Name: _____ Date: _____

AP Chemistry 30 L – Electrochemistry Review

1. Determine the oxidation numbers of the underlined element in the following compounds:
   a. $\underline{S}O_2$
   b. $\underline{Mn}O_2$
   c. $\underline{Cr^{3+}}$
   d. $\underline{S}O_4^{2-}$
   e. $H_3\underline{B}O_3$
   f. $Na_2\underline{O}_2$ (sodium peroxide)
   g. $\underline{Sn}$
   h. $K_2\underline{Cr}_2O_7$
2. Determine the oxidation number of each element in $(NH_4)_2CO_3$.
3. Is this a redox reaction? Explain why or why not.

   $$Na_2S\ (aq) + FeCl_2\ (aq) \rightarrow 2\ NaCl\ (aq) + FeS\ (s)$$
4. Balance each of the following half-reactions, then identify if it represents oxidation or reduction.
   a. $SO_3^{2-} \rightarrow SO_4^{2-}$ in acidic conditions
   b. $CrO_4^{2-} \rightarrow Cr^{3+}$ in basic conditions
   c. $2\ I^- \rightarrow I_2$
5. Balance each reaction using half-reactions.
   a. $NO + As \rightarrow N_2O + AsO_2^-$ (in acidic conditions)
   b. $Ce^{4+} + I^- \rightarrow Ce^{3+} + IO_3^-$ (in basic conditions)
6. The net equation for a voltaic cell is:

   $$Sn + 2\ Ag^+ \rightarrow Sn^{2+} + 2\ Ag$$
   a. Write the two half-reactions involved, and identify the anode and cathode.
   b. Calculate the net potential of the cell in standard conditions.
7. For the generic reaction:

   $$A\ (aq) + B\ (aq) \rightarrow A^-\ (aq) + B^+\ (aq)$$

   $E°_{cell}$ is a positive number.
   a. What is being oxidized, and what is being reduced?
   b. If you made a galvanic cell out of this reaction, which half-reaction would be occurring at the cathode, and which would be occurring at the anode?
   c. Which half-reaction would be higher in potential energy?
   d. What is the sign of the free energy change for the reaction?
8. A voltaic cell uses the reaction:

   $$Tl^{3+}\ (aq) + Cr^{2+}\ (aq) \rightarrow Tl^+\ (aq) + 2\ Cr^{3+}\ (aq)$$

   The cell has a measured standard cell potential of 1.19 V.
   a. Write the two half-cell reactions.
   b. If the reduction potential for the oxidation half-reaction is -0.41 V, what is the reduction potential for the reduction half-reaction?
   c. Sketch this cell. Label the anode, cathode and direction of electron flow.
9. Given these half-reactions:

   $Fe^{3+}\ (aq) + e^- \rightarrow Fe^{2+}\ (aq)$ $E°_{red} = 0.77$ V

   $S_2O_6^{2-}\ (aq) + 4\ H^+\ (aq) + 2\ e^- \rightarrow 2\ H_2SO_3\ (aq)$ $E°_{red} = 0.60$ V

   $N_2O\ (g) + 2\ H^+\ (aq) + 2\ e^- \rightarrow N_2\ (g) + H_2O\ (l)$ $E°_{red} = -1.77$ V

   $VO_2^+\ (aq) + 2\ H^+\ (aq) + e^- \rightarrow VO^{2+}\ (aq) + H_2O\ (l)$ $E°_{red} = 1.00$ V

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a. Write balanced chemical equations for the oxidation of Fe^{2+} (aq) by $S_2O_6^{2-}$ (aq), by N_2O (aq) and by VO_2^+ (aq).
b. Calculate $\Delta G°$ for each reaction at 298K.
c. Calculate the equilibrium constant for each reaction at 298K.

10. What is the effect on the cell potential for a cell with the following overall reaction when each change is made?

$$Zn\ (s) + 2\ H^+\ (aq) \rightarrow Zn^{2+}\ (aq) + H_2\ (g)$$

a. The pressure of the hydrogen gas is increased in the cathode compartment
b. Zinc nitrate is added to the anode compartment
c. Sodium hydroxide is added to the cathode compartment
d. The surface area of the anode is doubled

11. a. A Cr^{3+} solution is electrolyzed using a current of 7.60 A. What mass of Cr (s) is plated out after 2.00 days?
b. What amperage is required to plate out 0.250 mol Cr from a Cr^{3+} solution in a period of 8.00 h?