# 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)

**Duration: 3 Hours** **Year: 2025**

### Instructions

1. This paper consists of a total of **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 **10** marks in section A and **15** marks in section B.
4. Mathematical tables and non-programmable calculators may be used.
5. Communication devices and any unauthorised materials are **not** allowed in the examination room.
6. Write your **Examination Number** on every page of your answer booklet(s).
7. For calculations you may use the following:
   - Rydberg constant, $R_H = 1.097 \times 10^7\ m^{-1}$
   - Gas constant, $R = 8.314\ J\ mol^{-1}\ K^{-1}$ or $0.0821\ atm\ mol^{-1}\ K^{-1}\ dm^3$
   - Standard temperature = 273 K
   - Standard pressure = $1.01325 \times 10^5\ N\ m^{-2}$ = 1 atm = 760 mm Hg
   - Planck's constant, $h = 6.63 \times 10^{-34}\ J\ s$
   - Velocity of light, $c = 3.0 \times 10^8\ m/s$
   - Atomic masses: H = 1, C = 12, N = 14, Cl = 35.5, O = 16

## SECTION A (70 Marks)

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

1. (a) Describe five unique properties of carbon atom which enable it to form so many compounds. **(5 marks)**

   (b) The names of the following organic compounds are incorrect. Draw the structural formula for each compound and assign its correct IUPAC name.
   (i) 2,2-dimethyl-3-pentene
   (ii) 3- ethyl-4-heptene
   (iii) 2-methyl-4-heptene
   (iv) 2,2,3-methylbutane
   (v) 5-methyl-3-bromo-3-ethylhexane **(5 marks)**

2. (a) "Hydrogen bonding is essential in sustaining life." In four points, briefly justify this statement. **(4 marks)**

   (b) (i) Why is $AlCl_3$ covalent while $AlF_3$ is ionic.
   (ii) Identify the shape of the molecule and a type of hybrid orbital shown by the underlined atom; $\underline{Be}F_2$, $\underline{N}O_3^-$ and $\underline{B}F_3$ **(6 marks)**

3. (a) A reaction to produce ammonia gas from nitrogen and hydrogen gas, was carried in a 3.5 litres vessel at 375 °C and had a $K_C$ value of 1.5 $mol^2\ dm^{-6}$ according to the following equation:

   $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$.

   A sample drawn from the vessel and analyzed contained 0.25 moles of $N_2(g)$, 0.0032 moles of $H_2(g)$ and $6.42 \times 10^{-4}$ moles of $NH_3(g)$.
   (i) Establish whether the reaction system had attained equilibrium or not, when the sample was analyzed.

   (ii) State the direction of the reaction. **(6 marks)**

   (b) Given the following system at equilibrium;

   $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)\ \Delta H = -188\ kJ\ mol^{-1}$.

   Predict the changes of concentration of $SO_3$ if;
   (i) the pressure of the system is increased.
   (ii) a noble gas is added such that the pressure of the system increases and the volume changes occur.
   (iii) more $SO_3$ is added to the system.
   (iv) the temperature of the system is increased. **(4 marks)**

4. (a) Determine the maximum number of electrons, that can be associated with each of the following sets of quantum numbers:

(i) $n = 4, \ell = 2$.

(ii) $n = 2, \ell = 1, m_\ell = -1$.

(iii) $n = 3, \ell = 2, m_\ell = -2, ms = -\frac{1}{2}$. **(6 marks)**

(b) Excited hydrogen atom gives many emission lines. One of the series of lines called Bracket series occurs in the infrared region. It occur when an electron jumps from higher energy level orbitals to energy level n = 4. Calculate the wavelength of the lowest energy lines of this series. **(4 marks)**

5. (a) Use the kinetic equation to deduce the Graham's law. **(4 marks)**

(b) (i) At the ends of a horizontal glass tube, plugs of cotton wool soaked in concentrated ammonia solution and concentrated hydrochloric acid are inserted simultaneously. After a short time, a white ring of solid ammonium chloride forms at a certain point in the tube. If the distance between the inner surfaces of the cotton wool plugs is 50 cm, how far from the ammonia plug does the ammonium chloride ring form?

(ii) What is the molar mass of gas **Z**, if it takes 54.4 seconds for 100 $cm^3$ of gas **Z** to effuse through an aperture and 36.5 seconds for 100 $cm^3$ of oxygen gas to effuse through the same aperture? **(6 marks)**

6. (a) By using balanced chemical equations, explain the following observations:

(i) A dark brown color is produced when a dilute HCl is added to a solution containing potassium iodide and potassium iodate.

(ii) Iodine is more soluble in aqueous solution of potassium iodide than in water. **(4 marks)**

(b) By using three specific examples, show that the solutions of salts formed from strong acids and weak bases are acidic. **(4 marks)**

(c) When a solution of barium hydroxide [$Ba(OH)_2$] is mixed with a solution of sulphuric acid, a white precipitate forms and the electrical conductivity of the solution decreases markedly.

(i) Write a balanced chemical equation for the reaction that occurs.

(ii) Account for the decrease in electrical conductivity. **(2 marks)**

7. (a) Explain the applicability of the Hess's law of constant heat summation. **(2 marks)**

(b) (i) Calculate the lattice energy ($\Delta H_{LE}$) of a solid calcium chloride given the information that, the heat of sublimation ($\Delta H_{sub}$) for calcium is +11 kJ $mol^{-1}$ and its first and second ionization potentials ($\Delta H_{ip}$) are +33.5 $kJmol^{-1}$ and + 65.2 kJ $mol^{-1}$, respectively. The heat of dissociation ($\Delta H_{diss}$) for chlorine is +13.9 kJ $mol^{-1}$ and electron affinity ($\Delta H_{afl}$) for chlorine atom is –20.8 kJ $mol^{-1}$.

The standard heat of formation ($\Delta H^{\theta}_{f}$) of the solid calcium chloride is $-45.4$ kJ mol$^{-1}$.

(ii) If $Ca^{+}$ and $Cl^{-}$ ions formed a hypothetical crystal, CaCl(s) with its lattice similar to that of $CaCl_2$, the lattice energy for the hypothetical CaCl would be $+43$ kJ mol$^{-1}$. Use this value to calculate the heat of formation of the hypothetical CaCl.

(iii) Which of the two $CaCl_2$(s) or CaCl(s) has a stable crystal lattice? Briefly, explain your answer. **(8 marks)**

## SECTION B (30 Marks)

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

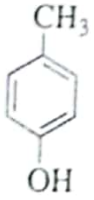
8. (a) (i) What are colligative properties?
(ii) Give two limitations of colligative properties. **(5 marks)**

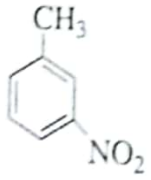
(b) A sugar solution with a concentration of 2.5 g dm$^{-3}$, gave an osmotic pressure of $8.3\times10^{-4}$ atm at 25°C. Calculate the molecular mass of the solute. **(5 marks)**

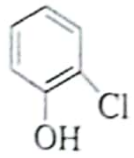
(c) A solution of Urea ($CON_2H_4$) contains 1.75 g dm$^{-3}$ in isotonic at the same temperature with a solution of 10 g of a certain sugar in 1dm$^3$ of an aqueous solution. Calculate the relative molecular mass of the sugar. **(5 marks)**

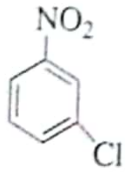
9. (a) Describe briefly the following with reference to substitution reactions on benzene:
(i) Activators
(ii) Deactivators **(4 marks)**

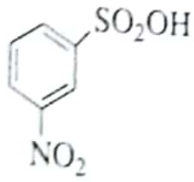
(b) State with reasons, the group which entered the benzene ring first from the following compounds:

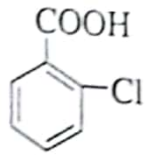
(i) 


(ii) 


(iii) 

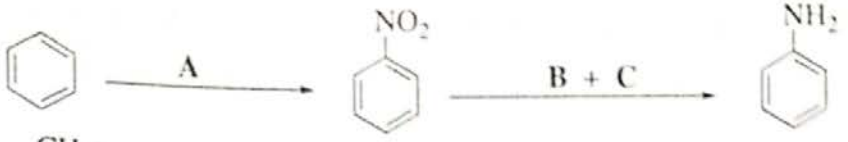

(iv) 

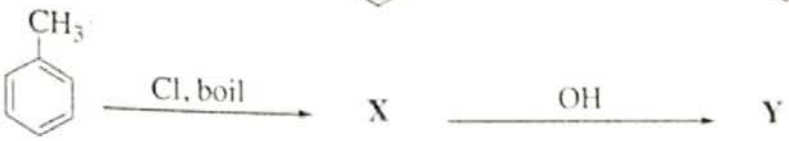

(v) 


(vi) 


**(6 marks)**

(c) Complete the following organic reactions by filling the missing structures and reagents designated by letters.

(i) 


(ii) 


**(5 marks)**

10. (a) What do you understand by the following terms?
    (i) Global warming
    (ii) Ozone layer **(2 marks)**

(b) Suppose you got a job at the National Environmental Management Council (NEMC) of Tanzania, and in one of the occasions, you are required to address the residents of a certain area on environmental issues. Briefly, explain the following:
    (i) Meaning of the word incineration.
    (ii) Two advantages and two disadvantages of incineration.
    (iii) Three harmful effects of particulate pollutants. **(8 marks)**

(c) (i) What would have happened if the greenhouse gases were totally missing in the earth's atmosphere? Briefly, explain.
    (ii) Give four damaging effects of an acidic rainfall. **(5 marks)**