AP Chem Redox Test Review!

$Rb^{+1}_{(aq)} + 1e^- \text{------>} Rb_{(s)}$ E°red = - 2.92 V

$2\ H_2O_{(l)} + 2e^- \text{------>} H_{2(g)} + 2\ OH^{-1}_{(aq)}$ E°red = - 0.83 V

$O_{2(g)} + 4\ H^{+1}_{(aq)} + 4\ e^- \text{-----> } 2\ H_2O_{(l)}$ E°red = 1.23 V

$F_{2(g)} + 2\ e^- \text{-----> } 2\ F^{-1}_{(aq)}$ E°red = 2.87 V

$I_{2(s)} + 2\ e^- \text{-----> } 2\ I^{-1}_{(aq)}$ E°red = 0.54V

$Cu^{+2}_{(aq)} + 2e^- \text{------> } Cu_{(s)}$ E°red = 0.34 V

$Ni^{+2}_{(aq)} + 2e^- \text{------> } Ni_{(s)}$ E°red = - 0.28 V

$Sn^{+2}_{(aq)} + 2e^- \text{------> } Sn_{(s)}$ E°red = - 0.14 V

$Zn^{+2}_{(aq)} + 2e^- \text{------> } Zn_{(s)}$ E°red = - 0.76 V

$Fe^{+2}_{(aq)} + 2e^- \text{------> } Fe_{(s)}$ E°red = - 0.44 V

$MnO_4^{-1}{}_{(aq)} + 5\ e^- + 8\ H^{+1}_{(aq)} \text{-----> } Mn^{+2}_{(aq)} + 4\ H_2O_{(l)}$ E°red = 1.51 V

dehydroascorbic acid + $2H^{+1}$ + 2e- ----> ascorbic acid E°red = 0.39 V

1a. Rank these from strongest to weakest oxidizing agent:

Ni^{+2}, Rb, Rb^{+1}, H_2O

1b. Which is a stronger reducing agent: H_2O or F^{-1}?

2a. For the "standard hydrogen electrode,"

a. What substances are present? At what pressures and/or concentrations are they present?

b. Write the half reaction that occurs at the anode, and fill in the half cell voltage.

_____ E°___ = _____ V

c. Write the half reaction that occurs at the cathode, and fill in the half cell voltage.

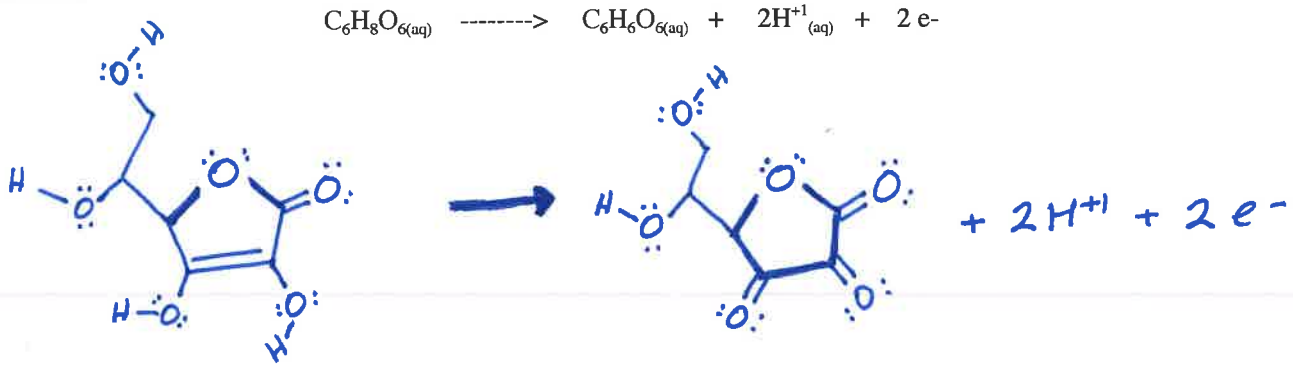
_____ E°___ = _____ V

d. Use the voltages given above to determine an activity series of metals and hydrogen. Include rubidium, nickel, tin, iron, zinc, copper, hydrogen.

3. If an aqueous solution of nickel (II) fluoride is electrolyzed, what will be the half rxn at each electrode?

4. Vitamin C (ascorbic acid; $C_6H_8O_6$) can be oxidized to $C_6H_6O_6$ (dehydroascorbic acid) according to the following half reaction:

$$C_6H_8O_{6(aq)} \text{ --------> } C_6H_6O_{6(aq)} + 2H^{+1}_{(aq)} + 2\,e^-$$



a. Write the balanced redox reaction that occurs, if ascorbic acid is oxidized by permanganate ion, in acidic solution.

b. What is the value of "n" for this rxn?____

c. Calculate ΔG° for this reaction.

d. Calculate Keq for this reaction at 25°C.

e. Write an expression for Kc, in terms of the appropriate concentrations.

A tablet/pill is tested for its vitamin C content. A 0.60 gram pill is crushed and dissolved into a sulfuric acid solution. This vitamin C/acid solution is now titrated with 0.045 M $KMnO_4$ solution. 20.8 mL of $KMnO_4$ were required to reach the end point.

f. Determine the oxidizing and reducing agents in the titration.

g. Calculate the number of moles of vitamin C that must have been dissolved in the solution.

h. Calculate the percent Vitamin C (by mass) in the pill.

5. To protect nails from rusting, they are often "galvanized": They are coated in a more reactive metal, so that the more reactive metal gets oxidized instead of the iron. (The more reactive metal can be called the "sacrificial anode.") Based on the voltages on page 1, which metal should be used to coat Fe nails: Tin or Zinc?

6. If you were going to make a [not very good] battery using the iron and tin half reactions on page 1,
a. What would be the overall reaction and cell voltage?

b. Calculate Keq at 25°C (Answer: 1.4×10^{10})

c. What substances would you put in all places in the battery?
d. Sketch the battery, and show the direction of flow of e- in the external circuit, and the direction of ion flow in the salt bridge. Also label the anode and cathode.

e. What would be the cell voltage at 25 °C, if the concentration of Fe^{+2} is 0.010 M, and the concentration of Sn^{+2} is 2.0 Molar? How does E compare to E°, and how does this relate to the value of Q?

f. What would be the cell voltage at 25 °C, if the concentration of Sn^{+2} is 0.010 M, and the concentration of Fe^{+2} is 2.0 Molar? How does E compare to E°, and how does this relate to the value of Q?

g. If the concentration of Fe^{+2} is 5.0 M, at what concentration of Sn^{+2} would the cell emf be equal to zero? Explain.

7. Concentration Cells:
a. Draw a picture of a concentration cell involving Co^{+2}. (What substances are present?)
b. Write a balanced equation for the reaction that occurs.

c. Answer these questions on your picture:
Which way will the e- flow in the external circuit?
Which directions do anions/cations flow through the salt bridge?
Which side is the anode/cathode?
How will the solute concentrations change over time on each side?
How do the electrode masses change over time on each side?
d. What is the value of E°cell? _____
e. If one of the solutions is 0.30 M, and one is 2.5 M, calculate the E_{cell} at 25°C

8. a. A solution of zinc iodide is electrolyzed. Zinc ion and iodide ion both react. If a current of 2.00 A is applied over 5.0 hours, what mass of zinc can form?

b. Calculate E°cell.

c. What is the minimum energy required for part (a)?

9. Show the balanced oxidation and reduction half reactions too.

In ACID: $Sb_2O_{3(s)} + H_2C_2O_{4(aq)} \text{ -----> } CO_{2(g)} + Sb_{(s)}$

In BASE: $Br^{-1}_{(aq)} + CrO_4^{-2}{}_{(aq)} \text{ ------> } BrO_3^{-1}{}_{(aq)} + Cr(OH)_{3(s)}$

In BASE: $IO_3^{-1}{}_{(aq)} + S_{(s)} \text{ ------> } I^{-1}_{(aq)} + SO_3^{-2}{}_{(aq)}$

10. Suppose that a reaction has an E°rxn of 0.10.
As the reaction proceeds in the forward direction,
Does Q_{rxn} increase or decrease? _____
Does E_{rxn} increase or decrease? _____

11. Each reaction below has a positive E°rxn.
Therefore each reaction could be used to make a "battery", also known as a _____cell or a _____cell.
For each reaction, determine the value of "n" for the reaction, and determine a substance that could be used for the electrode at the anode, and a substance that could be used for the electrode at the cathode.
(In several cases, more than one substance could work. You can just list one substance though.)

a. $2\ Co_{(s)} + Sn^{+4}_{(aq)} \text{ -----> } Sn_{(s)} + 2\ Co^{+2}_{(aq)}$

b. $CH_3OH_{(aq)} + Fe^{+2}_{(aq)} \text{ -----> } Fe_{(s)} + CH_2O_{(aq)} + 2\ H^{+1}_{(aq)}$

c. $2\ Cr^{+3}_{(aq)} + 3\ H_2O_{2\,(aq)} \text{ -----> } 3\ O_{2(g)} + 6\ H^{+1}_{(aq)} + 2\ Cr_{(s)}$

d. $3\ Mg_{(s)} + 8\ H^{+1}_{(aq)} + 2\ MnO_4^{-1}{}_{(aq)} \text{ -----> } 3\ Mg^{+2} + 2\ MnO_{2(s)} + 4\ H_2O_{(l)}$

e. $6\ OH^{-1}_{(aq)} + 6\ NH_3OH^{+1}_{(aq)} + IO_3^{-1}{}_{(aq)} \text{ -----> } 15\ H_2O_{(l)} + 3\ N_{2(g)} + I^{-1}_{(aq)}$

f. $2\ Ag^{+1}_{(aq)} + Sn^{+2}_{(aq)} + 2\ H_2O_{(l)} \text{ -----> } 2\ Ag_{(s)} + SnO_{2(s)} + 4\ H^{+1}_{(aq)}$

g. $Al_{(s)} + 3\ TiO^{+2}_{(aq)} + 6\ H^{+1}_{(aq)} \text{ -----> } 3\ H_2O_{(l)} + 3\ Ti^{+3}_{(aq)} + Al^{+3}_{(aq)}$

12. a. In reaction 11c, above, what mass of solid Chromium would plate out, if the reaction produces a current of 0.044 amps over a time period of 3.0 minutes? (What mass of solid Cr would form)

b. In reaction 11e, above, how long would it take (in minutes) to produce 5.0 mL of nitrogen gas at 25°C and 0.91 atm, if the reaction is producing a current of 0.022 amps?