Investigation 13.C: Electroplating Answer Key

Answers to Prediction Questions

A prediction made using Faraday's law involves a theoretical calculation, which does not take into account the experimental conditions, variations in materials used, and expertise of the experimenter. Therefore, you should have predicted that the mass of the copper plated onto the cathode would be less than predicted using Faraday's law.

Answers to Analysis Questions

1. The half-reaction occurring at the cathode (reduction of copper) is:
$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

2. You should use your measured results to calculate quantity of electricity, as done in the Sample Problem on p. 515 of the textbook. Assuming a current of 1.00 A and 1200 s:

$$\text{Quantity of electricity} = 1.00\ \text{A} \times 1200\ \text{s}$$
$$= 1.2 \times 10^3\ \text{C}$$

3.
$$\text{Amount of electrons} = 1200\ \cancel{\text{C}} \times \frac{1\ \text{mol e}^-}{96\,500\ \cancel{\text{C}}}$$
$$= 0.0124\ \text{mol e}^-$$

The half-reaction is: $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

$$\text{Amount of copper formed} = 0.0124\ \text{mol e}^- \times \frac{1\ \text{mol Cu}}{2\ \text{mol e}^-}$$
$$= 0.0062\ \text{mol Cu(s)}$$

$$\text{Mass of copper formed} = 0.0062\ \cancel{\text{mol}}\ \text{Cu} \times 63.6 \frac{\text{g}}{\cancel{\text{mol}}}\text{Cu}$$
$$= 0.40\ \text{g Cu(s)}$$

4. Assuming no trivial errors, the differences between the calculated mass and the actual mass will likely be the result of improper drying or differences in the actual current flow (quantity of electrons) moving through the circuit.

Answers to Conclusion Question

5. Typically the mass of the copper electroplated onto the cathode will be less than predicted, assuming you have completely dried the anode. The answer for the second part of this question will be based on your predictions at the start of the investigation.

Answers to Applications Questions

6. Assuming that the iron(II) ions will plate out in the reaction, compare the mass of iron that should theoretically plate out to the mass of the copper plated out. In this case, since the mass of 1 mol of iron is less than that of 1 mol of copper, and since the number of moles of electrons required per mole of iron(II) ions is the same as required for copper(II) ions, the total mass of iron plated out should be less than the mass of copper plated out.

7. With the current running for half the time, you would expect the mass of copper plated to be half the original amount. If the current runs for half the time, then only half the number of electrons are provided, and only half of the reduction reactions can take place.

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(cont'd)

8. The simple answer is no because there would be no difference between the standard reduction potentials of the electrodes. The more complicated answer is yes, if a porous barrier separates the anode and cathode and the concentrations of the copper sulfate solution (same electrolyte) are different on each side of the porous barrier. This voltaic cell, called a concentration cell, uses the fact that the two solutions will have a tendency to reach the same concentration level as the basis for the movement of electrons through the external circuit. You could also suggest that the slight differences in the purity of the electrodes could result in a very small cell potential.