DETERMINING THE CHARGE OF A SOLITARY ELECTRON

2019.2020 AP Chemistry Lab · 100 POINTS

Introduction:

In this investigation, you will monitor a special type of redox reaction, called an **electroplating reaction**. An electric current will drive this reaction between two copper strips and a solution of Cu^{2+} ions.

Purpose: 5 points

What you will do *and* how you will do it.

Pre-lab Questions: 44 Points

1. Perform an E°cell calculation, based on the ½ reactions occurring at each electrode. Show all work. (4 pts)
2. Compare and contrast an *electrolytic cell* versus a *galvanic* or *voltaic cell*. Be sure to include labelled diagrams that feature the loss/gain of mass and the flow of electrons. (10 pts)
3. What does the E°cell calculation tell you about the spontaneity of the reaction? What is the purpose of the power supply? Is this reaction galvanic or electrolytic? (6 pts)
4. Describe the process that occurs at the CATHODE. What is the cathode reaction? Is it reduction or oxidation? What happens to the mass of the cathode during the course of the experiment? Why? (4 pts)
5. Describe the process that occurs at the ANODE. What is the anode reaction? Is it reduction or oxidation? What happens to the mass of the anode during the course of the experiment? Why? (4 pts)
6. 1 amp·second (one amp flowing for one second) is considered 1 coulomb of charge. The actual charge of 1 mole of electrons is called 1 Faraday, which is equal to 96,500 Coulombs. Using this constant, complete the following calculation. How much nickel (in grams) would have plated onto the electrode if you allowed the electroplating experiment to go for 90.0 minutes at a current of 1.33 amps. $Ni^{2+} + 2e' \rightarrow Ni(s)$(6 pts)
7. If you were to try this experiment using a different metal for the electrodes, but the same electrolytic solution (Cu^{2+}), predict whether or not you would find similar values for the charge on the electron. Explain. (6 pts)
8. In reference to the lab you are about to do, how do you think the number of copper ions in solution at the start of the reaction compare to the number at the end? Explain your reasoning. (4 pts)

Safety Data Table/Physical Properties: 10 points

Procedure: 10 points

1. Obtain two copper strips to use as electrodes. If not already marked, scratch each electrode as (+) or (-) so you know which one is the cathode and which one is the anode. Clean each strip by scrubbing them thoroughly with steel wool until they are very shiny. Be careful with the metallic dust! It can be very dangerous if you get it in your eye. Clean your lab bench with a wet soapy sponge before moving to the next step.
2. In the Fume Hood, dip the copper strips briefly into dilute nitric acid. This should take about 30 seconds. Wash the nitric acid off of the electrodes with distilled water. In the Fume Hood, rinse the strips with acetone and then dry them with a paper towel. DO NOT TOUCH THE SURFACE ON WHICH THE COPPER WILL BE PLATED because fingerprints and dirt interfere with good results.
3. Weigh each clean, dry electrode and record in your Data Table.

4. Bend your copper strips over the edge of your 250 mL beaker so they cannot touch each other. Pour 150 mL of acidified copper(II)sulfate solution into the beaker.
5. Contact your instructor so he/she can hook up a *reference cell* to your power supply. This will allow the power supply to have the correct setting before any electrons flow through *your* cell.
6. Using alligator clips, securely clamp the electrodes to opposite sides of the 250mL beaker. BE SURE THAT THE ELECTRODES DO NOT TOUCH! Make sure your power source is off. Connect the negative electrode to the negative terminal of the power source. Likewise, connect the positive electrode to the positive terminal of the power source.
7. Find a nice starting point on the wall clock (like the 12 or the 6). Turn your power source on. Adjust the current if necessary so that it does not fluctuate. Make sure the power source is reading in amps.
8. Record the current indicated by the ammeter on the power source. Take a reading at the beginning of each minute for 20-25 minutes. Your current readings need to be as unchanging as possible. If you see considerable variance, you may adjust the amperes. Don't make any adjustments until the end of a 1-minute interval. Remember, in theory, you will need to quantify each individual second of your entire experiment!
9. After at least 20 minutes, you can end your experiment. Turn off the power. *Carefully* disconnect the electrodes. Re-Wash the electrodes carefully with distilled water and acetone and allow them to air dry.
10. Carefully, reweigh both electrodes. Record these masses in your Data Table.
11. Clean up your electrodes and solutions as instructed by your instructor.

Observations: 5 points

Data Table: 6 points

Calculations: 8 points
Make sure you calculate the charge of an electron two times. Once for each electrode.

Conclusion: 2 points

Error Analysis: 10 points
The actual charge of an electron is 1.60×10^{-19} coulombs/one electron.
Calculate a percent error for the value your obtained at each electrode.
Do you think both of your electrodes provide equally valid data?
Which electrode will you focus on for this error analysis?