Thermodynamics: The Big Picture

1. A reaction's change in free energy indicates its favorability; thus, a favorable reaction has $\Delta G < 0$.
2. For a redox reaction, the potential also indicates its favorability; thus, a favorable redox reaction has $E > 0$.
3. A reaction that is theromdynamially favorable may not occur for kinetic reasons; thus, failing to see a reaction does not imply that $\Delta G < 0$.
4. Together, the sign of a reaction's ΔH and ΔS indicate how its favorability changes with T; thus, at least one of the following is required if a reaction is favorable: $\Delta H < 0$ and/or $\Delta S > 0$.
5. A reaction's favorability depends on the concentrations of reactants and products, as described by $\Delta G = \Delta G^\circ + RT\ln Q$; thus, a reaction's ΔG changes as the reaction progresses.
6. A favorable reaction proceeds until it reaches equilibrium where $\Delta G = 0$; thus, $\Delta G^\circ = -RT\ln K$.
7. A reaction's ΔG, ΔH, and ΔS are state functions whose values depend only on where the reaction begins and where it ends; thus, we can calculate their values using any set of reactions of our chosing.
   - $\Delta H^\circ = \left[\sum_i \nu_i \Delta H^\circ_{f,i}\right]_{products} - \left[\sum_j \nu_j \Delta H^\circ_{f,j}\right]_{reactants}$
   - $\Delta S^\circ = \left[\sum_i \nu_i \Delta S^\circ_{f,i}\right]_{products} - \left[\sum_j \nu_j \Delta S^\circ_{f,j}\right]_{reactants}$
   - $\Delta G^\circ = \left[\sum_i \nu_i \Delta G^\circ_{f,i}\right]_{products} - \left[\sum_j \nu_j \Delta G^\circ_{f,j}\right]_{reactants}$
8. Heat, free energy, enthalpy, and entropy are conserved and are stoichiometric; thus
   - $q_{\text{rxn}} = -q_{\text{soln}}$
   - $q = mS\Delta T$
   - $\Delta H = \frac{q_{\text{rxn}}}{n_{LR}} \times \frac{\nu_{LR}}{\text{mol}_{\text{rxn}}}$
9. The potential of a redox reaction is independent of stoichiometry; thus $\Delta G = -nFE$, where n, the number of electrons transfered from the reducing agent to the oxidizing agent, accounts for stoichiometry when converting potential to free energy.