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Investigating the Effect of Concentrations of Solutions

Introduction

In this experiment we will be investigating the effect that the concentration of salt in water has on the resistance of the solution. The possible variables I could use are as follows:

Mass of salt, temperature, voltage used, volume of water used to dissolve salt.

The input variable will be the amount of salt we mix in the solution, and the output variables resulting from this will be the current and the resistance.

I have chosen to vary the amount of salt because I think that varying the mass of salt is easier and more accurate than varying the other variables.

I am going to keep the test fair by only varying the amount of salt I put into the solution, by carefully weighing its mass electronically, and by carefully measuring the amount of water I use to dissolve the salt in each time with measuring cylinders, and also stirring the solution until all of the salt has disappeared to make sure that it is accurate showing how salt effects conductivity. I will also carry the test out at room temperature.

The variables I am keeping constant are:

- **The input voltage used**
- **The volume of water used**
- **The temperature of the solution**

Prediction

I predict that the less salt that there is in the solution, the higher the resistance of the circuit. I expect each more amount of salt added will proportionally reduce the resistance of the circuit.

This is because water is a good insulator as it has very few ions in it and ions are needed to move freely to make a current. So when salt is added I expect these added ions to help the

water conduct better as they can move about and form a current and therefore reduce the resistance of the circuit. So I predict that the more ions that are added (the more salt ions) then the more ions that can carry the charge (as positive and negative ions carry charge) and so the more charge that is carried the more current that can flow (current=charge/time). The process that we are actually carrying out is electrolysis of the water the anode and cathode are carbon rods which will also separate the sodium and chloride ions which may affect the resistance of the solution if left on too long because the chlorine will evaporate but sodium will be left in the solution. This is because the positive sodium ions will be attracted to the cathode (negative) and the negative chlorine ions will go to anode (positive). This movement of ions will transfer the current.

Method

In this experiment I used a beaker, a measuring cylinder, an ammeter, a voltmeter, a power source, a thermometer (to check the water temp. only), a set of electronic scales, and carbon anodes. I will set the circuit up as follows:

I am going to take 8 measurements, varying the amount of salt from 0.5g to 4g. I also plan to do repeats to make the experiment fairer, to make sure I get accurate results and ensure I haven't gone wrong somewhere in my first experiment. I also ensured that my experiment was safe by not leaving the circuit running

for too long due to the chlorine (which is a poisonous gas) which is produced by the electrolysis. I also wore goggles to protect against splashes of solution and I ensured no one touched the circuit while it was running to make sure no one was electrocuted.

Preliminary Work

For the preliminary work I tested the experiment out to see what variables I could change and to see which variable which would be most accurate and easy to change. I did the experiment by setting up the circuit as above and by adding various amounts of salt to the water in the beaker, and quickly turning the power on and checking the ammeter and voltmeter for readings. As a result of this experiment I decided to use salt as it was the easiest and most accurate variable to use and I also decided on certain constants to be used for example I decided that 75ml of water was the best amount to use as any less wasn't enough to cover the anodes and keep its contact equal with the water. I also decided to keep the input voltage at 4 volts as this produced enough to give good results and didn't produce too much poisonous chlorine if kept on a little longer while taking results.

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Results

Below is a table of the results I obtained and the results of my repeat. The temperature of the water was always constant at 21ºC. The electrodes are kept 2cm apart in each test.

		Test 1			Test 2			Ave.
Volume Of water (cm^3)	Mass Of salt (g)	Voltage (V)	Current (A)	Resistance (Ω)	Voltage (V)	Current (A)	Resistance (Ω)	Ave. Resistance (Ω)
75	0.5	3.37	0.11	30.6	3.38	0.11	30.7	30.65
75	1.0	3.36	0.14	24.0	3.38	0.14	24.1	24.10
75	1.5	3.37	0.16	21.1	3.37	0.15	22.5	21.80
75	2.0	3.37	0.17	19.8	3.36	0.17	19.8	19.80
75	2.5	3.36	0.19	18.7	3.36	0.18	18.7	18.20
75	3.0	3.37	0.20	16.9	3.37	0.20	16.9	16.90
75	3.5	3.36	0.22	16.0	3.36	0.21	16.0	15.65
75	4.0	3.36	0.24	14.7	3.37	0.23	14.7	14.35

Analysis

To make my graph I calculated the resistance dividing the voltage by the current, and then taking the average for the two sets of results. From my graph I can see that my results give a visible pattern that agrees with my prediction that the more salt that there is the less resistance of the circuit, and this is a proportional result as the graph is a straight line except for one anomalous result. The less salt in the solution, the higher the resistance, as the graph is a straight line, and if following results fitted with these, then the line would run through the origin, therefore making the results proportional. However, the straight line may or may not run through the origin if the experiment was

continued, so I therefore cannot make a certain prediction, and I am just inferring from gathered evidence that this is so. My results have come out this way because as I stated in my plan, water on its own has few ions in it needed to carry electric charge, and so with less salt ions added to the solution, the higher the resistance of the circuit due to the water being a good insulator on its own. However when more salt is added the water has more ions in it capable of carrying electric charge, because the sodium and chlorine ions carry the charge and are attracted to the anodes, which transfers the current around the rest of the circuit, allowing the passing of current. The more ions the more charge, and so the less resistance that is produced by the solution.

Therefore these results support my prediction, as the straight line graph shows proportional results between the amount of salt in the solution, and the resistance.

Evaluation

From my graph I can see that there is one anomalous result, for 0.5g of salt, which shows slightly higher resistance proportionally to the other results. However the other results fit in almost exactly with the straight line. The anomalous result could have been caused by firstly human error in measurements or procedures during the experiment. Other factors may have been faulty connections in the electric circuit, contaminated water for the solution, a faulty set of scales that would have meant that either not enough or too much salt was added to the circuit. Also any of the electrical equipment could have been faulty during the experiment, or had a connection knocked loose during this result. Also the beaker may have been completely clean for the first result, but after it was reused maybe it wasn't cleaned out properly, causing this anomalous result.

From my graph I think that I can draw a clear pattern from an almost exact straight line, which I think allows me to make a clear conclusion, including the anomalous result, which doesn't affect the other results which all fit in unlike this result. This pattern suggests that my results are reliable. However, it would be preferable if the experiment could be carried further so that I could make sure of this pattern, but I didn't have enough time to do this.

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The problems of this experimental procedure are detailed above describing possible causes of the anomalous result, and problems could be improved by:

- **Reducing human error with more care and attention**
- **Checking equipment for faulty connections, or using newer equipment**
- **Using distilled or purer water for the experiment instead of tap water**
- **More accurate scales running to more decimal points**
- **More thorough cleaning of equipment after obtaining each result**

The experiment could be continued by using higher amounts of salt in the solution, until no more can be added (the solution is saturated), or even by using different solutions, like other salts, or effects of using acid instead of water etc. It would also be interesting to investigate the effects of using other salts, and whether they affect resistance similarly. All of these could provide more insight into the relevance of this experiment, and give a wider view of what material will allow the conduction of electricity.