G. Problems:

① Calculate the ΔG° for the following redox reaction:

$Cu(s) + Zn^{2+}(aq) \longrightarrow Cu^{2+}(aq) + Zn(s) \quad E^\circ = -1.10\ V$

$F = 9.6485 \times 10^4 \frac{J}{V\ mol}$

$\Delta G_{rxn}^\circ = -nFE^\circ$

$= -(2.00\ mol\ e^-) \times \left(\frac{9.65 \times 10^4 J}{V \cdot mol}\right) \times (-1.10\ V)$

$= +212\ KJ$

② Calculate the equilibrium constant, K_p, for the following reaction at 25.0°C if ΔG° is - 32.9 kJ:

$N_2(g) + 3\ H_2(g) \rightleftharpoons 2\ NH_3(g)$

$\Delta G^\circ_{rxn} = -RT \ln K_p$

$(-32.9\ KJ)\left(\frac{10^3 J}{KJ}\right) = -\left(8.3145 \frac{J}{K\ mol}\right)(298\ K) \ln K_p$

$K_p = 6 \times 10^5$

3 Calculate ΔG°, for the following reaction at 25.0°C if K_p is 1.1×10^{-16}:

$NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$

$\Delta G^\circ_{rxn} = -RT \ln K_p$

$= -\left(8.3145 \frac{J}{K\ mol}\right)(298\ K) \ln(1.1 \times 10^{-16})$

$= 91\ KJ$

④ Given the following ΔG° values:

$I^-(aq) = -51.7\ kJ/mol$

$Cl^-(aq) = -131.2\ kJ/mol$

Elements: $Cl_2 = \emptyset$, $I_2 = \emptyset$

Calclate E° for the following reaction: $Cl_2 + 2\ I^-(aq) \rightleftharpoons 2\ Cl^-(aq) + I_2$

$\Delta G_{rxn} = \sum n G^\circ_{Prod} - \sum n G^\circ_{reactants}$

$= \left[2\left(-131.2 \frac{KJ}{mol}\right) + \emptyset\right] - \left(\emptyset + 2\left(-51.7 \frac{KJ}{mol}\right)\right)$

$= -159.4 \frac{KJ}{mol}$

$\emptyset$ for an element

$\Delta G^\circ_{rxn} = -nFE^\circ$

$\left(\frac{10^3 J}{1 KJ}\right) \times \left(-159.4 \frac{KJ}{mol}\right) = -(2.00\ mol\ e^-)\left(\frac{9.65 \times 10^4 J}{V \cdot mol}\right) E^\circ$

$E^\circ = 0.826\ V$

5 Calculate K for the following reaction: $2\ SO_2 + O_2 \rightleftharpoons 2\ SO_3$ at 25.0°C

$\Delta G_f^\circ\ SO_2 = -300.8\ kJ/mol$

$\Delta G_f^\circ\ SO_3 = -370.4\ kJ/mol$

$\Delta G_{rxn} = 2\left(-370.4 \frac{KJ}{mol}\right) - \left(2\left(-300.8 \frac{KJ}{mol}\right)\right)$

$= -139.2 \frac{KJ}{mol}$

$\Delta G_{rxn} = -RT \ln K_p$

$-139.2 \frac{KJ}{mol} = -\left(8.3145 \frac{J}{K\ mol}\right)(298.15\ K) \ln K$

$K_p = 1.06$