Chemistry 230 -- Quiz 9

November 14, 2001 — Tellinghuisen

Pledge and signature:

Note: If you want your paper returned folded (*i.e.*, score concealed), please print your name on the back.

1. (4) 2.296 mol of CsCl is dissolved in 450.0 mL of water, and this solution is diluted with water to a volume of 1.000 L at 20.0°C and 1 atm. The density of the final solution is 1.2885 g/cm^3. What is the molarity of CsCl in the final solution?

$$\text{molarity} \equiv \frac{\text{mol solute}}{\text{L soln}} \Rightarrow 2.296 \frac{\text{mol}}{\text{L}}$$

2. (8) At 25.0°C and 1.00 atm, a 0.5000-mol/kg aqueous solution of NaCl has $\bar{V}_{NaCl} = 18.63$ cm^3/mol and $\bar{V}_{H_2O} = 18.062$ cm^3/mol. Find the volume at 25.0°C and 1.00 atm of a solution prepared by dissolving 1.0000 mol of NaCl in 2000.0 g of H_2O ($\mathcal{M}$ = 18.015).

$$V = n_A \bar{V}_A + n_B \bar{V}_B = 1.0000 \text{ mol} \times 18.63 \frac{\text{cm}^3}{\text{mol}} + \frac{2000.0 \text{ g}}{18.015 \text{ g/mol}} \times 18.062 \frac{\text{cm}^3}{\text{mol}} = 2023.8_5 \text{ mL}$$

3. (16) The molar enthalpy of mixing for forming solid solutions of NaCl and NaBr at 25°C as a function of the mole fraction x of NaBr is given by $\Delta H_{mix,m}(\text{kJ/mol}) = a\,x + b\,x^2 + c\,x^3$, where a, b, and c are numerical constants.

   (a) Obtain an expression for ΔH for mixing 1.000 mol NaCl with 3.000 mol NaBr.

   (b) Obtain an expression for the differential heat of solution of NaBr, as a function of a, b, c, and x.

(a) $\Delta H_{mix} = n \cdot \Delta H_{mix,m}(x) \Rightarrow \Delta H_{mix} = 4.000 \text{ mol} \left[a(0.75) + b(0.75)^2 + c(0.75)^3\right]$

(b) $\Delta H_{diff,A} = \left(\frac{\partial}{\partial n_A} \Delta H_{mix}\right)_{n_B,P,T} = \frac{\partial}{\partial n_A}\left(n \, \Delta H_{mix,m}\right)$

$$= \Delta H_{mix,m}(x) + n \frac{\partial}{\partial n_A}\left(\Delta H_{mix,m}\right)$$

$$= \Delta H_{mix,m} + n \cdot \frac{d \Delta H_{mix,m}}{dx} \cdot \frac{\partial x}{\partial n_A} \qquad x \equiv x_A = \frac{n_A}{n_A + n_B}$$

$$\frac{\partial x}{\partial n_A} = \frac{1}{n} - \frac{n_A}{n^2} = \frac{n_B}{n^2} = \frac{x_B}{n} = \frac{(1-x)}{n}$$

$$\hookrightarrow \Delta H_{diff,A} = (ax + bx^2 + cx^3) + n \times (a + 2bx + 3cx^2) \times \frac{(1-x)}{n}$$

$$= ax + bx^2 + cx^3 + a + 2bx + 3cx^2 - ax - 2bx^2 - 3cx^3$$

$$= a + 2bx + x^2(3c - b) + x^3(-2c)$$