

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

132/1

CHEMISTRY 1

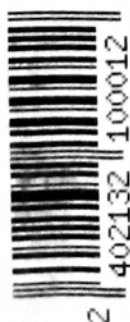
(For Both School and Private Candidates)

Time: 3 Hours

Year: 2024

Instructions

1. This paper consists of a total of **ten (10)** questions in sections A and B.
2. Answer **all** questions in section A and **two (2)** questions from section B.
3. Each question carries **ten (10)** marks in section A and **fifteen (15)** marks in section B.
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:
 - Gas constant, $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$ or $0.0821 \text{ atm mol}^{-1} \text{ K}^{-1} \text{ dm}^3$
 - GMV = $22.4 \text{ dm}^3 = 22400 \text{ cm}^3$
 - Standard temperature = 273 K
 - Standard pressure = $760 \text{ mm Hg} = 1.0 \times 10^5 \text{ N m}^{-2} = 1 \text{ atm}$
 - Planck's constant, $h = 6.626 \times 10^{-34} \text{ J s}$
 - Velocity of light, $c = 3.0 \times 10^8 \text{ m/s}$
 - Mass of an electron = $9.1 \times 10^{-31} \text{ kg}$
 - Atomic masses: $\text{H} = 1, \text{C} = 12, \text{O} = 16, \text{Ca} = 40$



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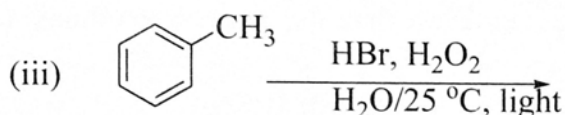
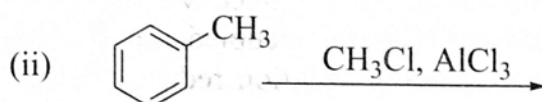
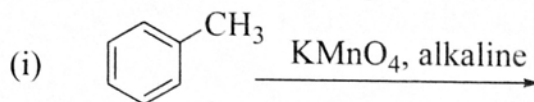
SECTION A (70 Marks)

Answer **all** the questions in this section.

1. (a) Briefly explain the following concepts by giving one example for each:
- (i) Nucleophilic addition reaction.
 - (ii) Elimination reaction.
 - (iii) Substitution reaction.
 - (iv) Mesomeric effect.
 - (v) Negative inductive effect. **(05 marks)**
- (b) A 20 cm³ volume of gaseous hydrocarbon was mixed with 140 cm³ of excess oxygen and exploded. After cooling, the mixture occupied 100 cm³. Absorption of the gas by concentrated potassium hydroxide solution reduced the volume by 60 cm³ and the unabsorbed gas relighted the glowing splint. Determine the molecular formula of the hydrocarbon. **(05 marks)**
2. (a) What is the difference between the following?
- (i) Subsidiary quantum number and magnetic quantum number.
 - (ii) Orbitals and degenerate orbitals. **(02 marks)**
- (b) By using a line diagram method, indicate the distribution of electrons in the following orbitals of atoms:
- (i) 2p of magnesium.
 - (ii) 3d of manganese.
 - (iii) 2p of carbon.
 - (iv) 4s of potassium.
 - (v) 3p of silicon. **(2.5 marks)**
- (c) (i) Given the principal quantum number $n = 2$, tabulate the related quantum numbers and provide the total number of electrons present in this energy level.
- (ii) Comment on the difference of the de Broglie wave lengths between a ball of 0.2 kg moving with a velocity of 3×10^8 m/s and that of an electron moving with the same velocity. **(5.5 marks)**
3. (a) While giving an example in each case, differentiate;
- (i) homogenous equilibrium from heterogeneous equilibrium.
 - (ii) equilibrium constant from reaction quotient. **(04 marks)**

- (b) When 0.4 mol of PCl_5 was heated in a 10 dm^3 vessel, it decomposed according to the equation: $\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$. When the equilibrium was established, the amount of Cl_2 in the vessel was found to be 0.25 mol. Calculate;
- The number of moles of PCl_5 and PCl_3 present at equilibrium.
 - The equilibrium concentrations for all the three components.
 - The equilibrium constant (K_C) for the decomposition reaction. **(06 marks)**

4. (a) Complete the following organic reactions by giving the major product(s) only:



(03 marks)

- (b) (i) What is the difference between a side chain reaction and an electrophilic substitution reaction?
- (ii) The alkoxy group ($-\text{OR}$) is an ortho-para directing group though oxygen is more electronegative than carbon. Explain briefly. **(05 marks)**

- (c) Draw the structures of the principal organic products obtained on the nitration of each of the following:

- p*-methylbenzoic acid
- m*-dinitrobenzene

(02 marks)

5. (a) (i) What are the three conditions that must be fulfilled for a solution to exhibit colligative properties? Provide a brief explanation in each condition.
- (ii) Assume you are given glucose solutions **A** and **B**, with concentrations of 1 and 2 M, respectively. Which of the solutions do you expect to have higher boiling point than the other? Give a reason to support to your answer.

(04 marks)

- (b) The boiling temperature of a solution prepared by dissolving 5.0 g of an organic solid in 100.0 g of benzene is 82.42°C . If the boiling temperature of pure benzene is 80.10°C ; determine the molecular weight of the organic solid. ($K_b = 2.53^\circ\text{C/m}$)

(04 marks)

- (c) Addition of 1 mol of NaCl into 1 litre of water causes the boiling point of water to increase, while addition of 1 mol of methyl alcohol into 1 litre of water decreases the boiling point. How can you justify this statement? **(02 marks)**

6. (a) Complete the following table by filling in the missing information:

Compound	Type of bond	Number of lone pair(s)	Type of hybridization	Geometrical shape
PCl ₃				
NH ₃				
CF ₄				

(06 marks)

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

- H₂O and HF have higher boiling points than PH₃ and HS.
- CO₂ and SO₂ have the same empirical formulae; however, CO₂ is non-polar while SO₂ is a polar compound.
- The type of bond in ethyne is stronger than that present in ethane. (04 marks)

7. (a) "The carbonate of sodium exists on heating, while that of iron does not." Briefly, justify this statement while supporting your answer with appropriate chemical equations. (03 marks)

- (b) Briefly explain five uses of metal carbonates in daily life activities. (05 marks)

- (c) As a chemist in one of the fertilizer company in Tanzania, you are required to prepare sulphates in one of the synthetic stages in a small scale. Briefly, advise four methods that you can use to prepare soluble metal sulphates. (02 marks)

SECTION B (30 Marks)

Answer **two (2)** questions from this section.

8. (a) (i) Differentiate ion exchange from acidic soil reaction.
(ii) Why is nitrate more leached than ammonium from the soil? Briefly explain.
(iii) Why sand soils have zero Cation Exchange Capacity (CEC)? (04 marks)
- (b) (i) Explain two roles of the following ions in liming:
CO₃²⁻, O²⁻, OH⁻, SiO₃²⁻
(ii) Calculate the amount of calcium carbonate required to lime an acidic soil that requires 100 g of calcium oxide for the same work. (06 marks)
- (c) (i) Despite the importance of using fossil fuels, they have drawbacks to the environment. Briefly, explain two drawbacks of such fuels.

(ii) Briefly, explain three measures that can be taken to reduce depletion of mineral resources. **(05 marks)**

9. (a) Compare the heat capacity of 2 kg steel frying pan and that of a 2 g steel pin. Are the heat capacities of these objects different? Explain briefly. **(02 marks)**

(b) A person took an ice cream from a refrigerator and kept it on a table; unfortunately, after 30 minutes the ice cream changed into juice. Is the process of changing ice cream into juice, an endothermic or exothermic? Give reason for your answer. **(02 marks)**

(c) (i) Draw and label a complete born Haber cycle of magnesium nitride.
(ii) Enthalpy of solution of $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ and BaCl_2 are 8.8 and -20.6 kJ/mol, respectively. Calculate the enthalpy change (ΔH) of the following reaction:
$$\text{BaCl}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow \text{BaCl}_2 \cdot 2\text{H}_2\text{O}(\text{s})$$
 (11 marks)

10. (a) Predict what will happen to the average kinetic energy of ideal gas molecules when the conditions change as follows:

(i) The pressure of the gas is increased by reducing the volume at constant temperature.

(ii) The pressure of the gas is increased by increasing the temperature at constant volume.

(iii) The average velocity of the molecules is increased by a factor of two.

(03 marks)

(b) Quicklime (CaO) is produced by the thermal decomposition of calcium carbonate (CaCO_3). Calculate the volume of CO_2 produced at s.t.p. from the decomposition of 152 g of CaCO_3 according to the reaction, $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$.

(05 marks)

(c) A colourless liquid was isolated from a petroleum sample and observed to have the properties of cyclohexane (C_6H_{12}). To determine the molar mass of the isolated liquid, Dumas' method was used and the following data were recorded:

Volume, (V) of the flask = 213 ml;

Mass of flask + gas = 78.386 g;

Mass of empty flask = 77.809 g;

Temperature, $T = 100^\circ\text{C}$;

Pressure (P) = 754 mm Hg;

Calculate the molar mass of the colourless liquid isolated and verify if the liquid was consistent with the suspected cyclohexane molecule. **(07 marks)**