665-0215 (10-200) Copper Plating Set

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.

Purpose: Demonstrating the copper plating of metal objects.

How to Teach with Copper Plating Set:

Concepts Taught: Ionization; Cations; Anions
Curriculum Fit: Electricity; Electrical Conductivity
Grades 9 and up.

Additional Materials Needed:

- 6 V Battery
- Rheostat
- Single-pole, single-throw knife switch
- Connecting leads
- DC ammeter
- DC voltmeter
- Laboratory scoop
- Glass stirring rod
- Distilled water
- 1,000 mL beaker
- Wash bottle
- Top loading balance
- Powder-free latex gloves
- Goggles or safety glasses
- Weighing dish

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 an ion? *It can be defined as: an electrically charged particle of atomic or molecular magnitude.*

What is solute? *It can be defined as: dissolved particles in solution.*

What is a solvent? *It can be defined as: the dissolving medium in a solution.*

What is a saturated solution? *It can be defined as: a solution that contains the maximum amount of solute for a given amount of solvent at constant temperature and pressure.*

Copper sulfate ionizes in solution according to the following equation:

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

At a potential difference of 6 V or less, atoms of copper are removed from the anode and go into solution as copper ions. Two electrons are given up by the copper in changing from an atom of copper to a copper ion. The two electrons move toward the anode (positive terminal) of the battery. Electrons move through the switch from the negative terminal of the battery.

The magnitude of the current to the cathode (negative terminal) is controlled by the resistance of the rheostat and by varying the voltage. Since the cathode is negatively charged, there is a surplus of electrons which means that copper ions free in solution are attracted to the cathode. According to the equation below, the copper ions acquire two electrons from the cathode and become copper atoms. The atoms adhere to the cathode.

$$Cu^{2+} + 2e^- \_ Cu$$

In equilibrium for every copper atom that comes from the anode and goes into solution as a copper ion, a copper ion leaves the solution and is deposited as a copper atom on the cathode.

Experiment:

Procedure:

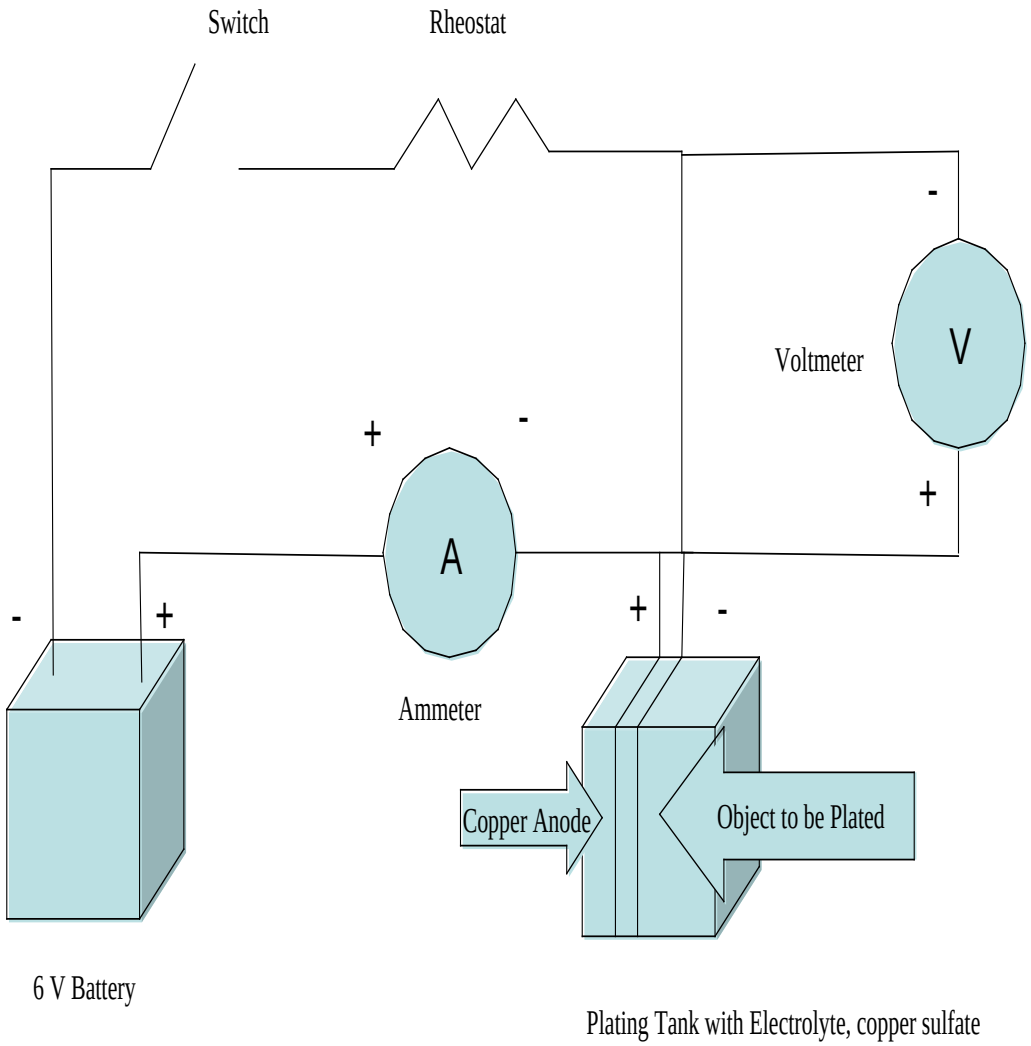
1. Prepare a saturated CuSO4 solution as follows:
   a. Fill the 2 liter battery jar with about 100 mL of distilled water.
   b. Use the laboratory scoop to add a sufficient amount of CuSO4 to the water and begin to stir the solution with the glass stirring rod. You will need to use the stirring rod to break up the crystals to get them to dissolve more quickly.
   c. Continue to add distilled water and CuSO4 to the water. Keep stirring until no more CuSO4 will dissolve. *Note: At room temperature, 24 g of CuSO4 dissolve in 100 mL of water to make a saturated solution. By extrapolation, it should take about 480 g of CuSO4 per 2,000 mL to make a saturated solution.*

d. Set this solution aside.

2. To ensure that the solution does not contain any other metallic ions which will interfere with the electroplating process, rinse the electrode using the wash bottle filled with distilled water over an empty 1,000 mL beaker. Wipe dry with a lint free cloth or Kimwipe®.
3. Dip the electrode in a beaker full of isopropyl alcohol and wipe dry using a lint free cloth or Kimwipe®.
4. 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.

Initial copper electrode mass (M1) = _____ (g)

5. Arrange the apparatus as shown in Figure 1 on page 4.
6. Attach the positive terminal of a storage battery or a power source to the rod from which the copper anode is hanging.



7. Hang the paper clip chain from the other rod, which is connected to the negative terminal of the storage terminal of the battery.
8. Close the switch and allow the electroplating process to continue for about ten minutes. A current of two to three amperes should be adequate.
9. After ten minutes, you should see copper building up on the cathode.
10. Open the knife switch to break the circuit.
11. Final copper electrode mass (M2) = (g)

Note: The loss in weight of the anode equals the gain in weight of the cathode (i.e., paper clips).

12. To determine the mass of copper used to plate the cathode use the following equation:

Mass of Copper = M1 – M2 = (g)

13. When you are done performing the experiment, dispose of the copper sulfate solution in a manner approved by your chemistry department. Rinse all the parts of the apparatus with distilled water.

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