

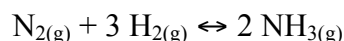
CH353 – Physical Chemistry I
Spring 2013, Unique 52575

Homework, Week 10

1. Determine ΔG_{rxn}^0 and K_P at 298 K for each of the following reactions:

- a) $\text{N}_2\text{O}_4(\text{g}) \leftrightarrow 2 \text{NO}_2(\text{g})$
- b) $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \leftrightarrow 2 \text{HI}(\text{g})$
- c) $3 \text{H}_2(\text{g}) + \text{N}_2(\text{g}) \leftrightarrow 2 \text{NH}_3(\text{g})$

2. The synthesis of ammonia is given by the formula



a) If you begin the reaction with n_0 moles of $\text{N}_2(\text{g})$ and $3n_0$ moles of $\text{H}_2(\text{g})$, find an exact expression for z_{eq} . Use this expression to discuss how z_{eq} varies with P and relate your conclusions to Le Chatelier's principle.

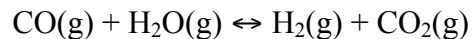
3. Sulfuryl chloride, SO_2Cl_2 , decomposes to sulfur dioxide and chlorine gas:



$\Delta G_f^0(\text{SO}_2\text{Cl}_2) = -371.3 \text{ kJ/mol}$, $\Delta G_f^0(\text{SO}_2) = -300.2 \text{ kJ/mol}$.

- a) Determine the equilibrium concentrations of each species if the system initially contains 1 mole of SO_2Cl_2 and 0 moles of SO_2 and Cl_2 at 1 bar
- b) Determine the equilibrium concentrations of each species if the system initially contains 1 mole of SO_2Cl_2 , 1 mole of SO_2 , and 0 moles of Cl_2 at 1 bar.
- c) Describe any differences according to Le Chatelier's principle.

4. The water-gas shift reaction is an important industrial source of pure $\text{H}_2(\text{g})$ for ammonia synthesis:



What would happen to the equilibrium concentration of each species if you increase the total pressure of the system by a factor of 100?

- 5. Until recently, values of K_P were reported assuming a standard state of 1 atm. Determine a general equation for converting K_P values at 1 atm to 1 bar.
- 6. Under certain conditions, water vapor dissociates into $\text{H}_2(\text{g})$ and $\text{O}_2(\text{g})$. At 2000 K and 1 bar, water vapor is 0.53% dissociated. At 2100 K and 1 bar, it is 0.88% dissociated. Determine the enthalpy of the dissociation reaction, assuming it is constant over this temperature range.