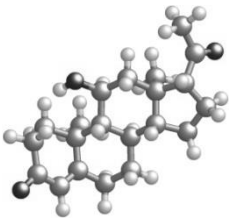

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Chemistry SPA Skill 3 – Planning an Experiment

To Investigate How the Mass of Copper Deposited at the Cathode During the Electrolysis of Aqueous Copper(II) Sulfate Varies with the Current that Flows Through the Circuit – Answer

a) Hypothesis

The *mass* (NOT *amount*) of copper deposited at the cathode during the electrolysis of aqueous copper(II) sulfate is directly proportional to the *current* (NOT *amount of charge*) that flows through the circuit.

b) Variables

- Independent variable (*input variable* – what you modify):

  Current, in amps, that flows through the circuit.

- Dependent variable (*output variable* – what you measure):

  Mass of copper, in grams, deposited at the cathode.

- Constant (variables that must remain the same for all experiments):

  Time.

  Concentration of copper(II) sulfate used.

  Volume of copper(II) sulfate used.

  Temperature of the experiment.

  Size / surface area of the copper anode and copper cathode.

If in any doubt about what an independent and dependent variables are, then just clearly state what will be *changed*, what will be *measured* and what will *remain constant* during the experiments.

c) Brief Outline of the Experiment

A known volume of copper(II) sulfate, of known concentration, will be electrolysed using a copper anode and copper cathode. The copper cathode will be weighed at the start and at the end of the experiment to determine its change in mass. The experiment will be performed five times using a different current, while all other variables (time, concentration and volume of copper(II) sulfate) are kept constant. The results will be presented by plotting a graph of mass of copper deposited against current. The greater the current used, the greater the mass of copper deposited at the cathode.

d) **Apparatus and Reagents**

Copper(II) sulfate solution of concentration 1.0 mol/dm^3

Strips of copper metal

Distilled water

250 cm^3 Beaker

100 cm^3 Measuring cylinder

Ammeter

Power supply

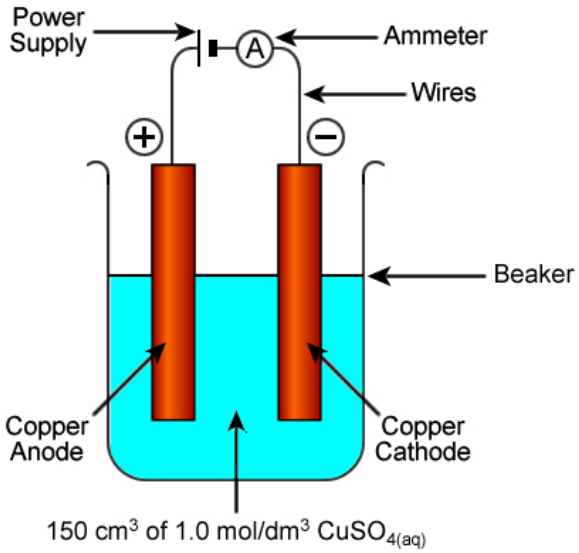
Wires and crocodile clips

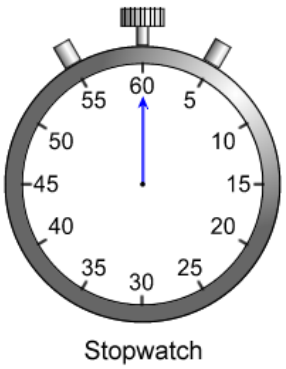
Weighing machine

Stopwatch

Tissue paper

e) **Diagram**





Note: It is possible to use a graphite cathode for this experiment, but a copper anode should be used to ensure that the concentration of copper(II) ions in solution remains constant.

f) Step-by-step Method

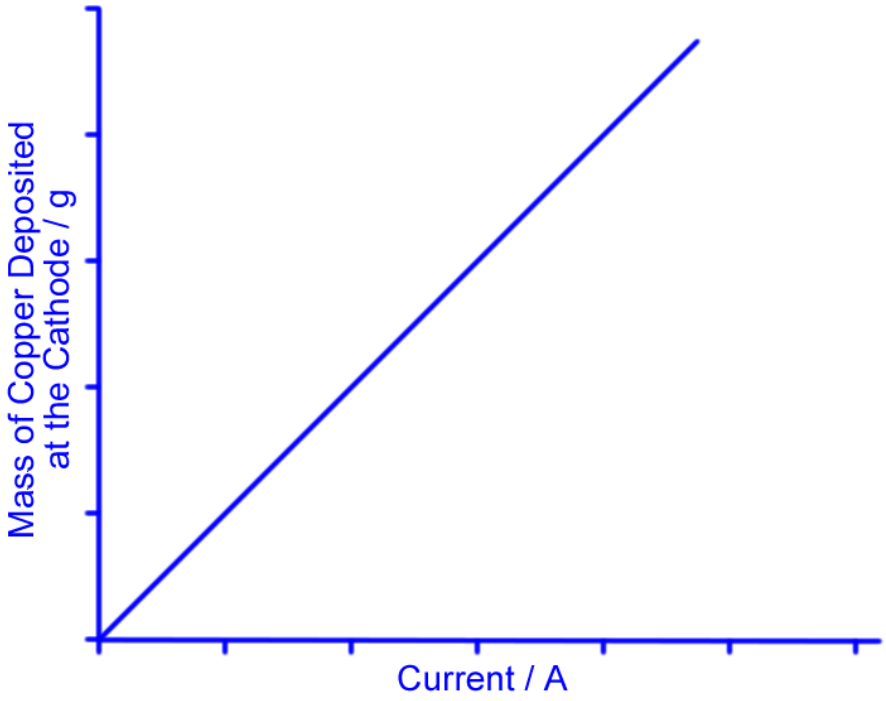
1. Using a 100 cm^3 measuring cylinder, measure 150 cm^3 of 1.0 mol/dm^3 copper(II) sulfate solution into a 250 cm^3 beaker. (Reasonable concentrations and volumes are stated. The glassware used to make measurements is stated).
2. Using a weighing machine, measure the mass of the strip of copper metal that will be used as the cathode. Record the data in the results table. (Essential measurements are clearly stated).
3. Using the wires and crocodile clips, connect the cathode to the ammeter, the ammeter to the power supply and the power supply to the anode.
4. Place the electrodes into the solution of copper(II) sulfate. Ensure that the electrodes are not in contact with each other.
5. Turn on the power supply and immediately start the stopwatch. (Stopwatch is started at the same time as the experiment).
6. Adjust the current to 0.1 A. (Reasonable current is stated)
7. Allow the electrolysis to proceed for 10 minutes (Reasonable time is stated).
8. After 10 minutes, turn off the power supply.
9. Dry the copper cathode with tissue paper, taking care not to remove any of the copper that has been deposited on it. OR Wash the copper cathode with distilled water and leave it to dry.
10. Using a weighing machine, reweigh the cathode. Record the data in the results table. (Essential measurements are clearly stated).
11. Repeat the experiment four more times, using currents of 0.2, 0.3, 0.4 and 0.5 A. For each experiment, use a fresh 150 cm^3 solution of 1.0 mol/dm^3 copper(II) sulfate, and new copper electrodes. Ensure that the experiment runs for exactly 10 minutes each time. (The experiment is repeated using different currents, all other variables are kept constant).

g) Results and Manipulation of the Results

Current / A	Mass of Copper Cathode at Start of Electrolysis / g	Mass of Copper Cathode at End of Electrolysis / g	Mass of Copper Deposited on Cathode during Electrolysis / g
0.1	A	B	B – A
0.2	C	D	D – C
0.3	E	F	F – E
0.4	G	H	H – G
0.5	I	J	J – I

The results are plotted on a graph showing the mass of copper deposited at the cathode in grams against the current that flowed through the circuit in amps. The graph would show that the mass of copper deposited at the cathode is directly proportional to the current that flowed through the circuit.

Graph: Mass of Copper Deposited at the Cathode / g Against Current / A
During the Electrolysis of Aqueous Copper(II) Sulfate



h) Source of Error

- Adjusting the current to the desired value during the first few seconds of the experiment may affect the mass of copper deposited at the cathode. If the initial current is too high, then the mass of copper deposited at the cathode will be greater than expected. If the initial current is too low, then the mass of copper deposited at the cathode will be less than expected.
- Some of the copper deposited at the cathode may break away from the surface of the cathode and fall to the bottom of the beaker. This will reduce the mass of copper deposited at the cathode that is recorded in the experiment.

- When drying the cathode with tissue paper, some copper may be removed from the surface of the electrode. This will reduce the mass of copper deposited at the cathode that is recorded in the experiment.

- When washing the copper cathode with distilled water, some copper may be removed from the surface of the electrode. This will reduce the mass of copper deposited at the cathode that is recorded in the experiment.