$

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

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



2

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**.

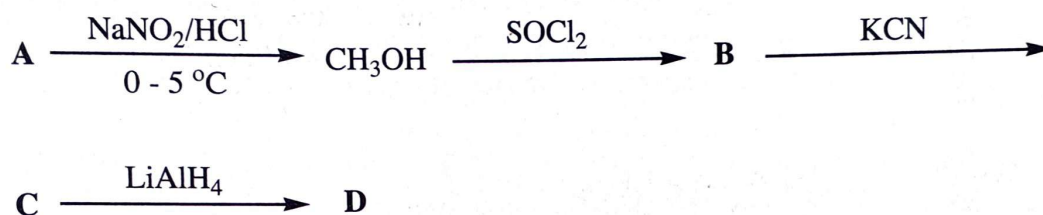
- (ii) Why aldehydes and ketones have lower boiling points than their corresponding alcohols and carboxylic acids? Explain briefly.
- (iii) A compound **B** (C_2H_4O) on oxidation gives compound **C** ($C_2H_4O_2$). Compound **B** undergoes haloform reaction. On treatment with HCN, compound **B** forms 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:

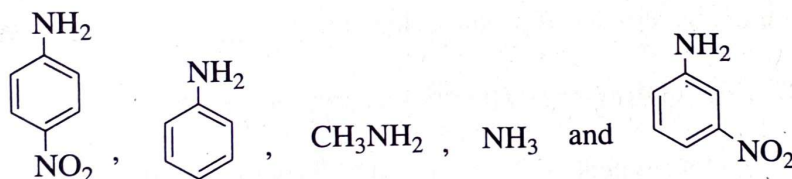
- (i) Methylamine has lower boiling point than methanol.
 (ii) Aniline does not undergo Friedel-Crafts alkylation.

(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.

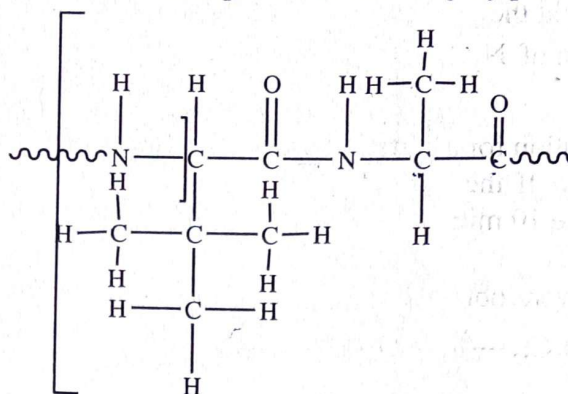
(04 marks)

(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)

- (c) Protein is the polymer of amino acid produced naturally by plants and has the formula;



- (i) Name the polymer.
- (ii) Suggest two monomers which might have been used to synthesize this polymer.
- (iii) Is this an addition polymer or condensation polymer? Give reasons for your answer.
- (iv) Write the reaction equation to show how this polymer is formed. **(06 marks)**
- (d) (i) Suppose you are a chemist in one of the synthetic industries and you are required to synthesize a polymer using acrylonitrile ($\text{CH}_2=\text{CH}-\text{CN}$) monomers. What type of polymerization process will you employ in order to synthesize the required polymer? Give a reason for your answer.
- (ii) With an example in each, distinguish homopolymer from co-polymer. **(05 marks)**
5. (a) Briefly describe four characteristics of *p*-block elements. **(04 marks)**
- (b) In four ways, briefly explain the factors affecting ionization energy. **(04 marks)**
- (c) How do oxides of period 3 elements react with water? Explain briefly and support your answer with appropriate chemical equations. **(08 marks)**
- (d) You have been asked to extract sodium metal from sea water through electrolysis. What will be the draw back and how would you overcome it? Explain briefly and support your answer with appropriate chemical equations. **(04 marks)**
6. (a) The decomposition of dinitrogen pentoxide is of first order being governed by the reaction equation $2\text{N}_2\text{O}_5(\text{g}) \rightarrow 4\text{NO}_2(\text{g}) + \text{O}_2(\text{g})$. When this reaction was allowed to proceed at 40°C , the following data were collected:

$[\text{N}_2\text{O}_5]$ (M)	Time (min)
0.400	0.00
0.289	20.0
0.209	40.0
0.151	60.0
0.109	80.0

Calculate;

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

(ii) The concentration of N_2O_5 after 10 minutes.

(10 marks)

(b) In the Arrhenius equation for a certain reaction, the values of A and E_a are $4 \times 10^{13} / s$ 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, $SO_2Cl_2 \xrightarrow{\Delta} SO_2(g) + Cl_2(g)$.

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)