

Electrochemical Cells

Pre-lab:

1. In Part B you will be preparing 3 dilutions of a CuSO_4 solution. Show all calculations for preparing these solutions and describe how you will make them.
2. Using a table of standard reduction potentials (you can find this in your textbook), record the standard reduction potentials for the redox half-reactions involving Cu^{2+} , Ag^+ and Zn^{2+} .

Objective:

- Investigate electrochemical potential using electrochemical cells.

Information:

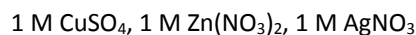
- Electric current is the flow of negatively charged particles. An electrochemical cell is a device that creates an electric current by converting chemical energy into electric current, or vice versa. Voltaic cells are electrochemical cells that produce current spontaneously by converting chemical energy into electrical energy via an oxidation-reduction reaction. By creating an electric potential between an "anode" and "cathode", electrons are forced to move from the anode to the cathode. The current will spontaneously flow from the anode to the cathode in a Voltaic cell.
- The force that moves the electrons in a Voltaic cell depends on many variables such as type of anode, type of cathode, temperature, external pressure, etc. The force is historically termed the "electromotive force", but the true form of the force is as an electric potential. The electric potential can be measured quantitatively by use of a voltmeter.
- A car battery is a Voltaic cell. It changes chemical energy into electrical energy. Batteries need three parts: a cathode (positive electrode), an anode (negative electrode), and an electrolyte (material to transfer electrons). The electrolyte material is most often referred to as the "salt bridge".

Procedure:

Part A: Setting up each half-cell:

A half-cell consists of a piece of metal partially immersed in a solution of a salt of the same metal.

1. Using labeled test tubes, place approximately 10 mL of each of the solutions below into a separate test tube:



2. Obtain a strip of each type of metal (these will have to be shared). Use sandpaper to clean the surface of the metal to remove any oxide coating.
3. A beaker of 1.0 M KNO_3 solution will be provided at the front of the room. Using forceps, soak a thin strip of filter paper in the 1.0 M KNO_3 solution. Remove it from the solution and place it on a paper towel to remove any excess solution. This is your salt bridge. You will need a fresh one for **each** voltaic cell.
4. Set up your electrochemical cell:
 - a. Set the test tubes close together and put one end of the salt bridge in one solution and the other end in the other solution
 - b. Use a multimeter to measure an electrical potential difference between two half-cells.
 - i. Connect the (-) lead (black) to the "COM" port of the multimeter. Connect the (+) lead (red) to the ' $\text{V}\Omega\text{mA}$ ' port. Turn the dial to "2 V" (this means that the meter will read a maximum of 2 V).
 - ii. Using the alligator clips, attach the (+) lead (red) to one metal electrode and connect the (-) lead (black) to the other metal electrode. Hold the strip of metal in the test tube that contains the ion of that metal (e.g., Zn metal in $\text{Zn(NO}_3)_2$ or Cu metal in CuSO_4)
 - iii. Observe the first *steady* potential from the meter. (The potential will change slowly, so record the first reading that seems like it is not noise from making the connection.)
 - iv. Repeat for a different metal/ion combination
5. Observe and record the potential difference for all the possible combinations of half-cells available in a well-constructed table.

Keys to good data:

Electrochemical Cells

Check the appearance of the metal strip before each measurement. If the strip appears dull you may need to sand it again before taking another measurement.

Make certain that the alligator clips are firmly attached to the metal strips so that there is a good electrical connection.

Make certain that the salt bridge makes contact with each solution.

Part B: Exploration on how cell potential changes with concentration

- Using clean test tubes, prepare a series of 1:10 dilutions of the stock solution of 1 M CuSO_4 as follows:
 - Prepare 10.0 mL of a 0.1 M solution of CuSO_4 from the 1 M stock.
 - Prepare 10.0 mL of a 0.01 M solution of CuSO_4 from the 0.1 M stock.
 - Prepare 10.0 mL of a 0.001 M solution of CuSO_4 from the 0.01 M stock.
- Measure the potential difference between the silver half-cell (1 M Ag^+) and a half-cell made from each of the different copper-ion concentrations. Connect the cell in such a way that you get a positive voltage reading. Record the measured potentials in a data table.

Clean up

Thoroughly rinse all metal strips with distilled water and dry the metal strips before returning them to the appropriate container.

Throw all your trash in the trash cans in lab.

Wipe down your lab bench when you are done.

Dispose of all solutions in the provided waste container.

Conclusions

1. What trend, if any, do you notice between cell potential and the metals used? (Periodic trend?)
2. What trend, if any, do you notice between the concentration and the cell potential?
3. What has a larger impact on the cell potential, the type of substance or the concentration of substance?