



Answer the following questions

(C=12, N=14, O =16, H=1 and Ar=40)

**Question-1: (12Marks)**

- a- Prove that the equation state of ideal gas mixture is  $P_T V = n_T RT$  and the volume fraction of any component in the gas mixture is the same as the mole fraction? (4)
- b-  $N_2O_4$  partially dissociated according to the following equation:  $N_2O_{4(g)} = 2NO_{2(g)}$  If it is found that 24 gm. of the gases mixture  $N_2O_4$  plus  $NO_2$  occupies  $0.015 m^3$  at  $90^\circ C$  and pressure of 730 mmHg. Calculate: (i) The percentage of  $N_2O_4$  in the gases mixture. (6)  
(ii) Partial pressure of  $NO_2$  in the mixture. (iii) The equilibrium constant  $K_p$  for the reaction?
- c- A  $585 cm^3$  Cylinder contains 1.0 gm. of argon gas (Ar) at  $22^\circ C$  Calculate the pressure using the equation of state for real gases. (for Ar,  $a=1.345 atm.Lit^2/mole^2$ , and  $b=0.43 Lit./mole$ ) (2)

**Question-2: (8Marks)**

- a- State the first and second law of thermodynamics? (2)
- b- What is meant by the extensive properties of the system? and Prove that the heat exchanged in a process carried out isochorically ( $Q_V$ ) is state function? (3)
- c- Express the free-energy change in a process in terms of the changes that occur in the enthalpy and entropy of the system? Using this expression, predict which of the following reactions would be spontaneous at  $25^\circ C$ :  
Reaction A:  $\Delta H = -10.5 kJ/mole$ , and  $\Delta S = 30 J/k$ ;  
Reaction B:  $\Delta H = 1.8 kJ/mole$ , and  $\Delta S = -113 J/k$ . (3)

**Question-3: (10Marks)**

- a- Explain Henry's law? (2)
- b- What is the composition of the vapor which is in equilibrium at  $30^\circ C$ . with a benzene ( $C_6H_6$ ) toluene ( $C_7H_8$ ) solution contains 70 % by weight benzene. (Consider at  $30^\circ C$ .  $P^0$  benzene = 119 tor and  $P^0$  toluene = 37 tor) (4)
- c- Given that the density of a solution containing of 1.71 gm. of ethylene glycol ( $C_2H_6O_2$ ) in 14 mole of water ( $H_2O$ ) is  $1.19 g/cm^3$ , calculate: (i) freezing point lowering, (ii) boiling point elevation and (iii) The osmotic pressure of solution at  $17^\circ C$ ? (for water,  $K_f = 1.86$  and  $K_b = 0.52$ ). (4)

**Question-4: (10Marks)**

- a- State the phase rule and apply this rule to interpret the triple point of water on its phase diagram? Confirm your answer with drawing. (3)
- a- The normal, (one atmosphere), boiling point of n-butane, is  $(-0.50^\circ C)$  Its enthalpy of vaporization, ( $\Delta H_{vap}$ ), is given as 5363.3 cal/mole. Calculate the vapor pressure of n-butane at  $20^\circ C$ ? (3)
- b- The solubility of ionic compound  $M_2X_3$  in water is  $3.6 \times 10^{-17} gm./lit$ . Calculate the solubility product,  $K_{sp}$ . (for  $M_2X_3$  molar mass = 288 gm/mole). (4)

**Question-5: (10 Marks)**

- b- What are the most common cathodic reactions encountered in metallic corrosion? (3)
- c- Explain the phenomena of activation polarization? Confirm your answer with drawing. (3)
- d- If you are given the following standard potentials  $E^0$ ,  
 $Cu^{++} + e^- \longrightarrow Cu^+$   $E^0 = 0.153 volt$        $Cu_{(s)} \longrightarrow Cu^+ + e^-$   $E^0 = -0.521 volt$
- (i) Calculate the equilibrium constant for the reaction.  $2Cu^+ = Cu^{++} + Cu_{(s)}$
- (ii) A 0.03 molar  $Cu(NO_3)_2$  solution is stored in a copper vessel. Calculate the equilibrium  $Cu^+$  concentration in this solution.? (4)

With My Best Regards and Good Luck