CHEM 1423
Chapters 13
Homework Solutions

TEXTBOOK HOMEWORK

13.43 (a) M_{init} = 0.24 M , V_{init} = 78 mL , M_{fin} = ? , V_{fin} = 0.25 L = 250 mL

$$M_{fin}V_{fin} = M_{init}V_{init} \rightarrow M_{fin} = M_{init} \cdot \frac{V_{init}}{V_{fin}} = 0.24\,M \cdot \frac{78\,mL}{250\,mL} = 0.075\,M$$

(a) M_{init} = 1.2 M , V_{init} = 38.5 mL , M_{fin} = ? , V_{fin} = 0.13 L = 130 mL

$$M_{fin}V_{fin} = M_{init}V_{init} \rightarrow M_{fin} = M_{init} \cdot \frac{V_{init}}{V_{fin}} = 1.2\,M \cdot \frac{38.5\,mL}{130\,mL} = 0.36\,M$$

13.47 (a) M(Gly) = 75.

$$n_{Gly} = 85.4\,g \cdot \frac{1\,mol}{75.\,g} = 1.139\,mol$$

$$m_{Gly} = \frac{n_{Gly}}{kg\ H_2O} = \frac{1.139\,mol}{1.27\,kg} = 0.897\,mol/kg \approx 0.90\,m$$

(b) M(Glycerol) = 92.

$$n_{Glycerik} = 8.59\,g \cdot \frac{1\,mol}{92.\,g} = 0.0934\,mol$$

$$m_{Glycerol} = \frac{n_{Glycerol}}{kg\ H_2O} = \frac{0.0934\,mol}{0.077\,kg} = 1.21\,mol/kg = 1.21\,m$$

13.49 M(Benz) = 78. d(Benz) = 0.877 g/mL , d(Hex) = 0.66 g/mL

(1) Calculate n_{Benz}

$$mass_{Benz} = 44\,mL \cdot \frac{0.877\,g}{1\,mL} = 38.6\,g$$

$$n_{Benz} = 38.6\,g \cdot \frac{1\,mol}{78\,g} = 0.495\,mol$$

(2) Calculate kg Hex

$$mass_{Hex} = 167\,mL \cdot \frac{0.660\,g}{1\,mL} = 110.2\,g = 0.110\,kg$$

(2) Calculate m_{Benz}

$$m_{Benz} = \frac{n_{Benz}}{kg\ Hex} = \frac{0.495\,mol}{0.110\,kg} = 4.50\,{}^{mol}\!/_{kg} = 4.50\,m$$

13.53 Initial Mass Calcs M(Isoprop) = 60. M(H_2O) = 18,

$$mass_{Isoprop} = 0.35\,mol \cdot \frac{62.\,g}{1\,mol} = 21.7\,g$$

$$mass_{H_2O} = 0.85\,mol \cdot \frac{18.\,g}{1\,mol} = 15.3\,g$$

(a) $$X_{isoprop} = \frac{n_{isoprop}}{n_{isoprop} + n_{H_2O}} = \frac{0.35}{0.35 + 0.85} = 0.292 \approx 0.29$$

(b) $$mass\%_{isoprop} = \frac{mass_{isoprop}}{mass_{isoprop} + mass_{H_2O}} \cdot 100 = \frac{21.7}{21.7 + 15.3} \cdot 100 = 58.6\% \approx 59\%$$

(c) $$m_{isoprop} = \frac{n_{isoprop}}{kg\,H_2O} = \frac{0.35\,mol}{0.0153\,kg} = 22.9\,mol/kg \approx 23\,m$$

13.55 Initial Calculations Assume 1 L = 1000 mL

(**Note: assuming an arbitrary number of grams instead also works)**

$$mass_{tot} = 1000\,mL \cdot \frac{0.9651\,g}{1\,mL} = 965.1\,g$$

Masses $$mass_{NH_3} = 965.1\,g \cdot \frac{8}{100} = 77.2\,g$$

$$mass_{H_2O} = mass_{tot} - mass_{NH_3} = 965.1 - 77.2 = 887.9\,g$$

Moles

$$n_{NH_3} = 77.2\,g \cdot \frac{1\,mol}{17\,g} = 4.54\,mol$$

$$n_{H_2O} = 887.9\,g \cdot \frac{1\,mol}{18\,g} = 49.33\,mol$$

(a) molality

$$m = \frac{n_{NH_3}}{kg\,H_2O} = \frac{4.54\,mol}{0.8879\,kg} = 5.11\,{}^{mol}\!\big/_{kg} = 5.11\,m$$

(b) Molarity

$$M = \frac{n_{NH_3}}{V_{soln}} = \frac{4.54\,mol}{1\,L} = 4.54\,mol/L = 4.54\,M$$

(c) Mole Fraction

$$X_{NH_3} = \frac{n_{NH_3}}{n_{NH_3} + n_{H_2O}} = \frac{4.54}{4.54 + 49.33} = 0.0843$$

13.72 M(Gly) = 92. , M(H_2O = 18.

$$n_{Glyc} = 34.0\,g \cdot \frac{1\,mol}{92.\,g} = 0.370\,mol\;Glyc$$

$$n_{H_2O} = 500.\,g \cdot \frac{1\,mol}{18.\,g} = 27.8\,mol$$

$$X_{H_2o} = \frac{n_{H_2O}}{n_{Glyc} + n_{H_2o}} = \frac{27.8}{0.370 + 27.8} = 0.987$$

s

13.76 M(Van) = 152.14

$$n_{Van} = 6.4\,g \cdot \frac{1\,mol}{152.14\,g} = 0.0421\,mol$$

$$m_{Van} = \frac{n_{Van}}{kg\;EtOH} = \frac{0.0421\,mol}{0.050\,kg} = 0.841\,mol\,/\,kg = 0.841\,m$$

$$i = 1(non - electrolyte)$$

$$\Delta T_b = T_b - T_b^0 = iK_b m_{van} = 1 \cdot \left(1.22\,^oC\,/\,m\right) \cdot \left(0.841\,m\right) = 1.06\,^oC \approx 1.03\,^oC$$

$$T_b = T_b^0 + \Delta T_b = 78.5\,^oC + 1.0\,^oC = 79.5\,^oC$$

13.80 K_f(H_2O) = 1.86 °C , M(NaCl) = 58.5 , M(CH_3COOH) = 60.
For each part, assume 1 kg = 1000 g of solution (this is arbitrary and doesn't change the answer.

$$mass_{NaCl} = \frac{1}{100} \cdot 1000\,g = 10\,g$$

$$n_{NaCl} = 10\,g \cdot \frac{1\,mol}{58.5\,g} = 0.171\,mol$$

$$mass_{H_2O} = 1000\,g - 10\,g = 990\,g = 0.99\,kg$$

(a)

$$m_{NaCl} = \frac{n_{NaCl}}{kg\;H_2O} = \frac{0.171\,mol}{0.99\,kg} = 0.173\,mol\,/\,kg = 0.173\,m$$

$$\Delta T_f = 0\,^oC - (-0.593\,^oC) = 0.593\,^oC$$

$$\Delta \mathrm{T}_f = iK_f m_{NaCl} \rightarrow i = \frac{\Delta T_f}{K_f m_{NaCl}} = \frac{0.593\,^oC}{\left(1.86\,^oC\,/\,m\right)\left(0.173\,m\right)} = 1.85$$

Note: This shows that, for a strong electrolyte, the van't Hoff is slightly less than the amount expected by complete dissociation. HOWEVER, when you're working a simple problem asking to find ƛT_f (or ƛT_b) for a strong electrolyte, assume 100% dissociation.

$$mass_{CH_3COOH} = \frac{0.5}{100} \cdot 1000\,g = 5\,g$$

$$n_{CH_3COOH} = 5\,g \cdot \frac{1mol}{60\,g} = 0.0833\,mol$$

$$mass_{H_2O} = 1000\,g - 5\,g = 995\,g = 0.995\,kg$$

(b)

$$m_{CH_3COOH} = \frac{n_{CH_3COOH}}{kg\;H_2O} = \frac{0.0833\,mol}{0.995\,kg} = 0.0837\,mol/kg = 0.0837\,m$$

$$\Delta T_f = 0\,^oC - (-0.159\,^oC) = 0.159\,^oC$$

$$\Delta \mathrm{T}_f = iK_f m_{CH_3COOH} \rightarrow i = \frac{\Delta T_f}{K_f m_{CH_3COOH}} = \frac{0.159\,^oC}{\left(1.86\,^oC/m\right)\left(0.0837\,m\right)} = 1.02$$

Note: Acetic Acid (CH_3COOH) has VERY little dissociation (we'll see this in a later chapter). Therefore, it is surprising that i ≈ 1