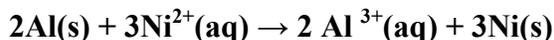# ELECTROCHEM 1

Answer these questions. Information can be found in the appendix E

1. A voltaic cell is constructed. One electrode compartment consists of an aluminum strip placed in a solution of $Al(NO_3)_3$ and the other has a nickel strip placed in a solution of $NiSO_4$. The overall cell reaction is:

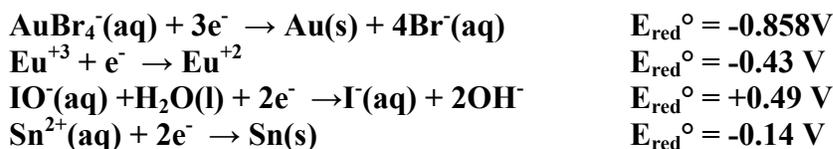 $2Al(s) + 3Ni^{2+}(aq) \rightarrow 2\ Al^{3+}(aq) + 3Ni(s)$

   (a) What is being oxidized, and what is being reduced?
   (b) Write the half-reactions that occur in the two electrode compartments
   (c) Which electrode is the anode and which is the cathode?
   (d) Indicate the signs of the electrodes?
   (e) Do electrons flow from the aluminum electrode to the nickel electrode or vice versa?
   (f) In which directions do the cations and anions migrate through the solution? Assume the Al is not coated with an oxide.

2. A voltaic cell that uses the reaction:

   $PdCl_4^{2-}(aq) + Cd(s) \rightarrow Pd(s) + 4Cl-(aq) + Cd^{2+}(aq)$

   has a measured standard cell potential of +1.03V. (a) Write the two half-cell reactions (b) By using data from Appendix E, determine $E°_{red}$ for the reaction involving Pd (c) Sketch the voltaic cell, label the anode and cathode, and indicate the direction of electron flow.

3. Given the following half reactions and associated standard reduction potentials:

$AuBr_4^-(aq) + 3e^- \rightarrow Au(s) + 4Br^-(aq)$	$E_{red}° = -0.858V$
$Eu^{+3} + e^- \rightarrow Eu^{+2}$	$E_{red}° = -0.43\ V$
$IO^-(aq) + H_2O(l) + 2e^- \rightarrow I^-(aq) + 2OH^-$	$E_{red}° = +0.49\ V$
$Sn^{2+}(aq) + 2e^- \rightarrow Sn(s)$	$E_{red}° = -0.14\ V$

   (a) Write the cell reaction for the combination of these half-cell reactions that leads to the largest positive cell emf and calculate the value. (b)Write the cell reaction for the combination of half-cell reactions that leads to the smallest positive cell emf , and calculate that value.

4. From each of the following pairs of substances, use the data in Appendix E to choose the one that is the strongest oxidizing agent:
   (a) Fe(s) or Mg(s)   (d) H_2O_2 or O_3
   (b) Ca(s) or Al(s)   (c) $H_2(g,acidic)$ or H_2S

5. A voltaic cell consists of a strip of cadmium metal in a solution of cadmium nitrate in one beaker, and in the other beaker a platinum electrode is immersed in a NaCl solution, with Cl_2 gas bubbled around the electrode. A salt bridge connects the two beakers (a) Which electrode serves as the anode and which as the cathode? (b) Does the Cd electrode gain or lose mass as the cell reaction proceeds? (c) Write the equation for the overall cell reaction (d) What is the emf generated by the cell under standard conditions?

6. For each of the following reactions, write a balanced equation, calculate the standard emf, calculate ΔG at 298K, and calculate the equilibrium constant K at 298K
   (a)Aqueous iodide ion is oxidized to $I_2(s)$ by $Hg_2^{2+}(aq)$ (b) In acidic solution, copper (I) ion is oxidized to copper (II) ion by the nitrate ion. (c) In basic solution, $Cr(OH)_3$ is oxidized by $CrO_4^{2-}(aq)$ by $ClO^-(aq)$

7. A voltaic cell utilizes the following reaction:

   $Al(s) + 3Ag^+(aq) \rightarrow Al^{+3}(aq) + 3Aq(s)$
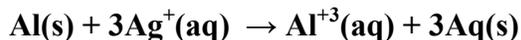
   What is the effect on the cell emf of each of the following changes? (a) Water is added to the anode compartment, diluting the solution? (b) The size of the aluminum electrode is increased (c) A solution of Silver (I) Nitrate is added to the cathode compartment, increasing the quantity of Ag+ but not changing its concentration (d) HCl Is added to the silver nitrate solution, precipitating some of the Ag+ as AgCl.

8. A voltaic cell utilizes the following reaction:

   $2\ Fe^{+3}(aq) + H_2(g) \rightarrow 2Fe^{+2}(aq) + 2H+(aq)$
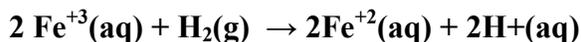
   (a) What is the emf of this cell under standard conditions?
   (b) What is the emf of this cell when $[Fe^{3+}] = 2.50$ M, $P_{H2} = 0.85$atm, $[Fe^{2+}] = 0.0010$M, and the pH in both compartments is 5.00

9. **Some years ago a unique proposal was made to raise Titanic. The plan involved placing pontoons within the ship using a surface controlled submarine-type vessel. The pontoons would contain cathodes and would be filled with hydrogen gas formed by the electrolysis of water. It has been estimated that it would require about 700 million moles of hydrogen gas to provide the required buoyancy to lift the ship.**

   (a) How many coulombs of charge would be required?
   (b) What is the minimum voltage required to generate Hydrogen and Oxygen if the pressure on the gases at the depth of Titanic is 300atm?
   (c) What is the minimum electrical energy required to raise Titanic by electrolysis?
   (d) What is the minimum cost of the electrical energy required to generate the necessary H_2 if the electricity costs about 85 cents per kilowatt-hour to generate at the site?