UNIVERSITY CEU SAN PABLO
SCHOOL OF PHARMACY
DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY

COMPLEMENTARY PROBLEMS OF PHYSICAL CHEMISTRY

2018-19

LESSON 6

33. When 1 g iodine is dissolved in 285 g of ethyl ether, the boiling point increases in 0.032ºC. What number of atoms has the iodine molecule in solution?

Data: M_I = 127 u.m.a; $T_b^o = 307.8\,K$; ΔH_{vap} = 81.5 cal·g^{-1}

Solution: Number of atoms of iodine molecule = 2

34. 6 g of a mixture of naphthalene ($C_{10}H_8$) and anthracene ($C_{14}H_{10}$) are dissolved in 300 g of benzene. When the solution is cooled, it begins to freeze 0.7 ^{o}C below the freezing point of pure benzene: 5.5 ^{o}C. Determine the mixture composition, taking into account that he cryoscopic constant of benzene is 5.1 K·kg·mol^{-1}.

Data: R = 0.082 l·atm·K^{-1}·mol^{-1} = 1.987 cal·K^{-1}·mol^{-1} = 8.314 J·K^{-1}·mol^{-1}
$M_{naphthalene}$ = 128 g·mol^{-1}; $M_{anthracene}$ = 178 g·mol^{-1}

Solution: $w_{naphtalene}$ = 3.4 g; $w_{anthracene}$ = 2.6 g

35. The boiling point of chloroform ($CHCl_3$) is 61.7 °C. A solution of 0.402 g of naphthalene ($C_{10}H_8$) in 26.6 g of $CHCl_3$ increases its boiling point in 0.455 K. Calculate $\Delta\overline{H}_V$ of $CHCl_3$

Data: R = 0.082 l·atm·K^{-1}·mol^{-1} = 1.987 cal·K^{-1}·mol^{-1} = 8.314 J·K^{-1}·mol^{-1}
($CHCl_3$) M ($CHCl_3$) = 119.4 g·mol^{-1}; M($C_{10}H_8$) = 128 g·mol^{-1}

Solution: $\Delta\overline{H}_V$ = 28856.65 J·mol^{-1}

36. What numerical relationship exists between the relative lowering of the vapour pressure and the depression of freezing point depression of an ideal dilute aqueous solution of sucrose at T temperature?. What will be that relationship if the solute is benzoic acid and its degree of dissociation in the solution is 4%?

Data: $M_{sucrose}$ = 342.33 g·mol^{-1}; $M_{benzoic}$ ac = 122.1 g·mol^{-1};
M_{water} = 18 g·mol^{-1}; K_m = 1.86 K·kg·mol^{-1};
R = 0.082 l·atm·K^{-1}·mol^{-1} = 1.987 cal·K^{-1}·mol^{-1} = 8.314 J·K^{-1}·mol^{-1} .

Solution: **a)** $\frac{\Delta P}{P_A^*} = 9.677\cdot10^{-3}\cdot\Delta T_F$; **b)** It would be equal

37. A commonly-used antifreeze in car radiators is ethylene glycol, $CH_2(OH)CH_2(OH)$. How many milliliters of this substance should be added to 6.5 l of water if the temperature of the coldest winter day is -5 °C?

Data: Kc = 1.86 K·kg·mol-1; $M_{ethylene}$ = 62 g·mol^{-1}; $\rho_{ethyleneglycol}$ = 1.11 g·cm^{-3}

Solution: V = 975.976 cm^3

38. The pure benzene freezes at 5.4 °C and a solution of 0.223 g of phenylacetic acid ($C_6H_5CH_2COOH$) in 4.4 g of benzene freezes at 4.47 ºC. The melting heat of benzene is 9.89 kJ·mol^{-1}. Calculate the apparent molecular weight of phenylacetic acid and discuss the result.

Data: M (phenylacetic acid) = 136 g·mol^{-1} ; M (benzene) = 78 g· mol^{-1}
R = 0.082 l·atm·K^{-1}·mol^{-1} = 1.987 cal·K^{-1}·mol^{-1} = 8.314 J·K^{-1}·mol^{-1}

Solution: $M_{apparent}$ (phenylacetic acid) = 273.56 g· mol^{-1}

39. Calculate for an aqueous solution with 0.300 mol·kg-1 of sucrose and a molarity of $C_{11}H_{22}O_{11}$ equal to 0.282 mol·dm^{-3}, at 20 ° C and 1 atm:

a) Calculate the osmotic pressure of this solution using van't Hoff equation ..

b) Determine the activity and the activity coefficient of water in this solution, taking into account that the experimental osmotic pressure for this solution is 7.61 atm.

Data: ρ H_2O **(** 20 ° C and 1 atm **)** = 0.998 g·cm $^{-3}$; M_{water} = 18 g·mol^{-1}
R = 0.082 l·atm·K^{-1}·mol^{-1} = 1.987 cal·K^{-1}·mol^{-1} = 8.314 J·K^{-1}·mol^{-1}

Solution: π = 6.775 atm; **b)** a (H_2O) = 0.9943; γ (H_2O) = 0.99969

40. The freezing point depression of an aqueous 0.010 m solution of acetic acid is 0.0193 oC. Calculate the degree of dissociation at this concentration and the acidity constant of acetic acid.

Data: R = 0.082 l·atm·K^{-1}·mol^{-1} = 1.987 cal·K^{-1}·mol^{-1} = 8.314 J·K^{-1}·mol^{-1}
$\Delta\overline{H}_m$ (H_2O) = 5.98 kJ·mol^{-1}

Solution: α = 0.03478; Ka = 1.5232·10^{-5}

41. The freezing point depression of an aqueous 0.100m solution of acetic acid is 0,190ºC at 1 atm. Determine the dissociation constant of acetic acid at this temperature

Dato: Kc (H_2O) = 1.86 K· kg·mol^{-1}

Solution: Ka = 4.72·10^{-5}

42. Calculate the degree of dissociation of a substance of 180g·mol^{-1} molecular weight, considering that it dissociates into two ions with equal charge and that the freezing point depression of 20 g dissolved in 100 cm^3 of water is 2.5 ^oC.

Dato: Kc (H_2O) = 1.86 K· kg·mol^{-1}

Solution: $\alpha = 0.2096$