615-4620 (10-012) Copper Voltameter

Parts List:

The apparatus consists of three copper plates suspended in a plastic jar from a cover with binding posts. The center plate acts as the cathode, while the two other plates act as the anode.

Warranty and Parts:

We replace all defective or missing parts free of charge. Additional replacement parts may be ordered toll-free. We accept MasterCard, Visa, checks and School P.O.s. All products warranted to be free from defect for 90 days. Does not apply to accident, misuse or normal wear and tear. Intended for children 13 years of age and up. This item is not a toy. It may contain small parts that can be choking hazards. Adult supervision is required.

How to Teach with Copper Voltameter:

Concepts Taught: Faraday's Law; Electrolysis; Ionization; Cations; Anions
Curriculum Fit: Electricity; Electrical Conductivity
Grades 9 and up.

Additional Materials Needed:

- Top loading balance
- 6 Volt battery
- Ammeter
- Stop watch or clock
- Rheostat
- Wash bottle filled with distilled water
- 1 M Copper sulfate ($CuSO_4$)
- Isopropyl alcohol $(CH_3)_2CHOH$
- Concentrated Sulfuric acid (H_2SO_4)
- Kimwipes
- (2) 1,000 mL beaker
- Funnel
- 100 mL volumetric flask
- Stir bar
- Weighing dish
- Powder-free latex gloves

Note: Always dispose of chemicals and solutions in a manner approved by your chemistry department in accordance with the Material Safety Data Sheet for the particular chemical.

Theory:

What is a faraday? It can be defined as: *the quantity of electricity necessary to deposit a gram equivalent of an ion.*
What is electrolysis? It can be defined as: *a process in which electrical energy is used to bring about a chemical change.*
What is a voltameter? It can be defined as: *a scientific instrument for measuring quantity of electricity.*
What is an ion? It can be defined as: *an electrically charged particle of atomic or molecular magnitude.*

Many aqueous solutions of acids, bases and salts are good conductors of electricity and varied chemical reactions occur when electrodes are suspended in these solutions and a voltage is applied, thus depositing metal ions on the plates. Copper sulfate ionizes in solution according to the following equation:

$$CuSO_4 \leftrightarrow Cu^{2+} + SO_4^{2-}$$

When a potential difference exists, atoms of copper are removed from the anode and go into solution as copper ions (Cu^{2+}). Two electrons are given up by the copper in changing from an atom of copper into a copper ion. These two electrons move toward the anode (positive terminal) of the battery or power source. Electrons move from the negative terminal of the battery or power source. For every copper atom that comes from the anode and goes into the solution as a copper ion, a copper ion leaves the solution and is deposited as a copper atom on the cathode.

Experiment: Application of Faraday's Laws to Electrolysis of Copper

Kit Components Needed:
Additional Items Needed:

Procedure:

1. Prepare a 1 M $CuSO_4$ solution as follows:
    a. Weigh 25 g of $CuSO_4$ in a weighing dish on an analytical balance.
    b. Using a funnel transfer the $CuSO_4$ to a 100 mL volumetric flask containing a stir bar and add distilled water to begin the dissolution. You may need to use a laboratory sonicator in order to break up the particles to get them to dissolve more quickly. Add distilled water to the flask up to the meniscus and cap. Invert to mix thoroughly.
    c. Add about 1 mL of concentrated sulfuric acid (H_2SO_4) to the flask.
    d. Set the solution aside.
2. Remove the center copper electrode by unscrewing it from the top. Handle it with care.
3. Rinse the electrode from step 2 using the wash bottle filled with distilled water over an empty 1,000 mL beaker. Wipe dry with a lint free cloth or Kimwipe®.
4. Dip the electrode in a beaker full of isopropyl alcohol and wipe dry using a lint free cloth or Kimwipe®.
5. Prepare the top loading balance to weigh the copper electrode. Using a sufficiently large weighing dish to hold the electrode, tare the dish and then obtain the weight of the copper electrode and record below.

Copper electrode mass = _____ (g)

6. Fill the plastic jar with the $CuSO_4$ solution prepared in step 1. Ensure that all the copper electrodes are parallel to one another. Make sure that the $CuSO_4$ is at a level where the copper electrodes will be covered when submerged. Place the cover with the copper electrodes suspended in the liquid. Only place the electrodes in the solution a few minutes before the current is applied because the copper is soluble in the electrolyte.
7. Remove the two screws (not attached to the three copper electrodes).
8. Connect in series a 6 V battery, ammeter and rheostat to the exposed terminals.
9. Adjust the rheostat so that a suitable current is obtained. If the current density is too large, you'll observe a flaking off of the copper deposit on the center cathode.
10. At this point, remove the gain plate and clean it using steps 2-5, including reweighing it and recording the value below. If necessary, lightly scrape off any loosely adhering granules of metal with very fine grade sandpaper.

Initial Copper electrode mass (M_1) = _____ (g)

11. Reassemble the apparatus using steps 6 – 8.
12. Have one student note the time and record it below.

Start time = _____

13. Start the current. One student should watch the ammeter and adjust the resistance to keep the current constant.
14. Allow the current to flow for about 20 minutes. Record the stop time below.

Stop time = _____

15. Stop the current flow and using powder free latex gloves, remove the center cathode (gain plate).
16. Weigh the gain plate and compute the gain in weight.

Final Copper electrode mass (M_2) = _____ (g)

Related Products:

Science First® *manufactures many low-cost items that can be ordered from most science education distributors. For more information, please contact us.*

665-0215 Copper Plating Set - This is a perfect kit for demonstrating the technique used for copper plating. Kit includes: Glass Battery Jar, Copper Anode, 2 Brass Connecting Posts, 2 Wire Connectors with Alligator Clips, 500g Copper Sulfate, MSDS, & Paper Clips.

665-0300 Complete Voltaic Cell Kit - This safe, sturdy kit can build a voltaic, storage, coulometer, dry, or Daniel cell. Includes: opaque polypropylene 8-oz cell body with a low profile and wide base to resist spills; porous cup for solution separation; instructions; 8 labeled electrodes (2 each, copper, zinc; 1 each, aluminum, carbon, iron, nickel). Screw-on plastic rim has 2 brass electrode holders which adjust to hold round or flat electrodes. Wt: 34 g. Box: 4.25 x 4.25 x 5".

Sorry, we do not include acids. Lead electrodes may be purchased separately.

665-0200 Voltaic Cell Kits - Build your own chemical cells by adding 8 oz. mason jar and acids. We include screw-on plastic ring; electrode brackets and hardware, 2 clip leads, instructions, electrodes. *Good for Science Fairs.*