### University of Arizona

# Materials Science and Engineering

## MSE 110: Solid State Chemistry

##### Measurement of the electromotive force of an electrochemical cell

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#### Measurement of the electromotive force of an electrochemical cell

**Introduction**

The transfer of electrons is called electrochemistry, with the most basic concept of electrochemistry being a car battery, where there are two metal nodes, and two separate reactions happen. A redox reaction (reduction-oxidation) involves one node losing electrons (oxidation) and another node gaining electrons (reduction). Through this understanding, we are able to calculate the standard reduction potential by using a voltage reader and knowledge of the two nodes and their reduction potentials. The experiment aims to solve this by creating simple set up for an explanation as to how electrons are transferred from one node to another, and to calculate their respective reduction potentials.

###### Experimental Procedure

Materials:

* 3 beakers
* 3 electrodes – zinc (Zn), tin (Sn), copper (Cu)
* CuSO4, ZnSO4, SnCl2 powders to prepare the Cu2+, Zn2+, Sn2+ ionic solutions
* KCl salt bridge to complete the circuit.
* Multimeter
* Two wires to connect the electrodes to multimeter
* Spatula for weighing powders.

Procedure:

1. Label the beakers with the names of the metals. Weigh 0.01 mol of CuSO4 in one, ZnSO4 in the second, and SnCl2 in the last. Account for some chemicals being hydrated or anhydrous. Molar weight of each compound is indicated on their respective containers as M.W. Record the values. Clean the spatula between each measurement to avoid contamination.
2. Clean up balance area. Do not leave any reactant powder on or around balance as it could corrode it.
3. Complete each beaker with DI water up to the 100 mL level.
4. Stir the solutions until all of the powder is dissolved. Thus, a 0.1 mol/L solution of each ion has been prepped.
5. Brush the electrodes with the sandpaper to remove oxidation and contaminants.
6. Connect the electrodes to the multimeter and immerse them into their respective solutions. The copper electrode must be in the Cu2+, the zinc in the Zn2+, and so on.
7. Turn on the multimeter and set it to measure the voltage.
8. Place a salt bridge across the two solutions. It will close the circuit by allowing charge to move from one beaker to the other, carried by the sulfate ions.
9. Record the voltage shown on the multimeter. Make sure to write down which end (positive or negative) of the voltmeter was connected to which electrode. This indicates which species receives electrons (is reduced/Red) and which beaker is giving away electrons (is being oxidized/Ox)
10. Perform readings for the Cu/Zn, Cu/Sn, and Sn/Zn cells. Rinse the salt bridge between each measurement.
11. When finished, pour the solutions into their respective waste buckets, do not pour any of the solutions down the sink.

###### Experimental Results

|  |  |  |  |
| --- | --- | --- | --- |
|  | Cu/Zn | Sn/Zn | Cu/Sn |
| EMF (V) | 1.099 | 0.612 | 0.489 |

EMF (V) of Zinc-Tin:

|  |  |  |  |
| --- | --- | --- | --- |
| Compound | Copper Sulfate | Zinc Sulfate | Tin Chloride |
| Molar Mass (grams) | 1.59609 | 1.6147 | 1.896 |
| Standard Reduction Potential (Values found) | Copper: 0.34 V | Zinc: -0.759 V | Tin: -0.149 V |
| Published Half Reactions | Copper: 0.3419 V | Zinc: -0.7618 V | Tin: -0.14 V |
| Percent Error | 0.0056% | 0.0037% | 0.0643% |

###### Discussion and Conclusions

Based on the percent error calculated, we can see that the values that we have obtained are very close to the actual published values. This indicates that our data is relatively good and almost error free. To minimize this error or other potential errors in the future, we could use a more accurate scale to weigh out the powder used, use a pipette or some form of liquid transfer to ensure that the amount of water we are placing in the beaker is exact and won’t dilute the solution, or we could wash the bridge with deionized water, placing it in a larger water bath to ensure that there is no mixing of solutions.

Works Cited

MSE 110 Lab Manual: Lab8 Measurement of the electromotive force of an electrochemical cell