Chemistry 230 -- Quiz 6

October 17, 2001 — Tellinghuisen

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1. (15) Consider the reaction, $N_2 + 3\ H_2 \rightleftarrows 2\ NH_3$ (where all components are gases).

   (a) Write the reaction equilibrium condition in a closed system. (Be specific for this reaction.)

   $\sum \nu_i \mu_i = 0 \Rightarrow \mu(N_2) + 3\mu(H_2) = 2\mu(NH_3)$

   (b) Suppose that initially a reaction vessel contains just 5.80 mol N_2 and 6.20 mol NH_3. At a later time 6.50 mol of N_2 is present. How much of each of the other components is present, and what is the extent of reaction ξ ?

   $\Delta n_{N_2} = 0.70\ mol \Rightarrow \Delta n_{H_2} = 3 \times 0.70\ mol = 2.10\ mol$

   and $\Delta n_{NH_3} = -2 \times 0.70\ mol = -1.40\ mol$

   $\hookrightarrow H_2 = 2.10\ mol\ ;\ NH_3 = 4.80\ mol$

   $\Delta n_i = \nu_i \xi \rightarrow \xi = -0.70\ mol$

   (c) Suppose the reaction is rewritten, $NH_3 \rightleftarrows {}^1/_2\ N_2 + {}^3/_2\ H_2$. Repeat the calculations of (b) for the same initial and final amounts of N_2 and NH_3.

   same final amounts of all 3 components.

   Consider N_2. $\Delta n_i = 0.70\ mol = \xi \nu = \xi(\frac{1}{2})$

   $\hookrightarrow \xi = 1.40\ mol$

2. (7) For each of the following — $CCl_4(l)$, $H(g)$, $N_2(g)$ —

   (a) Write the reaction of formation from reference-form elements at room T.

   $C(\text{graphite}) + 2\ Cl_2(g) \rightarrow CCl_4(l)$

   $\frac{1}{2}\ H_2(g) \rightarrow H(g)$

   $N_2(g) \rightarrow N_2(g)$

   (b) Is $\Delta H_f^\circ = 0$ for any of these at 50°C? If so, which ones? yes — $N_2(g)$

3. (4) For each of the following closed systems, write the conditions for material equilibrium between phases:

   (a) ice in equilibrium with liquid water. $\mu[H_2O(s)] = \mu[H_2O(l)]$

   (b) ice in equilibrium with an aqueous solution of sucrose.

   $\mu[H_2O(s)] = \mu[H_2O(\text{sln})]$ {+ $\mu[\text{sucrose(sln)}] = \mu[\text{sucrose(ice)}]$

   (c) a two-phase system of ether and water, with each phase saturated with the other component.

   $\mu[H_2O(aq)] = \mu[H_2O(eth)]\ ;\ \mu[\text{ether}(aq)] = \mu[\text{ether}(eth)]$