**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; $T_b^o = 307.8K$ ; $\Delta H_{vap} = 81.5\ cal \cdot g^{-1}$

**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 $^oC$ below the freezing point of pure benzene: 5.5 $^oC$. Determine the mixture composition, taking into account that he cryoscopic constant of benzene is 5.1 $K \cdot kg \cdot mol^{-1}$.

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

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

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



**Solution:** **a)** $\frac{}{P_A^*} - 9.677 \cdot 10^{-3} \cdot \Delta T_F$ ; **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 $^oC$?

**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$^{-5}$

**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 $^o$C.

**Dato:** Kc ($H_2O$) = 1.86 K· kg·mol$^{-1}$

**Solution:** $\alpha = 0.2096$