Homework #19-3: Spontaneity of Redox Reactions  Use a Standard Reduction Chart when necessary. From textbook, problems pg. 833 #20 (modified), 21, 22, 23(a&c), 24(a&c), 25

19.20  Over the last few chapters we have discussed 3 main methods of measuring an equilibrium constant.
   a) For each method below, write a formula that relates $K$ to the given measured quantity.

<table>
<thead>
<tr>
<th>Method #1: Measure equil conc</th>
<th>Method #2: Measure $\Delta G^\circ$</th>
<th>Method #3: Measure $E'_{\text{cell}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   b) Why is method #3 often the easiest way to find $K$?

c) When can’t method #3 be used to find $K$ in all situations?

19.21  Use standard reduction potentials to determine the equilibrium constant for the following reaction at 25°C. $\text{Mg(s)} + \text{Zn}^{2+}(\text{aq}) \rightleftharpoons \text{Mg}^{2+}(\text{aq}) + \text{Zn(s)}$

19.22  The equilibrium constant for the reaction, $\text{Sr(s)} + \text{Mg}^{2+}(\text{aq}) \rightleftharpoons \text{Sr}^{2+}(\text{aq}) + \text{Mg(s)}$, is $2.6 \times 10^{12}$ at 25°C. Calculate $E^\circ$ for a cell made up of Sr/Sr$^{2+}$ and Mg/Mg$^{2+}$ half cells.

19.23  Use the standard reduction potentials to find the equilibrium constant for each of the following reactions at 25°C:
   (a) $\text{Br}_2(l) + 2\text{I}^-(\text{aq}) \rightleftharpoons 2 \text{Br}^-(\text{aq}) + \text{I}_2(s)$

   (c) $5 \text{Fe}^{2+}(\text{aq}) + \text{MnO}_4^-(\text{aq}) + 8 \text{H}^+(\text{aq}) \rightleftharpoons \text{Mn}^{2+}(\text{aq}) + 4 \text{H}_2\text{O} + 5 \text{Fe}^{3+}(\text{aq})$
19.24 Calculate $\Delta G^\circ$ and $K_c$ for the following reactions at 25°C:

(a) $\text{Mg(s)} + \text{Pb}^{2+}(\text{aq}) \rightleftharpoons \text{Mg}^{2+}(\text{aq}) + \text{Pb(s)}$

(c) $\text{O}_2(\text{g}) + 4\text{H}^+(\text{aq}) + 4\text{Fe}^{2+}(\text{aq}) \rightleftharpoons 2\text{H}_2\text{O}(l) + 4\text{Fe}^{3+}(\text{aq})$

19.25 Under standard-state conditions, what spontaneous reaction will occur in aqueous solution among the ions Ce$^{4+}$, Ce$^{3+}$, Fe$^{3+}$, and Fe$^{2+}$? Calculate $\Delta G^\circ$ and $K_c$ for the reaction.

Answers:

- $K_c = 3 \times 10^{54}$
- $E^\circ = 0.368 \text{ V}$
- $K_c = 2 \times 10^8$
- $K_c = 3 \times 10^{62}$
- $\Delta G^\circ = -432 \text{ kJ/mol}$, $K_c = 5 \times 10^{75}$
- $\Delta G^\circ = -178 \text{ kJ/mol}$, $K_c = 1 \times 10^{31}$
- $\Delta G^\circ = -81 \text{ kJ/mol}$, $K_c = 2 \times 10^{14}$