Worksheet: Batteries

Name: _____ Group name: _____

In this lab you will measure **voltage** (potential energy per electron, unit **V**) and **current** (number of electrons moving through a wire, unit **mA**). For measuring this, you will use an electronic device called a multimeter, which can measure a variety of electrical quantities. Set it to **V⎓** to measure voltage, and to **mA⎓** to measure current. Make sure you turn it **off** after you use it.

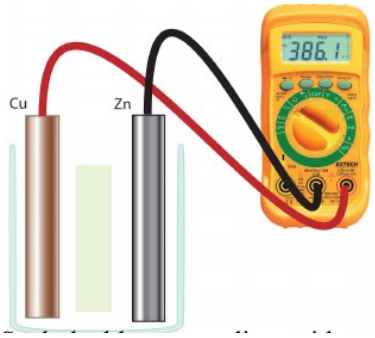
Since measurements are subject to random fluctuations due to a variety of factors you will find the voltage first fluctuating. Estimate the error from three measurements, taking the middle one as the value and the largest difference from the middle one as the error. A way to specify the error in a measurement compactly is to write *VALUE* ± *ERROR*, for example **3.4 ± 0.1 V** for a measurement of 3.4 V with an error of 0.1 V.

1. Make sure that both Cu, Zn bar, spacer and beaker are **clean and dry**. onnect one lead from the multimeter to the Cu bar, using an alligator-clip test lead. Connect the other to the Zn bar as shown. To make a good connection you can scratch the surface of the Cu and Zn with the alligator-clip test leads to get through the oxide layer on the surface.

   - Put the electrodes on top of each other and measure the voltage. Explain!

     Voltage: _____ ± _____ _____

2. Make a voltaic cell (battery): Use one copper (Cu) and one zinc (Zn) bar in a beaker separated by a plastic spacer. **Do not pour in any liquid yet**.



   - Measure the voltage of the dry electrodes:

     Voltage: _____ ± _____ _____

   - Get a stopwatch ready (use your phone). Add a small amount of soda (**less** than ¼ of the beaker). What happens to the voltage? How long does it take to stabilize to a new value?

     Stabilization time: _____ _____

- Once the voltage stabilizes, measure it:

  New Voltage: _____ ± _____ _____

  Volume of the liquid: _____ _____

- Roughly double the amount of coke in the beaker. Again, what happens to the voltage as you pour it in?

  Stabilization time: _____ _____

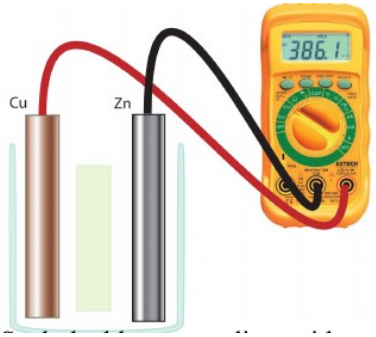
  New Voltage: _____ ± _____ _____

  Volume of the liquid: _____ _____

- Does the voltage significantly **increase**, **decrease**, stay about the **same**? (circle one). Explain your observation in terms of your understanding of the electrochemical cell:

- Which terminal is positive, copper or zinc? Why?

- (After you have done point 3, answer this:) Why does the voltage need some time to stabilize to a new value?



3. Leave the first beaker and electrodes as is. Carefully rinse and dry the second pair of electrodes as well as the second beaker. Create the same setup as before, but instead of coke, use a small amount (1 in high) of **de-ionized water**.

   - Measure the **current** (moving electrons) through the wire:

     Current: _____ ± _____ _____

   - Add a little bit of salt to the de-ionized water, but do not stir, and observe what happens to the current:

     Current: _____ _____ (you do not need to measure the error here)

   - Now stir with the straw and observe again:

     Current: _____ ± _____ _____

   - Explain the effect of salt in de-ionized water:

4. Pour out the water from the second beaker. Take half of the coke from the first beaker and pour it into the second beaker. You should have two identical cells now.

   - Measure the voltage in the second cell:

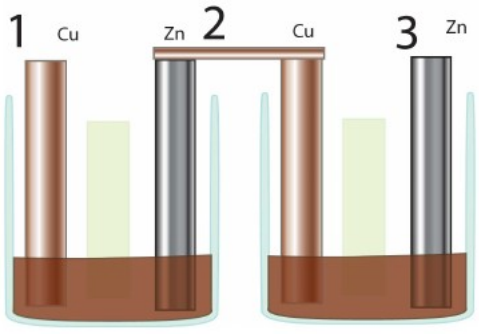
     Voltage: _____ ± _____ _____

   - Voltage of first cell (from question 1):

     Voltage: _____ ± _____ _____

   - Put the two cells in series by connecting the zinc electrode from the first cell to the copper electrode of the second cell.

     Voltage: _____ ± _____ _____



5. Connect your one and two cell batteries to the calculator. Use the alligator leads and mind the polarity (+ and -). Do you need **one** or **two** cells to run it?

6. **Bonus**: Replace the Zn electrode with Al (fold aluminum foil a few times to make it stiffer). What voltage do you observe? Why?

   Voltage: _____ ± _____ _____