# Determining Faraday's Constant Using Electrolysis (Copper)

**Aim**

To determine an experimental value for **Michael Faraday's constant (F)** by measuring the mass of copper deposited during electrolysis and calculating the total charge passed.

**Background Theory**

Faraday's constant is the charge of one mole of electrons

$$F = 96\,500 \text{ C mol}^{-1}$$

During electrolysis of copper(II) sulfate solution:

Key equations
$$Q = It$$
$$n(\text{Cu}) = \frac{m}{M}$$
$$n(e^-) = 2 \times n(\text{Cu})$$
$$F = \frac{Q}{n(e^-)}$$

Materials

- 250 mL beaker (used as electrolytic cell)
- Copper(II) sulfate solution
- Two copper electrodes
- Power pack (DC supply)
- Ammeter (connected in series)
- Stopwatch
- Electronic balance
- Connecting leads
- Distilled water
- **Acetone (washing agent)**
- Sandpaper

**Method**

1. Lightly sand the copper cathode to remove surface oxides.

2. Rinse with distilled water.

3. Wash with acetone to remove water and grease.

4. Allow to dry completely.

   Measure and record the initial mass of the cathode.

5. Set up the circuit as shown in fig 1.



Figure 1 – Determination of Faraday's constant setup.

   - Beaker containing $CuSO_4$ solution
   - Copper electrodes immersed but not touching
   - Ammeter in series
   - Connect to power pack

6. Set a constant current of 0.50 A.

7. Run electrolysis the current for 600 seconds time

8. Remove the cathode.

9. Rinse carefully with distilled water takin care not to break off any copper deposited on the cathode.

10. Wash with acetone and allow to dry.

11. Reweigh the cathode.

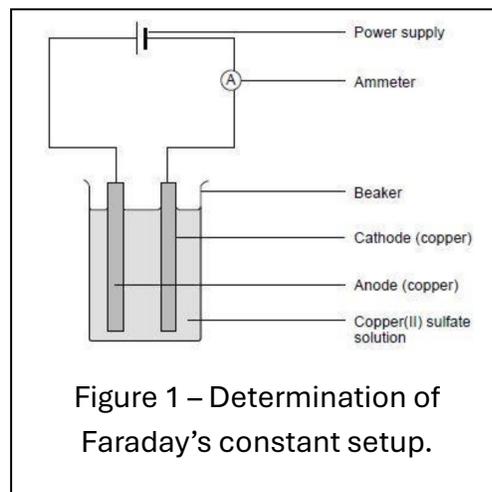12. Repeat steps 1-11 three more times.


**Data Table**

| Current (A) | Time (s) | Initial mass (g) | Final mass (g) | Mass gain (g) |
|---|---|---|---|---|
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|  |  |  |  |  |
|  |  |  |  |  |
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**Calculations**

1. Calculate charge passed $(Q = It)$

2. Calculate moles of copper deposited $(n(\text{Cu}) = \frac{m}{63.5})$

3. Calculate mols of electrons $(n(e^-) = 2 \times n(\text{Cu}))$

4. Calculate the experimental Faraday's constant $(F = \frac{Q}{n(e^-)})$

**Question 1**

Write the balanced half-equation occurring at the:

- Cathode     _____

- Anode      _____

**Question 2**

If a current of 0.45 A flows for 750 s, calculate the total charge passed.

**Question 3**

In another experiment performing the exact same electrolysis experiment a mass of copper of 0.142 g was deposited. Calculate the following .

     a) The number of moles of copper formed.

     b) The number of moles of electrons transferred.

     c) Calculate the number of Faradays of charge passed.

**Question 4**

Compare the experimental value of Faraday's constant with the literature value.

Explain any discrepancy.

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**Question 5**

With reference to your experimental data comment on the:

      i.      accuracy of the data.

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      ii.     repeatability of the data

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**Question 5**

Explain why the cathode must be washed with acetone before final weighing and describe the impact of the calculated value of Faraday's constant if the cathode was not washed.

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**Question 6**

Suggest one systematic error in this experiment and explain how it would affect the calculated value of Faraday's constant.

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