

CHUKA



UNIVERSITY

## UNIVERSITY EXAMINATION

RESIT/SUPPLEMENTARY / SPECIAL EXAMINATIONS EXAMINATION FOR THE  
AWARD OF DEGREE IN BACHELOR OF SCIENCE (CHEMISTRY)

CHEM 221: PHYSICAL CHEMISTRY

STREAMS:

TIME: 2 HOURS

DAY/DATE: WEDNESDAY 5/5/202111.30 A.M - 1.30 P.M.

## INSTRUCTIONS

- Answer any Question ALL Questions.

## QUESTION ONE (30 MARKS)

- 1a (i). Outline the assumptions underlying the kinetic theory of gases and comment on their shortcomings. (4 marks)
- (ii) Derive the fundamental kinetic theory by considering a gas in a cube. (6 marks)
- (iii) Write short notes on the distribution of molecular velocities. (4 marks)
- (b). Calculate the averages, the root mean squares and the most probable speeds for oxygen molecules at 298K. At what temperature would hydrogen have the same values of these speeds? (4 marks)
- (c). The compressibility factor for CO<sub>2</sub> at 273K and 100 atm ( $101.325 \times 10^5 \text{NM}^{-2}$ ) pressure is 0.2007. Calculate the volume occupied by 0.1 mole of the gas at 100 atm. and 273K.
- (i) by the ideal gas equation (2 marks)
- (ii) (ii) by making use of the compressibility factor (2 marks)
- (d) (i) Comment on the statement “the van der waal’s equation is an improvement over the ideal gas equation” (4 marks)

(ii) Deduce the law of corresponding states from the van der waals equation (4 marks)

**QUESTION TWO (20 MARKS)**

2 a (i). What is meant by the term “degree of hydrolysis and hydrolysis constant” (2 marks)

(ii). Deduce the relation between hydrolysis constant and the dissociation constant of the base in the case of the hydrolysis of a salt of a strong acid and a weak base. (6 marks)

(iii). Calculate the hydrolysis constant, degree of hydrolysis and pH value of  $10^{-2}$  M  $\text{NH}_4\text{Cl}$  solution at 298K ( $K_b = 1.8 \times 10^{-5}$  and  $K_w = 1.0 \times 10^{-14}$ ). (6 marks)

(b) (i) Calculate the solubility of silver chromate in a 0.1M solution of  $\text{AgNO}_3$  ( $K_{sp}$  for  $\text{Ag}_2\text{CrO}_4 = 9.0 \times 10^{-12}$ ) (2 marks)

(ii) Write short notes on the application of solubility product principle in the qualitative analysis (4 marks)

**QUESTION THREE (20 MARKS)**

3(a) (i) Discuss the laws of osmotic pressure and Van't Hoff's theory. (4 marks)

(ii) Obtain a relationship between osmotic pressure and elevation in boiling point of a solution. (3 marks)

(iii). A solution containing  $3.0 \times 10^{-4}$  kg of benzoic acid ( $M = 1.22 \times 10^1 \text{ Kg mol}^{-1}$ ) in  $2.0 \times 10^{-3}$  kg of benzene at  $0.317^\circ\text{C}$  below the freezing point of the solvent. Calculate

(i) The degree of association assuming that the acid exists as dimer in benzene (2 marks)

(ii) The apparent molar mass of the acid exists as dimer in benzene (2 marks)

(b). Explaining giving reasons the following:

(i) Addition of a nonvolatile solute lowers the freezing point and elevates the boiling point of the solvent

(1 mark)

(ii) Relative lowering of vapour pressure of a solvent depends only on the amount of the solute and is independent of its nature. (1 mark)

(iii) A solution of  $3.0 \times 10^{-4}$  kg of camphor ( $\text{C}_{10}\text{H}_{16}\text{O}$ ) in  $2.53 \times 10^{-2}$  kg of chloroform boils at 334.3K. Boiling point of chloroform is 334.0K. Calculate the  $\Delta H_{\text{vap,m}}$  and  $K_b$  for chloroform (4 marks)

(C). Describe the applications of phase rule in the desilverization of lead (3 marks)