

THE UNITED REPUBLIC OF TANZANIA
PRESIDENT'S OFFICE, REGIONAL ADMINISTRATION AND LOCAL
GOVERNMENT



FORM SIX SPECIAL SCHOOL JOINTS EXAMINATION
CHEMISTRY I

132/1

Time: 3:00 HRS

Monday 17-Feb-2020 PM

Instructions

1. This paper consists of **ten (10)** questions in sections A and B
2. Answer **seven (7)** questions from section A and **two (2)** questions from section B
3. Mathematical and non-programmable calculators may be used
4. Cellular phones are **not** allowed in the examination room
5. Write your **Examination Number** on every page of your answer sheets
6. For calculations you may use the following constants
 - Rydberg constant $R_H = 1.09678 \times 10^7 \text{ m}^{-1}$
 - Gas constant, $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$
 - Planks constant, $h = 6.63 \times 10^{-34} \text{ Js}$
 - Velocity of light, $c = 3.0 \times 10^8 \text{ m/s}$
 - The Cryoscopic constant of water = $1.86 \text{ K / mol}^{-1} \text{ kg}$
 - The ebullioscopic constant of water = $5.2 \text{ }^\circ\text{C/kg mol}^{-1}$
 - Atomic masses: H = 1, C = 12, O = 16, Cl = 35.5, He = 2 Na = 23, S = 32, K = 39, I = 127
 - Avogadro's constant, $N = 6.022 \times 10^{23} \text{ mol}^{-1}$

SECTION A

This section consists of SEVEN (7) questions with TEN (10) marks each.
Answer ALL questions from this section.

1. (a) State the following;

- (i) Aufbau principle
- (ii) Paul's exclusion principle
- (iii) Hund's rule of maximum multiplicity
- (iv) Half-filled and full-filled orbital rule

(4 marks)

(b) The wavelength of lines in the Balmer series of hydrogen spectrum is given by the expression;

$$\frac{1}{\lambda} = R_H \left(\frac{1}{2^2} - \frac{1}{n^2} \right) \quad \text{Where, } n \text{ is an integer greater than } 2$$

(i) Draw an energy level diagram to show the origin of second and fourth lines in the particular series.

(ii) Calculate the frequency of the first line in the series. (5 mark)

(c) How does atomic spectrum differ from continuous spectrum? (1 mark)

2. (a) (i) State why the boiling point of water rise due to addition of table salt. (2 marks)

(ii) State the laws which apply to the osmotic pressure of dilute solution (1.5 marks)

(iii) Briefly explain, with reason(s), whether the osmotic pressure method would be satisfactory for determining the relative molecular mass of ethanoic acid in a concentrated solution of the acid in a suitable solvent (1.5 marks)

(b) (i) Calculate the freezing point of a solution of 22.5 g of cane sugar ($C_{12}H_{22}O_{11}$) in 450 g of water

(ii) If a solution of potassium chloride in water had a freezing point of $-0.048^\circ C$, compare this value to the one obtained in (i) above and state from which solution will the ice first separate (5 marks)

- 3(a) (i) What are the three characteristics of a system in chemical equilibrium?
 (ii) Tabulate the influence of changes in pressure, temperature and addition of catalyst on the equilibrium constant and equilibrium position **(4.5 marks)**

(b) Phosphorus pentachloride gas was allowed to dissociate into phosphorus trichloride gas and chlorine gas at 500 K in 5 litres flask. If 0.2 moles of phosphorus pentachloride were used for such reaction, at equilibrium 60% of it was found to have dissociated and the total pressure was found to be 300 torr. Calculate the equilibrium constant, K_p for the reaction **(5.5 marks)**

4. (a) Define the following terms;
 (i) Degree of dissociation
 (ii) Partial pressure of gases **(2 marks)**

(b) (i) Real gases are those which disobey gas laws. Outline two assumptions of kinetic theory of gases which must be modified for gas to behave ideally.
 (ii) Calculate the root mean square velocity for the atoms in a sample of helium gas at 25°C. **(5 marks)**

(c) The relative density of Iodine at atmospheric pressure and 1250°C is 87. Calculate the percentage dissociation of Iodine into atoms under these conditions. **(3 marks)**

5. (a) What do you understand by the following terms;

- (i) Dative bonds
 (ii) Inter-molecular hydrogen bond
 (iii) Covalent bond
 (iv) Intra-molecular hydrogen bond

Handwritten notes:
 $\frac{P}{m^2} \frac{J}{m^3}$
 $\frac{m^2 \cdot m^3}{m^3}$
 $\frac{m^5}{m^3}$
 $\frac{m^2}{m}$
 $\frac{m^2}{m}$

(4 marks)

(b) Predict whether each of the following molecules has a dipole moment

- (i) BrCl (ii) BF₃ (iii) CH₂Cl₂

Handwritten notes:
 $\frac{\mu}{m}$
 $\frac{m}{m}$

(3 marks)

(c) Explain the following observations;

(i) The bond between hydrogen and chlorine in hydrogen chloride is not hundred per cent covalent or electrovalent

Handwritten notes:
 $\frac{m}{m}$
 $\frac{m}{m}$
 $\frac{m}{m}$

(ii) HI does not form hydrogen bonding while HF does although both are hydrides of group seven (3 marks)

(iii) Some compounds of Lithium have partially covalent character (1 mark)

6. (a) State Hess's law of heat summation

(b) (i) Differentiate standard heat of formation from standard bond dissociation energy of a substance

(ii) Calculate the enthalpy change for the reaction; $2\text{NH}_3(\text{g}) \rightarrow \text{N}_2(\text{g}) + 3\text{H}_2(\text{g})$
given that: $E(\text{N-H}) = 388 \text{ kJ mol}^{-1}$, $E(\text{N=N}) = 944 \text{ kJ mol}^{-1}$ and $E(\text{H-H}) = 436 \text{ kJ mol}^{-1}$. (9 marks)

7. With the help of balanced equations, what would be the products of:

(i) Heating alkali and alkali earth metal carbonates

(ii) Dissolving potassium nitrate in concentrated sulphuric acid and iron (ii) sulphate

(iii) Dissolving chlorides of aluminium and sodium in water

(iv) Dissolving aluminium in concentrated nitric acid

(v) Passing electricity in solid or molten aluminium chloride and aqueous solution of aluminium chloride. (10 marks)

SECTION B

Answer TWO (2) questions in this section. Each question carries 15 marks.

1. (a) In the bromination reaction of methane to yield halogenated methane, ethane is formed as one of the products. Using chemical equations, explain how the ethane is formed. (4 marks)

(b) An alcohol is prepared by the reaction between water and an alkene despite that the two reagents are of the same type.

(i) Briefly explain the similarity between water and any named alkene with respect to organic reactions

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- (ii) With the help of chemical reaction(s) show how the reaction for formation of alcohol from the two reagents in (a) above is made possible **(3 marks)**
- (c) Addition of bromine water to an alkene A (C_4H_8) gave compound B. Acid-catalysed dehydration of B yielded two isomeric bromoalkanes C and D. Cleavage of compound C with trioxxygen with subsequent reductive hydrolysis resulted into ethanal being isolated as one of the products. Similar treatment of compound D yielded propanal rather than ethanal. Explain the observations described above and identify compound A, B, C and D. **(8 marks)**
- 9) (a) Briefly explain each of the following terms as applied in organic reactions
- (i) Inductive effect
 - (ii) Mesomeric effect **(04 marks)**
 - (iii) Reactivity of lone pairs
 - (iv) Reaction mechanism
- (b) Write down the reactions showing the formation of the attacking reagents which are involved in the;
- (i) nitration of benzene **(03 marks)**
 - (ii) sulphonation of benzene
 - (iii) acylation of benzene
- (c) (i) Briefly explain the reaction which involve the replacement of chlorine from 1-chlorobutane by the hydroxyl group
- (ii) Give the mechanism for the reaction above and indicate in what ways it differ from the mechanism for the corresponding reaction with the isomer 2-chloro-2-methylpropane
- (iii) For each reaction mechanism in (ii) above, outline three (3) conditions which favor the formation of the products **(06 marks)**
- (d) The halobenzenes are exceptions to the general deactivating rules of substituents. Explain this unusual influence of halogens on benzene **(2 marks)**

10. (a) Define the following terms as used in soil chemistry
- (i) Colloidal state
 - (ii) Cation exchange capacity
 - (iv) Percentage base saturation
- (1.5 marks)**
- (b) (i) Briefly explain two methods used to measure soil pH
- (ii) Explain the major sources of negative charges on the surface of soil colloids?
 - (iii) Outline the general characteristics of phosphatic fertilizers
- (8 marks)**
- (c) 10g of oven dry soil were shaken in 20cm³ of 0.1M hydrochloric acid solution. The mixture was then filtrated and the soil thoroughly washed in distilled water, the filtrate and washings were neutralized by 12cm³ of 0.1M sodium hydroxide. If the total cation exchangeable capacity of the soil is 25meq/100g of oven dried soil. Calculate the percentage base saturation of the soil
- (5.5 marks)**