**Part 3. Electrolysis.**

Electrolysis is the process of applying a current to a chemical system to cause a particular redox reaction to occur that would not normally occur spontaneously.

Some variables that affect electrolysis systems include (a) the type of metal–metal ion involved, (b) the amount of current used to cause the electrolysis, and (c) the amount of time the electrolysis process is allowed to proceed.

You will study only the electrolysis of a copper system. There are six combinations of currents and times you will use. Divide your class so that all these combinations are used and so that there is also appropriate replication.

<table>
<thead>
<tr>
<th>Total Coulombs</th>
<th>Time (seconds)</th>
<th>Current (amps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>180</td>
<td>600</td>
<td>0.30</td>
</tr>
<tr>
<td>180</td>
<td>1200</td>
<td>0.15</td>
</tr>
<tr>
<td>360</td>
<td>600</td>
<td>0.60</td>
</tr>
<tr>
<td>360</td>
<td>1200</td>
<td>0.30</td>
</tr>
<tr>
<td>720</td>
<td>600</td>
<td>1.20</td>
</tr>
<tr>
<td>720</td>
<td>1200</td>
<td>0.60</td>
</tr>
</tbody>
</table>

**Procedure**

Clean and rinse a plating tank with distilled water. Add 1.0 M copper (II) sulfate to the plating tank leaving about 0.5 cm of clearance at the top of the plating tank (Figure 12-5).

Attach your clean pre-massed stainless electrode and a pre-massed copper electrode (from the reagent bench) to the underside of the plating tank lid. The electrodes should be parallel and about 1.0 centimeter apart as shown in Figure 12-5.

![Figure 12-5. Plating tank filled with 1.0 M copper (II) sulfate solution (left). Copper and stainless steel electrodes connected to underside of plating tank lid. The electrodes are one centimeter apart and parallel to each other (cannot touch).](image)

You will attach the DC power supply so that the positive terminal is connected to the copper electrode. The negative terminal is connected to the ammeter and then to the stainless steel electrode in series. Figures 12-6a and 12-6b illustrate how to make these connections for two different ammeters.

Clean the stainless steel electrode by placing it in hot nitric acid for five minutes. Use tongs to avoid getting acid on your skin. Remove the electrode and dip it in the tub of rinse water found near the nitric acid. Rinse the electrode again with distilled water, then dip it in the beaker of acetone at the reagent bench. Place the rinsed electrode on a clean paper towel to dry. Handle the cleaned electrode with a paper towel to keep the electrode clean. Touching with your gloves may leave a residue. When the electrode is dry, find its mass to the nearest milligram.
Figure 12-6. Wire placement when the multimeters (a) and (b) are used as an ammeter during electroplating.

For meter (b), turn the dial of the ammeter to “A,” press the yellow button on meter (b) once to turn it on and another time to select DC. Your instructor will mention any other specific instructions with regard to either meter.

Have a stopwatch ready. One partner should turn on the power supply and set it to about 1 volt and the other partner should start the stopwatch when the power supply is turned on. Quickly adjust the voltage to obtain the target current. Allow the current to run for the assigned time. Take current readings every minute and determine an average current to use in calculations (to account for instrument “noise”).

Figure 12-7. Close-up of ammeters (a) and (b).
When you are finished plating based on your assigned time, turn off the power supply. Have a 400 mL beaker filled with distilled water ready. Remove the stainless electrode CAREFULLY and dip it into the distilled water and then into the acetone. Very gently, dry the electrode on a paper towel and find its mass.

**Analysis**

1. What is the definition of an amp?

2. Write the equations for the oxidation and reduction systems in your cell, How many moles of electrons are transferred?

3. What is the molar mass of the metal you are using?

4. What is the relationship between the amount of current that is used and the change in mass of the stainless steel electrode? Explain. Does the mass increase or decrease, and why?

5. What is the relationship between the amount of time your experiment ran and the change in mass of the stainless steel electrode? Explain.

6. How does varying the current or time affect your results?

7. How can you relate the change in mass, average current, and time to Faraday’s constant?

**Calculations**

Let’s consider some points related to your calculations.

1. What is the charge in coulombs for one *electron*?

2. What is the charge in coulombs for one *mole* of electrons?

**The SWH Format for Your Laboratory Report**

Make sure to present your work in the SWH format for your lab report including beginning questions; safety; tests and procedure; data, observations, graphs, balanced equations, and calculations; claims; evidence and analysis; and reading and reflection. For details about the complete SWH report format, please see pp. 27–28. After completing your report, please answer any post-laboratory question(s).

**Post-Laboratory Questions**

1. Suppose that you planned to gold-plate a medallion using a 0.500 M solution of Au(NO₃)₃ using a current of 0.50 amps over a period of 3 hours.
   
   a. How many grams of gold would plate on the metal used for the medallion? Explain what you are thinking as you show your calculations.

   b. How much 0.500 M Au(NO₃)₃ solution would you need to prepare to accomplish this?

   c. If the price of the base metal is negligible, and the price of gold is $1791.05/oz. (as of the date of this publication), what is the value of the medallion?