**Building Simple Electrochemical Cells**

An electrochemical cell is made by combining an oxidation reaction with a separate reduction reaction to produce a flow of electrons(electricity). The two reactions are placed in separate cells to prevent direct contact. A salt bridge is used to allow for a movement of ions between the cells, that will complete the circuit. Half-cell potentials are additive to give the potential voltage difference expected for a given voltaic cell. In this experiment, simple metal-metal ion half cells [M(s) / M2+(aq)] will be used to establish voltaic cells, the potentials of which will be measured. For example, the reactions for a zinc/copper battery are below:

 Zn → Zn2+ + 2e- Anode

 Cu2+ + 2e- → Cu Cathode

The sum of these two half-reactions is

 Cu2+ + Zn → Zn2+ + Cu where Eºcell = Eºox + Eºred

 Materials:

 20 drops 1M Zn(NO3)2 20 drops 1M Cu(NO3)2 20 drops 1M KNO3 20 drops 1M Pb(NO3)2 20 drops 1M Co(NO3)2

 Small pieces of metals: Pb, Cu, Fe, Zn, Co

 Multimeter or voltmeter Wire leads Sandpaper Filter paper

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**Procedure:**

1. Use sandpaper to clean small pieces of the various metals used in this lab. Make sure to sand out both sides of the metal and sand very well as the more you sand, the better your results. For the Pb, since it is in a round shape, you must hit the Pb with a hammer to flatten it out and then sand it.
2. 

Remember to reapply KNO3 during the experiment to keep the “salt-bridge” intact.

1. Touch one of the wires from a DC voltmeter to the copper metal and the other wire to the zinc metal. If the voltage is negative, switch the wire connections. Record the positive voltage and note which metal is connected to the negative terminal (black wire) and which is connected to the positive terminal (red wire) of the voltmeter.
2. After finding which terminal (either red or black) goes with the zinc, don’t move that terminal. On each metal, find voltages on various places on the metal and average the voltage. Move the opposite terminal to each of the other metals and record voltages in a data table.
3. Compare the values recorded with the values found in the book.

**Conclusions:**

1. When the negative terminal wire is connected to the anode (where oxidation occurs) and the positive terminal wire is connected to the cathode (where reduction occurs), a positive cell voltage is observed. Make a table of the half-cells and note which half-cell is the oxidation reaction. Record their observed positive voltages.

2. Write the balanced net ionic equation for the overall reaction in each voltaic cell.

3. Look up the reduction potentials for each half-reaction in your book, and calculate the theoretical voltages for each electrochemical cell. Compare how your results fit the theoretical values. Make a note on any that demonstrated extreme differences and explain what could cause the differences between the theoretical and experimental voltage values.

4. Which solution do you think was the closest to 1M and explain why.

5. For each metal, was Zn the anode or cathode?