

MYP Year11 Chemistry 'Electrolysis Lab'

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Introduction:

There are many different factors that can affect the mass of copper deposit on the graphite electrode after electrolysis reaction of copper sulphate such as the increase in voltage, the concentration of ions in electrolyte, surface area of electrodes, type of electrodes, type of ions in the solution, the temperature of the solution and the distance between electrodes. The factor that I am investigating today is how the increasing voltage of current circulating through the closed loop would affect the mass of copper deposit on the electrode.

Aim:

To investigate how increasing voltage affects the rate of electrolysis by measuring the change in mass of the cathode in a given time.

Variables:

Independent Variable	Dependent Variable	Controlled Variable
The voltage of electric current circulating through the electrode (Voltage of 2, 4, 6, 8 and 10V)	The difference between initial mass and final mass (g) of the cathode (negative electrode)	Temperature the investigation is carried out in (room temperature)
		Volume of copper (II) sulphate the electrode is dipped in (100ml)
		Duration of time electrode is left in the solution with electric current flowing through it (5minutes)
		The concentration of the copper (II) sulphate solution (1 mol)
		Distance between two electrodes (approx. 5cm)
		The surface area of how deep the electrodes are dipped into the electrolyte copper sulphate solution.

Hypothesis:

It is believed that the higher the voltage of the electric current that flows through the close circuit, the heavier the mass of the electrode after 5 minutes. This is because the higher voltage would cause more negative electrons to be given to the cathode per unit of time, causing the rate of electrolysis to increase. Hence, more copper would be deposited onto the electrode within the given time. [1]

Apparatus:

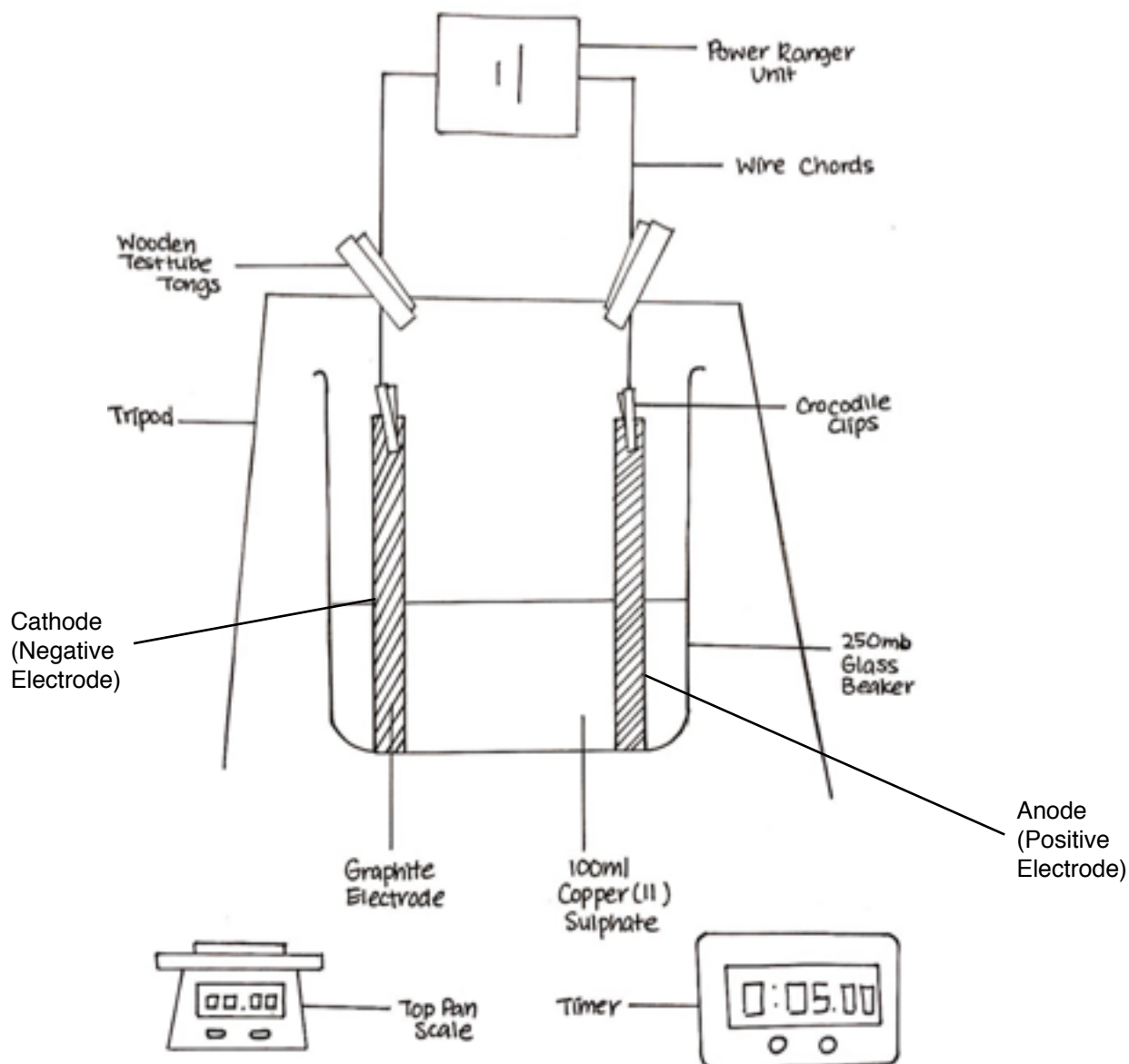
Apparatus	Description and Notes
Ranger power unit (Measuring Voltage)	The ranger power unit is the source of electric current that circulates through the close loop of the power source and electrode.
Crocodile clips	Connected to the end of the wires and the graphite for electrical connections with the electrodes.
x2 Wires	The wire connected to the red output of the power unit would be the positive terminal and the black output would be the negative terminal.
Tripod	Used as a stand for the wires to hang on it during the experiment in order to control the length of the electrode that is dipped into the solution.
x2 Wooden test tube tongs	Used to secure the wires on the tripod in order to prevent it from moving closer to each other in the solution.
250ml Beaker	This is where the experiment would be carried out. It is to be filled with 100ml of copper sulphate. 250ml is an ideal size beaker as a smaller or larger beaker would be difficult to control the surface area of the electrode dipped into the solution.
150ml Graduate Cylinder	Used to accurately measure out 100ml of Copper Sulphate solution.
100ml of Copper (II) Sulphate	This is the electrolyte that is used in the experiment.
Graphite	Used as the electrode of the experiment.

Top Pan Scale	A scale that would measure up to 2 decimals. It is used to measure the mass of the electrode before and after it's reaction with copper sulphate.
Timer	Used to measure the amount of time the electrode is dipped into the solution.

Method:

- 1) Set out the apparatus: tripod, power ranger unit, wires, crocodile clips, beaker, timer, top pan scale, graphite, copper (II) sulphate, and wooden test tube tongs on the workbench according to the apparatus drawing below.
- 2) Attach the crocodile clips to the end of the wires and plug the power unit into the power socket. (Remember to keep the power unit off while you do so)
- 3) Set the voltage to 2 volts.
- 4) Measure 100ml of Copper Sulphate with a Graduated Cylinder.
- 5) Pour 100ml of Copper Sulphate into the beaker.
- 6) Weigh the mass of the cathode graphite rod that will be attached to the negative terminal with the top pan scale.
- 7) Record the mass of the rod into the table of results under "initial mass".
- 8) Attach the graphite rods to the ends of the crocodile clips and place them into the beaker.
- 9) Make sure the wires are suspended at the same length with the graphite touching the bottom of the beaker and that they are 5cm apart.
- 10) Secure the wires on the tripod with the wooden test tube tongs.
- 11) Set the timer to 5 minutes.
- 12) Start the timer and turn on the power unit at the same time.
- 13) Turn off the power unit once 5 minutes is over.
- 14) Remove the graphite rod attached to the negative terminal from the crocodile clips and dry it with paper towels.
- 15) Weigh the mass of the graphite rod again with the top pan scale.
- 16) Record the mass of the rod into the table of results under "final mass".
- 17) Repeat steps 5 to 15 again for test 2.
- 18) Repeat steps 5 to 16 again with the voltage of 4, 6, 8 and 10.
- 19) Calculate the difference in initial mass, final mass and the average mass increase of both tests.
- 20) Record your results into the respective columns of your graph.
- 21) Plot your results from the "average mass increase" column onto an average mass/voltage graph.
- 22) Identify the line of best fit.

Apparatus Diagram:



Fair Testing:

Controlled Variable	How is it controlled?	Why does it need to be controlled?
Temperature the investigation is carried out in (room temperature) and the temperature of the solution.	This can be controlled by turning off the fan and air conditioner as well as closing the windows to prevent wind. This would not have a large impact on the investigation. We can also control the temperature of the solution by using a water bath.	The increase of the solution's temperature would increase the rate of reaction as particles would have more kinetic energy.

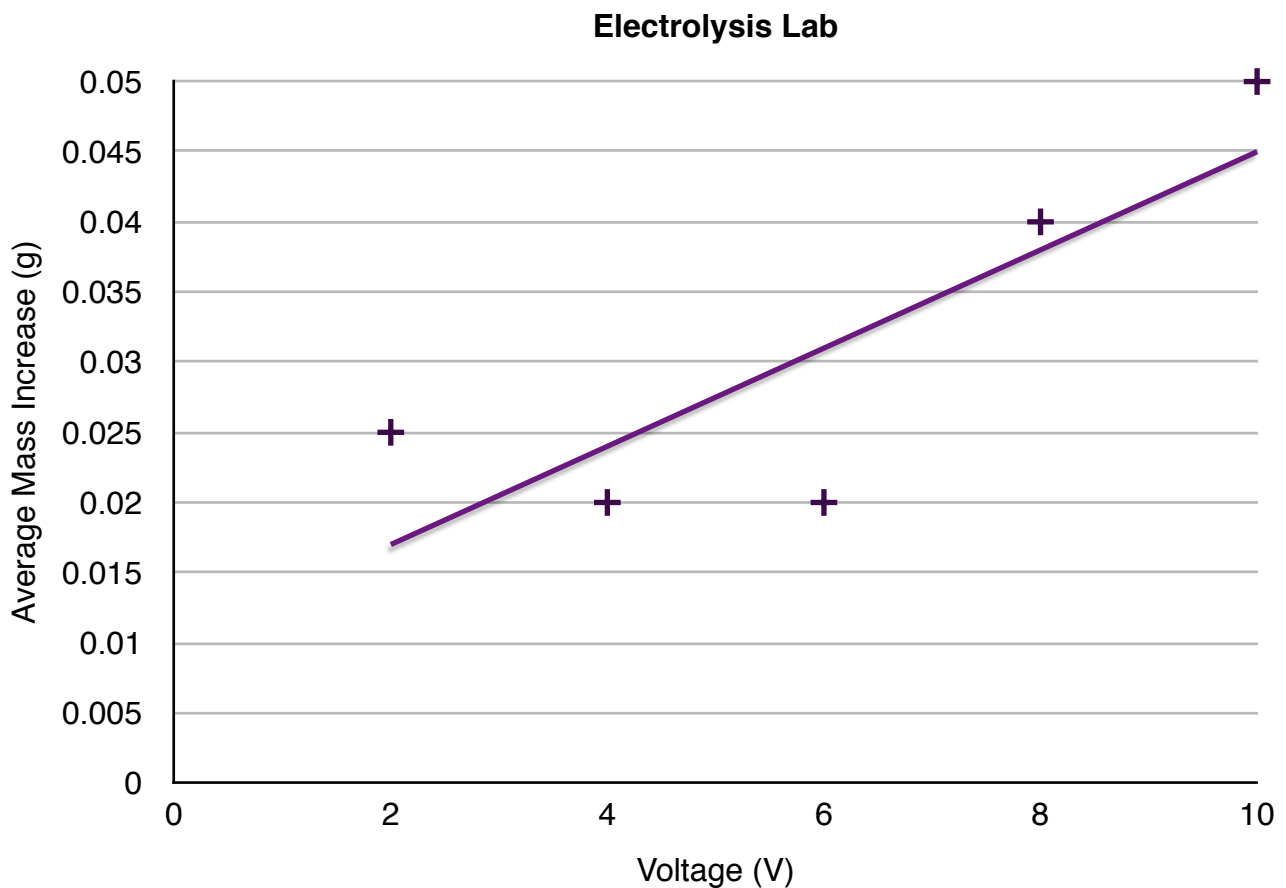
<p>Volume and surface area of copper (II) sulphate the electrode is dipped in (100g)</p>	<p>This can be controlled by suspending the electrode at the same height each time. This would be more effective if we do not move the wires and wooden tongs, but to release the electrode from the crocodile clips each time.</p>	<p>This is important as a larger surface area for reaction to take place at the same time would increase the rate of reaction of electrolysis.</p>
<p>Duration of time electrode is left in the solution with electric current flowing through it (5minutes)</p>	<p>This can be controlled by having the same person to start and stop the stopwatch each time and another person to turn the power unit on and off. It would be best if we set it to the timer setting instead of the stopwatch setting as a timer would remind us when time is up and also be more accurate than a stopwatch.</p>	<p>This is important as more or less reaction can take place in different durations of time negative electrons is pumped into the cathode.</p>
<p>The concentration of the copper (II) sulphate solution (1 mol)</p>	<p>This can be controlled by changing the solution of copper sulphate during each test and change of mass. We must also ensure that we are using solutions with the same concentration (1 mol) each time.</p>	<p>This is important as the concentration of the solution would decrease with each trial which would affect the rate of reaction of electrolysis.</p>
<p>Distance between two electrodes (approx. 5cm)</p>	<p>We can control this by placing the ruler on the top of the beaker and judging the distance between the 2 electrodes each time. This would not be exact each time, but it would be have a very large impact to our results. For better accuracy, it is best not to move the wires and wooden tongs, but to release the electrode from the crocodile clips each time.</p>	<p>This is important as the decrease of distance between the two electrodes would increase the current. Hence, it would increase the rate of reaction of electrolysis.</p>

Table of Results:

Voltage (v)	Test 1			Test 2			Average Mass Increase (g)
	Initial Mass (g)	Final Mass (g)	Difference in Mass (g)	Initial Mass (g)	Final Mass (g)	Difference in Mass (g)	
2	3.1	3.11	0.04	3.23	3.24	0.01	0.025
4	3.11	3.13	0.02	3.24	3.26	0.02	0.02
6	3.13	3.14	0.01	3.26	3.29	0.03	0.02
8	3.14	3.18	0.04	3.29	3.33	0.04	0.04
10	3.18	3.23	0.05	3.33	3.38	0.05	0.05

All my results in this colour is listed as anomalies due to it's irregular pattern. But due to the limited data I have, I have decided to include the anomalies into the calculations to find the final average mass increase.

Graph of Results:



Conclusion:

From the general trend line of shown on my graph, I can conclude that the higher the voltage, the higher the rate of electrolysis. This statement can be justified as point 1 at the 2 volts had an increase of 0.025g, whilst point 4 at 8 volts had an increase of 0.04g and point 5 at 10 volts increased 0.05g. The results above supports my hypothesis that the higher the voltage the faster the rate of electrolysis as it would cause more negative electrons to be given to the cathode per unit of time. Although my results supports my hypothesis, there were two anomalies in my results (test at the 2 and 4 volts) which might affect the validity of my results. The reason why the rate of electrolysis increase is that higher voltage would increase the amount of electrons delivered from the battery per unit of time. The increase of the amount of electrons will lead to a higher rate of successful collision with the positive ions (cations) that is attracted to the cathode in the Copper Sulphate solution to form neutral copper atoms on the cathode. Similarly, oxygen would also be produced from reaction at the anode.

The two anomalies on my does not make scientific sense as it cannot be fully explained through scientific knowledge. The first anomalie shows that the mass increase decreased at a higher voltage. This can be explained as I did not change the solution after the first test, leading to the decrease of the rate of electrolysis as the concentration of my solution decreased. This is one of the factors that affected the validity of my results. The second point of anomalie at 6 volts cannot be explained as it did not continue to decrease (affected by the decrease of concentration), nor did it increase to follow the trend line. Although the point at 8 volts follow the trend line, the reliability of the result is also very low as sudden large increase in mass does not make scientific sense. Another factor that could have affected the reliability of my results was the change of scale we used to weigh the mass of the cathode and we only carried out two tests. Hence, we could not clearly justify our results. A solution to these factors that led to the unreliability of my results is to constantly use the same scale throughout the experiment and to change the solution after each trial to main a consistent concentration for a fair test. Finally, it would also increase the reliability of my results if I had more time to carry out at least one extra test for each voltage to justify my results. I also think that the validity of my results at 2 and 6 volts were very low as the mass difference between test 1 and 2 was very large. In conclusion, the results obtained from this investigation was valid but not reliable as I feel that several results would not be repeatable in future experiments.

Evaluation:

There were several experimental errors in my investigation that could have affected the results of my experiment. The first one is the change in concentration. As I have explained above, the reliability of my results is decreased due to the decrease of concentration. To improve this, I simply have to change the solution after each test which would be simple to do, but I must make sure that there would be enough solution for me to carry out all 3 tests. The second major error is the the change of scale which affected the mass of each test. This can be

improved by consistently using the same scale in future experiments. Finally I can further increase the reliability of my results by carrying out more tests to justify my results. Overall, I feel that this was a successful investigation as I was able to produce a relatively logical trend line that was supported by my hypothesis.