Chapter 6 Homework Solutions

6.1 m = 0.112 mol Glu/kg H_2O M(Glu) = 180 g/mol

$$mass = 250\,g\,H_2O \cdot \frac{0.112\,mol\,Glu}{1000\,g\,H_2O} = 0.028\,mol\,Glu \cdot \frac{180\,g\,Glu}{1\,mol\,Glu} = 5.04\,g\,Glu$$

6.2 M(H_2O) = 18 g/mol mass(H_2O) = 1.0 kg = 1000 g

n_{Ala} = 0.134 mol

n_{H2O} = 1000 g x 1 mol/18 g = 55.6 mol

$$X_{Ala} = \frac{n_{Ala}}{n_{Ala} + n_{H_2O}} = \frac{0.134\,mol}{0.134\,mol + 55.6\,mol} = 2.40x10^{-3}$$

6.3 M(Suc) = 342 g/mol M(H_2O) = 18 g/mol

mass(H_2O) = 100 g = 0.10 kg

n_{H2O} = 100 g x 1 mol/18 g = 5.56 mol

$$X_{Suc} = 0.124 = \frac{n_{Suc}}{n_{Suc} + 5.56} \rightarrow 0.124n_{Suc} + (0.124)(5.56) = n_{Suc}$$

$0.876n_{Suc} = 0.689 \rightarrow n_{Suc} = 0.787$ mol

mass(Suc) = 0.787 mol x 342 g/mol = 269 g

6.4 Assume that 150 cm^3 H_2O = 150 g H_2O = 0.15 kg H_2O because d(H_2O) = 1.00 g/cm^3

n_{Suc} = 7.5 g x 1 mol/342 g = 0.0219 mol

$$m_{Suc} = \frac{0.0219\,mol\,Suc}{0.15\,kg\,H_2O} = 0.146\,mol\,Suc/kg\,H_2O = 0.145\,m$$

$\Delta T_f = K_f m_{Suc}$ = (1.86 °C/m)(0.146 m) = 0.27 °C = $T_f^o - T_f = 0 - T_f$

Therefore, T_f = -0.27 °C

6.5 $K_f(CCl_4)$ = 30 K kg/mol = 30 ºC/m ΔT_f = -9.3 ºC - (-14.7 ºC) = 5.4 ºC = 5.4 k

$m_X = \Delta T/K_f$ = 5.4 ºC / 30 ºC/m = 0.18 m = 0.18 mol/kg CCl_4

n_X = 0.18 mol / kg CCl_4 x 0.75 kg CCl_4 = 0.135 mol

$mass_X$ = 28 g (given in problem)

$$M_X = \frac{mass_X}{n_X} = \frac{28\,g}{0.135\,mol} = 207\,g/mol$$

6.6 $\Pi = [\text{Urea}]RT \rightarrow [Urea] = \dfrac{\Pi}{RT} = \dfrac{120\,kPa}{(8.314\,kPa \cdot L/mol \cdot K)(300\,K)} = 0.048\,mol/L$

In dilute aqueous solution, molality ≈ Molarity.

Therefore, m_{Urea} = 0.048 m.

$\Delta T_f = K_f m_{Urea}$ = 1.86 ºC/m x 0.048 m = 0.09 ºC = $T_f^o - T_f = 0 - T_f$

Therefore, T_f = -0.09 ºC

6.7 n_{Suc} = 75 g x 1 mol/342 g = 0.22 mol
n_{H2O} = 140 g x 1 mol/18 g = 7.78 mol

(a) $$X_{Suc} = \frac{n_{Suc}}{n_{Suc} + n_{H_2O}} = \frac{0.22}{0.22 + 7.78} = 0.028$$

(b) $$m_{Suc} = \frac{n_{Suc}}{mass\,H_2O} = \frac{0.22\,mol}{0.14kg} = 1.57\,mol/kg = 1.57\,m$$

(c) mass(tot) = 75 + 140 = 215 g

$$V = \frac{mass}{density} = \frac{215\,g}{1.23\,g/mL} = 175\,mL = 0.175\,L$$

$$[Suc] = \frac{n_{Suc}}{V} = \frac{0.22\,mol}{0.175\,L} = 1.26\,mol/L = 1.26\,M$$

6.8 $$c' = \frac{0.15\,g}{0.10\,L} = 1.5\,g/L$$

Π = 2.00 torr x 1 kPa/7.50 torr = 0.267 kPa

$$M = \frac{c'RT}{\Pi} = \frac{(1.50\,g/L)(8.314\,kPa \cdot L/mol \cdot K)(298\,K)}{0.267\,kPa} = 13{,}900\,g/mol$$

Alternate Solution on next page (prefer alternate)

6.8 Alternative Solution

1. Calculate n_{Lys} Π = 2.00 torr x 1 kPa/7.50 torr = 0.267 kPa, T = 298 K

[Lys] = Π/RT = (0.267 kPa)/(8.31 kPa-L/mol-K)(298 K) = 1.078×10^{-4} mol/L

n_{Lys} = [Lys] x V = 1.078×10^{-4} mol/L x 0.10 L = 1.078×10^{-5} mol

2. Calculate M_{Lys} mass(Lys) = 0.15 g

M_{Lys} = mass(Lys)/n(Lys) = 0.15 g/1.078×10^{-5} L = 1.39×10^{4} g/mol = 13,900 g/mol

6.9 n_{Na3PO4} = 15 g/164 g/mol = 0.0915 mol

m_{Na3PO4} = 0.0915 mol / 0.12 kg = 0.76 mol/kg = 0.76 m

$$[Na_3PO_4] = \frac{n}{V} = \frac{0.0915\,mol}{0.132\,L} = 0.69\,mol/L = 0.69M$$

$Na_3PO_4(aq) \rightarrow 3\ Na^+(aq) + PO_4^{3-}(aq)$ Therefore, i = 3 + 1 = 4

(a) $\Delta T_b = iK_b m_{Na3PO4}$ = 4 x 0.51 ^oC/m x 0.76 m = 1.55 ^oC
Therefore, T_b = 100 ^oC + 1.55 ^oC = 101.55 ^oC

(b) Π = i [Na_3PO_4]RT = 4 x 0.69 mol/L x 8.314 kPa-L/mol-K x 313 K
= 7180 kPa = 71.8 bar