

CHEM 3410: Physical Chemistry I — Fall 2009

October 12, 2009

Lecture 17: K_p as a function of temperature

References

1. Levine, *Physical Chemistry*, Sections 6.1–6.4

Key Concepts

- The equilibrium constant, K_p , is a function of temperature but not of total pressure : $K_p(T)$. If we assume that the standard enthalpy of the reaction ($\Delta\bar{H}_{rxn}^\circ$) is independent of temperature, then we can arrive at the following expression for the temperature dependence of K_p :

$$\ln K_p(T_2) = \ln K_p(T_1) + \frac{\Delta\bar{H}_{rxn}^\circ}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$$

This gives a quantitative representation of Le Chatelier's principle regarding the response of a system at equilibrium to changes in temperature.

- We can express the equilibrium constant in terms of mole fractions as well and arrive at the following expression:

$$K_p = P^{\Delta\nu} \frac{A_C^c X_D^d}{X_A^a X_B^b}$$

where $\Delta\nu$ is the difference in the stoichiometric coefficients $((c + d) - (a + b))$.

- What can we do with the new power we have over equilibrium?
 - Predict composition of a system at equilibrium
 - Estimate the effect of temperature changes on the favored direction of a chemical reaction
 - Determine equilibrium constants from standard free energies of formation or the other way around
 - See how pressure would effect the equilibrium in a quantitative way