Suggested Problems: Chapter 16

Problem 16.23: For (a), we see that Mg(s) is oxidized to Mg^{2+}(aq) and that Ni^{2+}(aq) is reduced to Ni(s). The standard state reduction potential for Mg^{2+}/Mg is –2.372 V and the standard state reduction potential for Ni^{2+}/Ni is –0.257 V. The standard state potential for the reaction is

$$E^\circ = E^\circ_{\mathrm{Ni}^{2+}/\mathrm{Ni}} - E^\circ_{\mathrm{Mg}^{2+}/\mathrm{Mg}} = -0.257 - (-2.372) = +2.115 \text{ V}$$

Because the potential is postive, we know that the reaction is favorable.

For (b) we see that Cu(s) is oxidized to Cu^{2+}(aq) and that Ag^{+}(aq) is reduced to Ag(s). The standard state reduction potential for Cu^{2+}/Cu is 0.34 V and the standard state reduction potential for Ag≡/Ag is 0.7996 V. The standard state potential for the reaction is

$$E^\circ = E^\circ_{\mathrm{Ag}\equiv/\mathrm{Ag}} - E^\circ_{\mathrm{Cu}^{2+}/\mathrm{Cu}} = 0.7996 - 0.34 = +0.4596 \text{ V}$$

Because the potential is postive, we know that the reaction is favorable.

For (c), we ignore the nitrate ion, $\mathrm{NO_3^-}$, as it does not undergo any reactions. We see that Mn(s) is oxidized to Mn^{2+}(aq) and that Sn^{2+}(aq) is reduced to Sn(s). The standard state reduction potential for Mn^{2+}/Mn is -1.185 V and the standard state reduction potential for Sn^{2+}/Sn is -0.1375 V. The standard state potential for the reaction is

$$E^\circ = E^\circ_{\mathrm{Sn}^{2+}/\mathrm{Sn}} - E^\circ_{\mathrm{Mn}^{2+}/\mathrm{Mn}} = -0.1375 - (-1.185) = +1.0589 \text{ V}$$

Because the potential is postive, we know that the reaction is favorable.

For (d), we ignore the nitrate ion, $\mathrm{NO_3^-}$, as it does not undergo any reactions. We see that Fe^{2+}(s) is oxidized to Fe^{3+}(aq) and that Au^{3+}(aq) is reduced to Au(s). The standard state reduction potential for $\mathrm{Fe}^{3+}/\mathrm{Fe}^{2+}$ is 0.771 V and the standard state reduction potential for Au^{3+}/Au is 1.498 V. The standard state potential for the reaction is

$$E^\circ = E^\circ_{\mathrm{Au}^{3+}/\mathrm{Au}} - E^\circ_{\mathrm{Fe}^{3+}/\mathrm{Fe}^{2+}} = 1.498 - (-0.771) = +0.727 \text{ V}$$

Because the potential is postive, we know that the reaction is favorable.

Problem 16.27: The relationship between ΔG° and E° is

$$\Delta G^\circ = -nFE^\circ$$

where n is then number of electrons transferred in the redox reaction and F is Faraday's constant (96485 J/V • mol e⁻). For (a) we have

$$\Delta G^\circ = -(2 \text{ mol e}^-) \times (96485 \text{ J/V} \bullet \text{ mol e}^-) \times (0.000 \text{ V}) \times \frac{1 \text{ kJ}}{1000 \text{ J}} = 0 \text{ kJ}$$

For (b) we have

$$\Delta G^\circ = -(2 \text{ mol e}^-) \times (96485 \text{ J/V} \bullet \text{ mol e}^-) \times (0.434 \text{ V}) \times \frac{1 \text{ kJ}}{1000 \text{ J}} = -83.7 \text{ kJ}$$

For (c) we have

$$\Delta G^\circ = -(1 \text{ mol e}^-) \times (96485 \text{ J/V} \bullet \text{ mol e}^-) \times (-2.439 \text{ V}) \times \frac{1 \text{ kJ}}{1000 \text{ J}} = +235.3 \text{ kJ}$$