SI Chemistry - Spring 2008

Establishing a Table of Reduction Potentials

Objectives:

(a) To provide experimental background for understanding the E˚ table.
(b) To determine the reduction potentials for some metals relative to an arbitrarily chosen metal.
(c) To write reduction half reactions and rank them from the highest potential (substance most easily reduced) to the lowest potential.

Introduction:

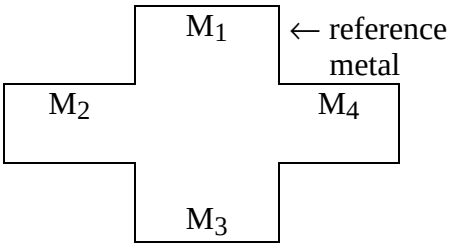
In this experiment, you will assign arbitrarily a value of zero to the reference half cell. Since two half cell potentials can be added to give the potential difference (E˚) expected for a given voltaic cell, and zero is assigned to the reference half cell, then the reading on the voltmeter will represent the overall cell voltage.

Materials:

Filter paper
1 M $NaNO_3$
1 M $Zn(NO_3)_2$, $Cu(NO_3)_2$, $Pb(NO_3)_2$, $Fe(NO_3)_3$
Zinc, copper, lead, and iron strips
Voltmeter
Wires with alligator clips

Procedure:

1. Place a filter paper as shown on a glass plate.



2. Place two drops of the appropriate metal nitrate solution (**excluding sodium nitrate**) on each segment of the filter paper. Note which nitrate solution you place in the "M1" position. This is your reference metal.

3. Place the drops of sodium nitrate solution on the center of the filter paper to act as a salt bridge between the half cells.

4. Place each clean metal strip on ***its*** nitrate solution; copper on copper nitrate, lead on lead nitrate, etc.

5. Connect a wire from one metal to one lead of the voltmeter and another wire from the reference metal (M1) to the other lead of the voltmeter. You should always connect the metals (electrodes) so as to get a positive reading.

6. Repeat step 5 so that all metals have been combined with the reference metal.

Data:

1. In each combination:

   (a) record which electrode was connected to the + lead of the voltmeter. (This is the anode of your cell where oxidation occurs.)
   (b) record which electrode was the cathode.
   (c) record the voltage observed.

Extension Questions:

1. Write a balanced overall equation for the redox reactions occurring in each of the three cells.

2. Write reduction half reactions for each of the three cells ranking the cell with the highest voltage first and the cell with the lowest voltage last. After the half reaction, indicate the cell voltage.

3. Did the voltages for the two cells agree with your predictions? Why or why not?

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Cell

Anode black	Cathode red	Voltage (V)	Equation
1.			
2.			
3.			

Next, connect the reference metal to the anode and the other metals to the cathode. **This time it is acceptable to have a negative voltage**. Write a reduction half-reaction and voltage for each of the metals. **The reference metal will have a voltage of zero**. Rank the highest voltage 1st and the lowest 4th.

Half-Reaction	**Voltage**	**Ranking**
1.		
2.		
3.		
4.		

Predict the voltage for two other cells. Then, test and measure the voltage. Record results below:

Cell	Voltage
1.	
2.	