LAIKIPIA UNIVERSITY

UNIVERSITY EXAMINATIONS

SECOND SEMESTER 2023/2024 ACADEMIC YEAR

SECOND YEAR EXAMINATION FOR THE DEGREES OF BACHELOR OF EDUCATION (SCIENCE) AND BACHELOR OF SCIENCE (GENERAL)

CHEM 221: PHYSICAL CHEMISTRY II

STREAM: R ***TIME: 2 HRS***

DAY:FRIDAY [11.30A.M-1.30P.M] ***DATE: 19/04/2024***

THIS QUESTION PAPER CONSISTS OF THREE (3) PAGES

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INSTRUCTIONS

Answer **All** the questions and show working clearly.

QUESTION ONE (30 MARKS)

a) Define the terms mole fraction, molarity and normality.

(3 Marks)

b) i) State Raoult's Law.

(2 Marks)

ii) Calculate the vapour pressure lowering caused by the addition of 100 g of sucrose (mol mass = 342) to 1000 g of water if the vapour pressure of pure water at 25°C is 23.8 mm Hg.

(4 Marks)

c) A sample of oxygen is collected by the downward displacement of water from an inverted bottle. The water level inside the bottle is equalized with that in the trough. Barometric pressure is found to be 757 mm Hg, and the temperature of water is 23.0 °C. What is the partial pressure of O_2? Vapour pressure of H_2O at 23°C = 19.8 mm Hg.

(4 Marks)

d) Show how the Boyle's law can be derived from the ideal gas equation, $PV=1/3mNu^2$

(4 Marks)

e) The solubility of $BaSO_4$ is 2.33×10^{-4} g/ml at 20°C. Calculate the solubility product of $BaSO_4$ assuming that the salt is completely ionized.

(3 Marks)

f) Explain any two factors that influence the degree of dissociation of an electrolyte.

(4 Marks)

g) Briefly describe the Bronsted-Lowry concept of salt hydrolysis.

(3 Marks)

h) Draw a well labelled phase diagram of a water system clearly showing the critical point and triple point.

(3 Marks)

QUESTION TWO (20 MARKS)

a) From the Kinetic theory of ideal gases, show that, $PV=1/3mNu^2$

(9 Marks)

b) Explain the term colligate property.

(3 Marks)

c) One mole of water vapour is confined to a 20 litre flask at 27°C. Calculate its pressure using:

(i) van der Waal's equation

(ii) General ideal gas equation

Given that:

$a = 5.464$ litre^2 atm mol^{-1}

$b = 0.0305$ litre mol^{-1}

R = 0.0821 litre atm. deg^{-1} mol^{-1}

(5 Marks)

d) Calculate the mole fraction of HCl in a solution of hydrochloric acid in water, containing 36 per cent HCl by weight.

(3 Marks)

QUESTION THREE (20 MARKS)

a) Calculate the pH of the following solutions and state whether they are acids or bases:
   i) NaCN (0.20 M, $K_a = 4.0 \times 10^{-10}$)
   ii) CH_3COONH_4 ($K_a = 1.75 \times 10^{-5}$, $K_b = 1.80 \times 10\text{-}5$, $K_w = 1.00 \times 10^{-14}$)
   iii) NH_4Cl (0.20 M, $K_b = 1.80 \times 10^{-5}$)
   iv) HCl (3.3×10^{-2} M)

(12 Marks)

b) 5 g of NaCl is dissolved in 1000 g of water. If the density of the resulting solution is 0.997 g per ml, calculate the molality, molarity, normality and mole fraction of the solute, assuming volume of the solution is equal to that of solvent.

(5 Marks)

c) State any two features of the Boltzmann distribution in gas molecules.

(2 Marks)

d) Highlight one limitation of Henry's law.

(1 Mark)