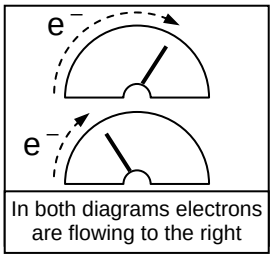
Making galvanic cells 17.5 (pg. 708 – 711)

Purpose:

Make a galvanic cell, investigate how it works, and compare the voltage produced by different cells

Procecure:

1. Your teacher will explain to you how to read a voltmeter.
2. Obtain a copper plate, a zinc plate, an aluminum plate and some paper towel. Clean each metal plate very well with steel wool. Rinse and dry.
3. Obtain three 250 mL beakers, a 400 mL beaker, a voltmeter, a "U-tube", four pieces of cotton wool (about half the size of your thumb), two wires (with one alligator clip per wire), and a pair of forceps. Clean the beakers. Label them with tape: $Zn(NO_3)_2$, $Cu(NO_3)_2$, and $Al(NO_3)_3$.
4. Into each beaker place about 125 mL of the appropriate solution (according to beaker labels).
5. Rest the U-tube in a 400 mL beaker so that the ends of the tube face up. Fill the tube all the way to the ends with KNO_3 solution. Plug both ends tightly with cotton wool. Ideally the cotton should be flush with the ends of the tube and there should be almost no air in the tube. Eventually the cotton will become wet with KNO_3. You have just made a "salt-bridge".
6. Stand the Cu plate in the $Cu(NO_3)_2$ solution, Al in $Al(NO_3)_3$ and Zn in $Zn(NO_3)_2$.
7. Clip one end of a wire to the Cu plate, plug the other end into the voltmeter. Similarly connect the Zn plate to the voltmeter. The voltmeter requires that positive and negative poles be correctly positioned. If you do not get a reading when the half-cells are connected, reverse the inputs. If the voltage still reads 0, record this as the voltage under "Voltage (no bridge)".
8. Remove the salt-bridge from its beaker. Invert it and remove any excess liquid from the ends by touching them to a paper towel. Push the half-cell beakers close together. Submerse one end of the salt-bridge into one half-cell and the other end into the other half-cell. Record the voltage. If you do not get a reading, reverse the inputs to the voltmeter. Record (in the table) which half-cell the needle points to. This is important because the needle indicates the direction that electrons are flowing. Remove the salt-bridge.



In both diagrams electrons are flowing to the right

9. Look at the plates. Notice that the surface that was submersed may look different. One plate has a deposit on it; the other has lost mass. You had the half-cells connected for only a short time. It takes longer to see clearly which has gained mass and which has lost mass. Inspect the plates on display and indicate in the data table which of your plates should have a deposit.
10. Place the salt bridge (with ends pointing up) into the 400 mL beaker. Carefully remove the cotton plugs with forceps (be careful not to push the cotton down into the U-tube). Dry off the ends of the U-tube. Fill it back up with KNO_3. Plug both ends tightly with new pieces of cotton.
11. Attach Al and Zn half-cells to the voltmeter. Record the voltage with and without a salt-bridge.
12. As before, remove the cotton from the U-tube and dry off the ends. Place cotton in the trash.
13. Return the solutions to their original containers. **Be very careful to put each solution back in its correct container**. If you are unsure, please get help. Rinse and return equipment.

	voltage (no bridge)	voltage (bridge)	voltmeter points to	deposit forms on
Cu – Zn				
Al – Zn				

Questions: (refer to 17.5) (remember that the voltmeter's needle points in the direction of e^- flow)

1. For the Cu – Zn cell draw and label the apparatus (draw Cu to the left, Zn to the right):
   For each half-cell Indicate a) the balanced half-reaction, b) whether the half-reaction is an oxidation or a reduction reaction, c) if the electrode is the anode or the cathode, d) whether the electrode is positive or negative. Also indicate i) in which direction each of the ions in the salt bridge is moving, ii) the direction of electron flow for the cell, iii) the overall cell reaction.
2. Repeat question 1 using the Zn – Al cell (draw Zn on the right)
3. Explain, in detail, what function the salt-bridge plays in a galvanic cell.
4. Do all galvanic cells produce the same voltage? Justify your answer.