

THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATIONS COUNCIL
ADVANCED CERTIFICATE OF SECONDARY EDUCATION
EXAMINATION
132/1
CHEMISTRY 1

(For Both School and Private Candidates)

Time: 2:30 Hours

Thursday, 11th February 2010 p.m.

INSTRUCTIONS

1. This paper consists of fourteen (14) questions in sections A, B and C.
2. Answer four (4) questions from section A and three (3) questions from each of sections B and C.
3. Each question carries ten (10) marks.
4. Mathematical tables and non-programmable calculators may be used.
5. Cellular phones 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 constants:
Rydberg constant $R_H = 1.09678 \times 10^7 \text{ m}^{-1}$
Gas constant, $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$ or $0.0082 \text{ atm mol}^{-1} \text{ K}^{-1} \text{ dm}^3$
GMV = 22.4 dm^3
1 litre = $1 \text{ dm}^3 = 1000 \text{ cm}^3$
Temperature = 273 K
Pressure = 760 mmHg
Planck constant, $h = 6.63 \times 10^{-34} \text{ Js}$
Velocity of light, $C = 3.0 \times 10^8 \text{ m/s}$
Atomic masses: H = 1, C = 12, N = 14, O = 16,
Na = 23.

This paper consists of 7 printed pages.

SECTION A (40 marks)

Answer four (4) questions from this section.

1. (a) Define the following:
- | | |
|-------------------|---------------------|
| (i) Isotopes | (ii) Atomic number |
| (iii) Mass number | (iv) Radioactivity. |
- (4 marks)
- (b) Explain why $^{18}_8\text{Z}$ and $^{16}_8\text{Z}$ atoms have identical chemical properties but $^{134}_{90}\text{X}$ and $^{134}_{91}\text{X}$ have different chemical properties. (1 mark)
- (c) X is a radioactive element which undergoes transition as follows:
- $$\text{X} \xrightarrow{\beta \text{ emission}} \text{Y} \xrightarrow{\beta \text{ emission}} \text{Z} \xrightarrow{\alpha \text{ emission}} \text{W}$$
- If the atomic number of X is 17 and its mass number is 37, what are the atomic numbers and mass numbers of the isotopes Y, Z and W? (2 marks)
- (d) Describe three (3) applications of radioactivity. (3 marks)
2. (a) Electronic configuration of silver violates Aufbau's building principle. Justify this statement and explain briefly the observed violation. (2 marks)
- (b) (i) Define the term quantum number.
(ii) What are the four (4) properties described by quantum numbers? (6 marks)
- (c) Why do ionization energies increase from left to right across the periodic table? (2 marks)
3. (a) Define the following giving one example in each case:
- | |
|---------------------------|
| (i) Hydrogen bond |
| (ii) Coordinate bond |
| (iii) Polar covalent bond |
| (iv) Electrovalent bond. |
- (4 marks)
- (b) (i) Describe the conditions necessary for the formation of hydrogen bond. How does the described bond differ from other intermolecular forces?
(ii) With the help of diagrams, show the type of hybridization, geometry and bond angle found in methane, ethane and ethylene molecules.
(iii) By using diagrams explain why NH_3 and CH_4 have tetrahedral geometrical structures but the bond angle in CH_4 which is 109.5° is greater than in NH_3 . (6 marks)
4. (a) State the following:
- | |
|---------------------------------|
| (i) The equilibrium law. |
| (ii) Le Chaterlier's principle. |
- (3 marks)

- (b) Explain briefly the following:
 (i) Dynamic equilibrium
 (ii) Reaction quotient. **(3 marks)**
- (c) Dinitrogen tetraoxide in its liquid state was used as one of the fuels on the Lunar lander expeditions for the NASA space vessels. In the gas phase it decomposes to gaseous nitrogen dioxide as shown in the following equation:
- $$\text{N}_2\text{O}_{4(g)} \rightleftharpoons 2\text{NO}_{2(g)}$$
- $\text{N}_2\text{O}_{4(g)}$ was allowed to reach equilibrium at 400°C where $K_{sp} = 0.133$ atm. At equilibrium the pressure of $\text{N}_2\text{O}_{4(g)}$ was found to be 2.71 atm.
- (i) Write the equilibrium expression in terms of concentration.
 (ii) Write the equilibrium expression in terms of the partial pressures.
 (iii) Calculate the equilibrium pressure of $\text{NO}_{2(g)}$. **(4 marks)**
5. (a) Define the following terms:
 (i) Colligative properties (ii) Ideal solution. **(2 marks)**
- (b) List the following in the order of increasing boiling points:
 0.03M hexane, 0.03M potassium chloride and 0.03M acetic acid. **(2 marks)**
- (c) (i) The melting point of camphor is 176.5°C . When 0.125 g of sulphur is finely ground with 3.62 g of camphor, the resultant mixture melts at 171.4°C . What is the molecular weight of sulphur in camphor?
 (ii) Water and ethanol form an azeotropic mixture of composition 95.6% ethanol which boils at 78.15°C . Sketch a well labelled temperature – composition curve for the water-ethanol mixture. Explain whether it is possible to obtain pure ethanol from a water – ethanol mixture. **(6 marks)**
6. (a) Give a brief explanation of the following terms:
 (i) Mole
 (ii) Molarity
 (iii) Avogadro's constant
 (iv) A molar solution. **(4 marks)**
- (b) One eighth of a mole of a certain hydrated salt contains 11.2 g of water. Calculate the number of molecules of water of crystallization of the salt. **(2 marks)**
- (c) The atomic radius of sodium is 1.86×10^{-8} cm, and the molar volume of sodium is 23.68 cm^3 . If 68.52 % of this volume is the actual volume occupied by sodium atoms, calculate the Avogadro's constant.
 (Volume of one sodium atom $= \frac{4}{3}\pi r^3$). **(4 marks)**

SECTION B (30 marks)

Answer **three (3)** questions from this section.

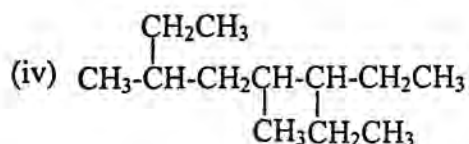
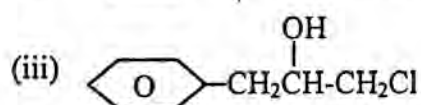
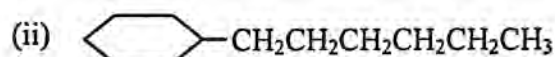
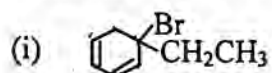
7. (a) The empirical formula of nicotine, a poisonous compound found in tobacco is C_5H_7N . Its molecular weight is 162. What is the molecular formula of the compound? (2 marks)
- (b) How many grams of oxygen are required to burn 57.0 g of octane? (2 marks)
- (c) What is the arrangement of electrons in $^{60}_{27}\text{Co}$ which is used in cancer therapy? (2 marks)
- (d) One mechanism for the removal of excess heat generated by metabolic process in the body is evaporation of the water by sweat. In a hot, dry climate as much as 1.5 litre of water per day may be lost by one person. Calculate the amount of heat required to evaporate this water at $T = 46^\circ\text{C}$. ($\Delta H_{\text{vap}} = 43.02 \text{ kJ mol}^{-1}$ at 46°C) (4 marks)
8. (a) In what ways does the chemistry of hydrogen resemble that of
(i) alkali metals
(ii) halogens? (4 marks)
- ✓ (b) Explain the meaning of the following terms:
(i) Lone pair electrons
(ii) Electronegativity
(iii) Electron affinity. (3 marks)
- (c) Describe two industrial methods for the preparation of hydrogen. (3 marks)
9. (a) State the allotropic properties of carbon. (2 marks)
- ✓ (b) Account for the following:
(i) Ba and Mg are group two elements but $\text{Mg}(\text{NO}_3)_2$ does not impart colour to the Bunsen burner flame while $\text{Ba}(\text{NO}_3)_2$ does.
(ii) K^+ and Ca^{2+} have the same number of electrons but the size of K^+ is larger than Ca^{2+} .
(iii) Be is in period two and group two while Al is in period three and group three but the properties of their compounds resemble in most aspects. (6 marks)

- (c) Explain why the acidity of the hydrides of group seven elements increases down the group? (2 marks)
10. (a) Explain briefly the following terms: (3 marks)
- Indicator
 - Titrant
 - End - point.
- (b) Commercially available concentrated hydrochloric acid is an aqueous solution containing 38% HCl acid by mass and has a specific gravity of 1.18 g/cm^3 .
- Calculate its molarity.
 - How many cm^3 of concentrated hydrochloric acid are required to make 25 cm^3 of 0.01 M HCl solution? (7 marks)

SECTION C (30 marks)

Answer three (3) questions from this section.

11. (a) Write the IUPAC names for the following compounds:



(4 marks)

- (b) Write the structural formulae of the following compounds:

- Propan-1-ol
- 4-methylcyclohex-1-ene
- 1-isopropyl-methylcyclohexane
- 4-methylpent-2-yne.

(4 marks)

- (c) Write the equations for suitable laboratory methods of preparing the following alkanes starting from one organic compound that has less than four carbon atoms only.
- 2,3-dimethylbutane.
 - Pentane.

(2 marks)

12. (a) (i) Write the structural isomers of molecular formula C_4H_9Cl .
 (ii) Explain by using chemical equations the chemical test which can be used to distinguish the isomers in 12 (a) (i).

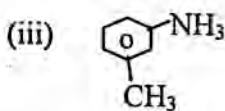
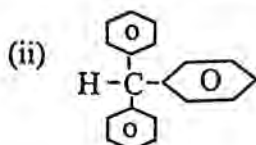
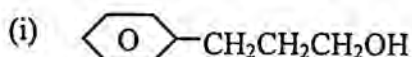
(4 marks)

- (b) Write the equations for the following reactions:

- Benzene and chloromethylbenzene (benzyl chloride), in the presence of $AlCl_3$.
- 1-chloromethyl-4-nitrobenzene and benzene, in the presence of $AlCl_3$.

(3 marks)

- (c) Name the following compounds:



(3 marks)

- (a) Write chemical equations showing how you would prepare the following compounds:

- Butan-2-ol from 2-iodobutane
- Propane from 1-bromopropane
- 1-iodobutane from 1-bromobutane
- Methoxymethane from chloromethane
- Butane from ethane
- Methylbenzene from acetylene.

(6 marks)

- (b) Suggest suitable tests to distinguish the following compounds:

- But-2-yne and butane
- Cyclobutane and pent-2-ene
- Methanol and ethanol
- 2-butyne and 1-butyne.

(4 marks)