 Voltaic Cells Name________________Per____

Introduction

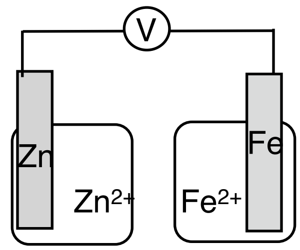
In this LAD you will set up several micro-scale electrochemical cells and measure the cell potential.

Materials on Tray

- 2x well plate
- Metals to be tested: Zn, Fe, Cu, Mg, Pb, Al, Ag
- droppers with various 0.20 M metal nitrate solutions: Zn^{2+}, Fe^{2+}, Cu^{2+}, Mg^{2+}, Pb^{2+}, Al^{3+}, Ag^{+}
- sand paper
- 4x alligator clip wires
- 2x voltmeter
- small beaker with string saturated in potassium nitrate
- 2x forceps

PreLAD

1. We will set up 21 different electrochemical cells. Using the seven metals listed above and their corresponding metal ion solutions. In the data table on page 2, you will write the reaction that represents the spontaneous reaction for a cell made with the listed metals.
2. Use the blue Standard Reduction table (or in your text on pg 1046, short version on pg 791) to calculate the voltage for each of the 21 spontaneous reactions.
   FOR EXAMPLE:



3. For the first two metals listed, Zn and Fe you have to decide whether the zinc get oxidized or reduced, which corresponds to the iron getting reduced or oxidized. You will set up two well plates as shown in the diagram to the right. The zinc electrode will be placed in the zinc solution and the iron electrode will be placed in the iron solution. The question is which way are the electrons flowing, from Zn to Fe, or from Fe to Zn. How do you know? By looking up the reduction potentials for the two half reactions and determining which metal must be reduced and which must be oxidized in order to give a positive cell potential.
4. So look up: $Zn^{+2} + 2e \rightarrow Zn$ $E_{red} = -0.763V$ and $Fe^{+2} + 2e \rightarrow Fe$ $E_{red} = -0.44V$
5. Since the iron has a higher reduction potential, it is going to be reduced, and the zinc is going to be oxidized because it has a lower reduction potential. When you plug into the formula:
   - $E_{cell} = E_{red}$ (Fe) + E_{ox} (Zn, the opposite sign of it's E_{red})
   - $E_{cell} = -0.44V + 0.763V = +0.323V$ and a positive E_{cell} means that the reaction is spontaneous when iron is reduced and the zinc is oxidized.
   - This then allows you to write the reaction: $Zn + Fe^{2+} \rightarrow Zn^{2+} + Fe$

Procedure

1. Identify the pieces of metal which will serve as your electrodes.
2. Set up a well plate diagram to keep track of which metal ions you place in which well.
3. Set up a cell by placing the metal ion solution in one well, and another metal ion solution in another well.
4. Use a piece of string saturated with KNO_3 as a salt bridge to connect the two half reactions.
5. Clip a voltage lead (or connector cord with alligator clips) from the multimeter to two metal electrodes. The metal electrode should be placed in the corresponding metal ion solution.
6. Measure the voltage. *If a positive voltage reading is obtained,* record the voltage and circle which metal is attached to the negative lead − This will be the anode, the metal at which the oxidation occurs. *Note:* If a negative voltage reading is obtained, reverse the polarity (by switching the positive and negative leads) of the metal electrodes to obtain a positive reading. This will allow you to report which metal is serving as the anode each time.
7. Observe any signs of a chemical reaction in or around each metal electrode. Look for color changes to the electrode or look for bubbles that would indicate the formation of a gas.
8. Repeat steps 3–7 to measure the voltage for different combinations of metals. Remember to record the identity of the negative electrode once a positive voltage is obtained.

Process the Data

Use the data table on the back to record your measured voltages.
Compare your measured voltage with the theoretical voltage and calculate % error.

Metals circle the anode metal from lab	**Net Ionic Equation** (PreLAD − underline the predicted anode metal)	**Predicted E° voltage** (PreLAD)	**Experimental Measured voltage**	**Percent Error**
Zn, Fe	$Zn + Fe^{2+} \rightarrow Zn^{2+} + Fe$	+0.323V		
Zn, Cu				
Zn, Mg				
Zn, Pb				
Zn, Al				
Zn, Ag				
Fe, Cu				
Fe, Mg				
Fe, Pb				
Fe, Al				
Fe, Ag				
Cu, Mg				
Cu, Pb				
Cu, Al				
Cu, Ag				
Mg, Pb				
Mg, Al				
Mg, Ag				
Pb, Al				
Pb, Ag				
Al, Ag				