

# HOW DOES SURFACE AREA AFFECT FARADAY'S LAWS?

## Introduction

By designing and performing a number of electrolysis experiments the English chemist, Michael Faraday, was able to determine that there was a correlation between the mass of substance deposited and the charge passed through the cell. Faraday's law states that "the amount of any substance deposited or liberated during electrolysis is proportional to the quantity of electric charge passed and to the equivalent weight of the substance"

For this experiment Faraday's law is going to be investigated and used to determine if the surface area of an electrode affects the amount of substance that will be deposited onto it if the charge is kept constant.

**AIM:** To investigate how surface area affects the mass deposited on the cathode during electrolysis by electroplating various shaped copper cathodes to therefore determine if Faraday's law is effected by a change in surface area.

**HYPOTHESIS:** By changing the surface area of the copper cathodes the mass gained will remain constant between various shaped cathodes due to the same amount of copper being deposited if the charge is kept constant, in accordance to Faraday's law.

### Controls:

metal used (Copper)  
surface area of various shaped cathodes (e.g. all pipes same length/thickness)  
same batch of copper sulphate solution (0.5M)  
same mL of electrolyte  
position in room  
scales used  
distance between electrodes in system  
Anode (shape and size)  
Time: 2 minutes for each test

### Dependant Variable:

Mass of copper deposited

### Independent Variable:

Shape/surface area of cathode

Surface area of cathodes  
Washer: 0.038  
Cylinder: 0.023  
Mesh: 0.032



## Method

Step 1

- Prepare various copper electrodes by sanding and then weigh each cathode and the anode
- Set up apparatus as seen in the diagram below

Step 2

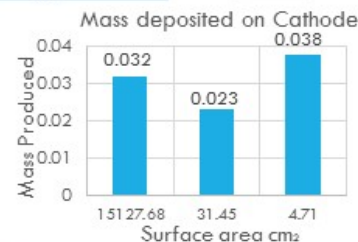
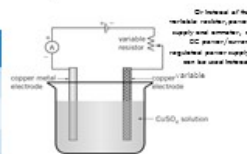
- Allow power into the circuit, restricted at 0.5 A, for 2 minutes then rinse the electrodes with acetone and record the measured weights.

Step 3

- Repeat until 3 washers, 3 pipes and 3 pieces of mesh have been electroplated.

## Results

	Average change in mass (g)	
Copper washer	Anode -0.017	Cathode +0.038
Copper mesh	Anode -0.008	Cathode +0.032
Copper pipe	Anode -0.023	Cathode +0.023



## Discussion

The cathodes tested in the experiment have various surface areas ranging from 4 cm<sup>2</sup> to 16000. This difference was used to test Faraday's law and investigate the proportional correlation between the charge and mass deposited.

The charge was kept constant and controlled at 0.5 A throughout all 2 minute tests. The mass deposited on the each cathodes was consistent regardless of the surface area, ranging from 0.023g to 0.038g, with only 0.016 between the smallest and largest values. The mesh which had the largest surface area by far had the median mass deposited. This demonstrates Faraday's law as if charge and mass weren't proportional the mass deposited would be far larger than the other electrodes tested, due to its significantly larger surface area.

Three trials for each shaped cathode were tested to get more accurate and reliable data, the results in the table are averages of the raw data. By doing this the variables that could alter data are minimised to provide the most accurate results as possible.

Errors and limitations include the copper washer being unevenly plated which resulted in copper particles falling off the cathode when it was removed from the solution. This created a minor fault in the experiment as some of the measurable plating was lost. The pipe and mesh did not have the same issue. The shape of the curved washer may have accounted for the coppers lack of ability to coat the washer. The copper sulphate solution was reused which may have altered the results as there would be a lower percentage of copper ions in solution after each test. Not all electrodes could be fully submerged in the solutions due to the wires coming into contact, this also effected the amount of surface area available to be plated. However this was accounted for in the available surface area calculations

To improve the experiment fresh copper sulphate could be used for each test to have a consistent amount of copper ions, larger beakers could have been used to allow for more of the electrodes to be in the solution. The major outlier in the experiment is the mesh cathode with an average of 0.008 which is far too low and does not comply with the other results.

## Conclusion

Through doing this experiment the effect of surface area on the amount of copper deposited is very little. If the charge is kept constant then the mass of copper deposited will be approximately the same, as long as all controls are maintained.

The variables are difficult to control in this experiment making it hard to obtain perfect results in ideal conditions however the data supports the hypothesis of mass and charge being proportional and the theory behind the investigation.

It was also observed that the more uneven the surface was the better the copper plated onto it.

