ELIZADE UNIVERSITY, ILARA – MOKIN, ONDO STATE, NIGERIA
DEPARTMENT: PHYSICAL AND CHEMICAL SCIENCES
FIRST SEMESTER EXAMINATIONS: 2019/2020 ACADEMIC SESSION
COURSE CODE: CHM 305 COURSE TITLE: PHYSICAL CHEMISTRY II
HOD's SIGNATURE

TABLE OF CONSTANTS:

Speed of light c, 2.997 x10^{8}m/s
Faraday constant F, 96500 C/mol
Gas constant R, 8.314JK^{-1}mol^{-1}
Gas constant R, 8.314 x 10^{-2}Lbar K^{-1}mol^{-1}
Mass of proton, 1.672x x10 $^{-27}$kg
Mass of electron 9.109x10 $^{-31}$kg
Elementary charge e, 1.602 x 10^{-19}C
Boltzmann constant k, 1.38 x10^{-23}J/K
Planck's constant h, 6.626 x10^{-34}Js,
Atomic mass unit u, 1.661 x10^{-27}kg
Mass of neutron, 1.6739 x 10^{-27}kg
Avogadro's constant Na, 6.022 x10^{23} mol^{-1}

DURATION: 2 HOURS
INSTRUCTIONS: ATTEMPT TWO QUESTIONS FROM SECTION A AND TWO QUESTIONS FROM SECTION B

SECTION A

Question One

a. Explain how colligative properties are used to determine molar mass.[7marks]
b. The enthalpy of fusion of lead (M.wt 207.8g/mol) is 5.2kJ/mol and its melting point is 327°C. what is its ideal solubility in bismuth (M.wt 208.98g/mol) at 280°C. [5marks]
c. What is the implication of the Walden's rule? [3marks]

Question Two.

a. A container is divided into 2 equal compartments. One part contains 3mol hydrogen gas and the other 1mol nitrogen gas at 298K. Calculate the Gibbs energy of mixing when the partition is removed. Assume the gases are ideal.[5marks]
b. Ethylene glycol ($C_2H_6O_2$) is an anti-freeze and a non-volatile electrolyte. Calculate the change in boiling point and freezing point of 25.0 mass % solution of ethylene glycol in H_2O.
c. K_f = 1.860C/m K_b = 0.510C/m [6marks]
d. The mobility of Li^+ ion in aqueous solution is 4.01 x 10 $^{-8}$ m ^{2} s $^{-1}$V $^{-1}$ at 29°C. the potential difference between two electrodes placed in solution is 12.0 V, if the electrodes are 1.00cm apart, what is the drift speed of the ion [2marks].

d. State the assumption(s) of the Derjagun, Landon, Verwey and Overbeck (DLVO) Electric double layer theory [2marks]

Question Three.

a) Discuss three applications of electrochemistry [9marks]

b) Calculate the dissociation constant and limiting conductivity of 0.05M ethanoic acid at 300K given the degree of deprotonation is 0.0423 and conductivity is $1.65 mSm^2$ [3 marks]

c) An electrode is placed in 0.10 M Cu^{+2} aqueous solution at 298K. if the thickness of diffusion layer is 0.3mm and the molar conductivity is 107SCm2; what is the limiting current density? [3 marks]

SECTION B

Question One.

a. Show that $TV^{\gamma-1}$ is a constant for the reversible adiabatic expansion of a mole of an ideal gas of constant heat capacity where $\gamma = C_p/C_v$ **[5 marks]**

b. 4 g of Neon at 10°C and 202650 Nm^{-2} are subjected to reversible adiabatic expansion to a pressure of 760 mmHg. Calculate the work done. **[4 marks]**

c. 32 g of oxygen expands reversibly under isothermal conditions from a volume of $0.0030m^3$ to 90000 cm^3 at 50°C. Evaluate: (i) q, (ii) ΔE and (iii) W. **[6 marks]**

Question Two.

a) Distinguish between Gibbs free energy and Helmholts free energy **[4 marks]**

b) Given that A = E-TS, show that the maximum work obtainable at a constant temperature is at the expense of the decrease in the Helmholtz free energy of the system. **[4 marks]**

c) Calculate the final pressure when two moles of helium at 30°C and 76 cm Hg is expanded reversibly and isothermally to a final volume of $1.5m^3$ **[7 marks]**

Question Three

a. With the aid of a suitable plot, discuss the two major postulates of statistical thermodynamics **[4 marks]**

b. 5 moles of an ideal gas at 10°C is compressed adiabatically to $1/4^{th}$ of the original volume. Calculate the temperature differential after compression. **[5 marks]**

c. 3 moles of Argon at 2 atm is compressed adiabatically and reversibly from 100 L to 5×10^4 cm^3 at 10°C. The molar heat capacity, Cv at constant volume of Argon is 12.5 j/mol/k. Calculate the final pressure of Argon. **[6 marks]**