# Thermodynamics 1 • CHEM 220

1. Calculate the standard entropy change for the following reaction.

$2\ Ag_2O(s) \rightarrow 4\ Ag(s) + O_2(g)$

$\Delta S^\circ = 4(42.55) + 1(205.07) - 2(121.3) = \boxed{132.7\ J/K}$

2. Predict the sign of ΔS for the following reactions:

A) $2\ NH_3(g) \rightarrow N_2(g) + 3\ H_2(g)$ +

B) $CaO(s) + CO_2(g) \rightarrow CaCO_3(s)$ −

C) $2\ CO(g) \rightarrow 2\ C(s) + O_2(g)$ − (is questionable, but 2 gas particles to 1 gas particle more significant than 2 solid particles formed)

D) $NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$ +

3. Write equation for the reaction with $\Delta G^\circ_{rxn} = \Delta G^\circ_f$ for $Al_2O_{3(s)}$

$2\ Al_{(s)} + \frac{3}{2}\ O_{2(g)} \rightarrow Al_2O_{3(s)}$

4. Based on the ΔH° and ΔS° for ethanol ($CH_3CH_2OH$), determine the boiling point of ethanol.

4. $CH_3CH_2OH_{(l)} \rightleftharpoons CH_3CH_2OH_{(g)}$

$\Delta G^\circ = \emptyset$ (equilibrium)

$\Delta H^\circ = -235.3 - (-277.0) = +41.7\ kJ/mol$

$\Delta S^\circ = 282.7 - 160.7 = +122.7\ J/mol \cdot K$

$\emptyset = \Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$

$\Delta H^\circ = T\Delta S^\circ$

$T = \frac{\Delta H^\circ}{\Delta S^\circ} = \frac{41.7\ kJ/mol}{0.1227\ J/K \cdot mol} = 340.\ K$

$T = 67\ ^\circ C$

5. Consider the reaction:

$2\ N_2O_{(g)} + 3\ O_{2(g)} \Leftrightarrow 4\ NO_{2(g)}$

| | | | |
|---|---|---|---|
| 104.20 | ∅ | 51.23 | $\Delta G^\circ_f$ (kJ/mol) |
| 82.05 | ∅ | 33.1 | $\Delta H^\circ_f$ (kJ/mol) |
| 219.85 | 205.07 | 240.04 | $S^\circ$ (J/K·mol) |

A) Calculate ΔG° for this reaction at 25°C

either $\Delta G^\circ$ calc is acceptable

$\Delta G^\circ_{rxn} = 4(51.23) - 2(104.20) - 3(\emptyset) = -3.48\ kJ$

$\Delta G^\circ_{rxn} = \Delta H^\circ - T\Delta S^\circ = -31.7\ kJ - (298.15\ K)(-0.09475\ kJ/K \cdot mol) = -3.45\ kJ$

B) Calculate ΔG for this reaction at 100°C

$\Delta G^\circ = -31.7\ kJ - (373\ K)(-0.09475\ kJ/K \cdot mol)$

$\Delta G^\circ_{100^\circ C} = 3.64\ kJ$

$\Delta H^\circ_{rxn} = 4(33.1) - 2(82.05) = -31.7\ kJ$

$\Delta S^\circ_{rxn} = 4(240.04) - 2(219.85) - 3(205.07) = -94.75\ J/K \cdot mol$