Week 9 Discussion

March 1st, 2022

1. **State Change of an Ideal Gas** 1.50 mol of N_2 gas at a constant pressure of 1.50 atm is allowed to expand from 8.00 L to 15.00 L accompanied by a temperature change from 97.5 K to 183 K. Assume ideal gas conditions.

(a) Estimate $C_{P,m}$ using the equipartition theorem.

(b) Compute the change in enthalpy for this state change.

2. **Equipartition Theorem** 2.150 mol of $CH_4(g)$ at a constant volume of 1.00 L is heated from 220 K to 260 K accompanied by an increase in pressure from 15.4 bar to 28.1 bar. Assume ideal gas conditions.

(a) Estimate $C_{V,m}$ using the partition theorem.

(b) Compute the change of internal energy for this state change.

3. **Van't Hoff Equation** $Ca(OH)_2(aq)$ is a sparingly soluble ionic salt. The temperature dependence of the solubiility product constant $K_{sp} = a(Ca^{2+})\ a^2(OH^-)_2$ of $Ca(OH)_2(aq)$ is plotted below

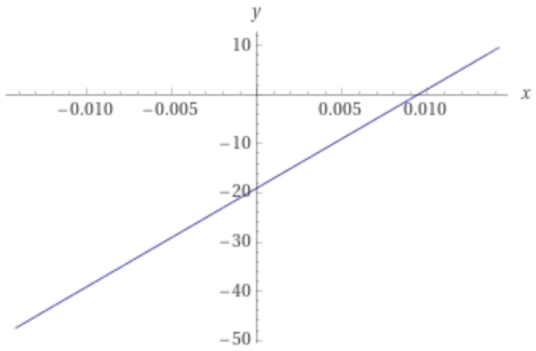

Figure 1: Van't Hoff plot with the form $y = 2010.9x - 10.002$.

(a) Using the linear regression from the plot above, determine the standard molar enthalpy and entropy for the dissolution of $Ca(OH)_2(aq)$.

(b) If the temperature is decreased, does the solubility of $Ca(OH)_2(aq)$ increase, decrease or stay the same?

4. **Thermodynamic Equilibrium** A chemist needs to prepare the compound $PH_3BCl_3(s)$ according to the following reaction for which $K = 19.2$ at 50.0°C.

$$PH_3(g) + BH_3(g) \rightleftharpoons PH_3BH_3(s)$$

Molecule	ΔH_f° (kJ/mol)
$PH_3(g)$	5.47
$BH_3(g)$	106.69
$PH_3BH_3(s)$	3.55

Table 1: ΔH_f° for various compounds.

(a) Determine the equilibrium constant K at 70.0°C.

(b) Determine the standard molar free energy of reaction at 50.0°C.