Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **Battery Simulation**

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Background Information: When redox reactions take place there is a **transfer of electrons**. If the two reacting substances are separated, the electrons can travel through a wire to create electric power. To maintain cell charges, a **salt bridge** is also required. This setup is known as a **battery**, or **voltaic cell**.

Guiding Question: How do the movement of particles such as anions, cations, and electrons produce changes in a voltaic cell observed at the macroscopic level?

Materials: 8- 2e- bingo chips, 3 Na+ bingo chips, 19 Cl- bingo chips, 8 Zn/Zn+2 foam chips, Cu/Cu+2 foam chips.

Pre-Lab Questions:

1. According to Table J, which element is more easily oxidized: zinc or copper?
2. Write the oxidation half reaction for the reaction between zinc and copper.
3. Write the reduction half reaction for the reaction between zinc and copper.
4. Write the overall reaction for the reaction between zinc and copper.

**Part A:** Building a Voltaic Cell: Using the template on page 5, and the materials provided, set up your initial battery conditions:

* + Place 4 chips labeled Zn(s) on the Zn electrode. Place a chip labeled 2e- over each Zn(s).
  + Place 4 chips labeled Cu(s) on the Cu electrode. Place a chip labeled 2e- over each Cu(s).
  + Place 4 chips labeled Zn+2 in the solution of half cell 1.
  + Place 4 chips labeled Cu+2 in the solution of half cell 2.
  + Place 3 chips labeled Na+ and 3 chips labeled Cl- in the salt bridge.
  + Place 8 chips labeled Cl- in the solution of half cell 1.
  + Place 8 chips labeled Cl- in the solution of half cell 2.
  + For simplicity, water is not represented in the model, but should be in each half cell and the salt bridge to allow ions to flow. Additionally, the relative sizes and amount of the atoms, electrons, and ions are inaccurate but scaled down for modeling purposes.

1. What do the 2e- chips represent for the Zinc and Copper atoms?
2. If each *colored* chip counts as one, record the mass of the:
   1. Zinc electrode:
   2. Copper electrode:
   3. Overall mass (consider that the mass of electrons are negligible) of the whole battery:
3. What is the overall charge of:
   1. Half Cell 1:
   2. Half Cell 2:
4. Have your instructor check your setup and answers above before proceeding.
5. Draw a representation of this set up on page 4, initial. Provide a key.

**Part B:** The Voltaic Cell in Use: Using your voltaic cell set up, perform the following steps:

* Allow **one** zinc atom to undergo oxidation and remove its 2e-. When the 2e- are lost, the Zn atom will turn into a Zn+2 ion, so flip the chip over to reveal the new symbol and let it “dissolve” into the half cell 1 solution.
* Move the **2 electrons** through the wire (remember they are super tiny and can travel through the wire made out of conductive metal) and allow them to build up on the Copper electrode.
* **One** copper ion in the half cell 2 solution will attract to the new electrons and reduce, gaining those electrons. Take one Cu+2 ion, flip it to reveal the Cu(s) and place the 2e- chip on top to create the Cu atom.

1. What is the difference between an atom and an ion?
2. Where are all the atoms, on the electrode or in the solutions of the half cells?
3. What is the new mass of the:
   1. Zinc electrode:
   2. Cu electrode:
   3. Overall mass of the whole battery:
4. Should the overall mass of the cell change since Part A? Why or why not?
5. Why are Cu+2 ions attracted to electrons?
6. What is the overall charge of:
   1. Half Cell 1:
   2. Half Cell 2:
7. To neutralize the half cells, additional Na+ and Cl- ions need to travel from the salt bridge into the half-cell solutions. To which half-cell do each of the ions travel to restore neutrality? Move Na+ and Cl- ions to their correct half-cell solutions.
8. The cathode is where reduction takes place and oxidation takes place at the anode. Which electrode is the anode in your cell?
9. Have your instructor check your setup and answers above before proceeding.
10. Using your key, draw a representation of this new cell on page 4. Include labels of the anode and cathode and show the direction of electron, cation, and anion flow.
11. Explain in terms of atoms and ions:
    1. Why the anode loses mass:
    2. Why the cathode gains mass:
    3. Why the overall mass is conserved:

Initial:

Final:



