Factors affecting the rate of Cooling

Purpose

The purpose of this investigation is to find the factors affecting the rate cooling. If there are more than two factors that do affect the rate of cooling then are there relationships between them.

Prediction

In my experiments I am going to use 6 different sized beakers, however I will keep the volume inside the beakers at a constant 50ml. It is likely that when I change the size of the beaker to a larger one then the cooling will take less time. This is be cause there is more surface area exposed to the surrounding air. It is also likely that if I increase the volume but keep the same size beaker the cooling will take longer. This is because the liquid not exposed to the air will retain its heat for a longer period of time.

It is also likely that when the temperature of the solution is increase the speed of the cooling will increase. This is because the molecules will have more energy; this will make them move faster. This will mean that the molecules will disperse heat evenly.

When the experiment finishes I will have a set of results and from those I will produce some graphs. It is likely that these graphs will show a relationship between temperature and time. I believe that the graph will begin with a ste ep line, as the heat is high but will then begin to level out as the heat decreases.

Method

Having analysed both variables I have decided to conduct an investigation concerning the surface area.

Equipment Used:

$50cm^3$ beaker	Stopwatch
$100cm^3$ beaker	Bunsen burner
$250cm^3$ beaker	Tri-Pod
$400cm^3$ beaker	Heat proof-mat
$800cm^3$ beaker	Thermometer
Water	Gauze

- To keep an accurate measurement I will use the same thermometer and end the experiment when the liquid reaches 50 ^oC.
- I will measure the time it takes from when the liquid reaches 95 ^oC.

- To keep accurate and constant results I will ask a friend to measure the time while I measure the temperature of the liquid.
- I will keep the total volume of water at a constant 50cm ^{3}.
- I will try and keep the light as constant as possible by always have a fluorescent tube light lit above the experiment to keep visibility to a maximum.
- The stopwatch will be started as soon as the liquid reaches 95^{o}C and when the Bunsen burner has been removed.

For this experiment I am going to change the surface area exposed to the surrounding air. I will use six different sized beakers each with a different radius in order to gather enough information to see a pattern if there is one.

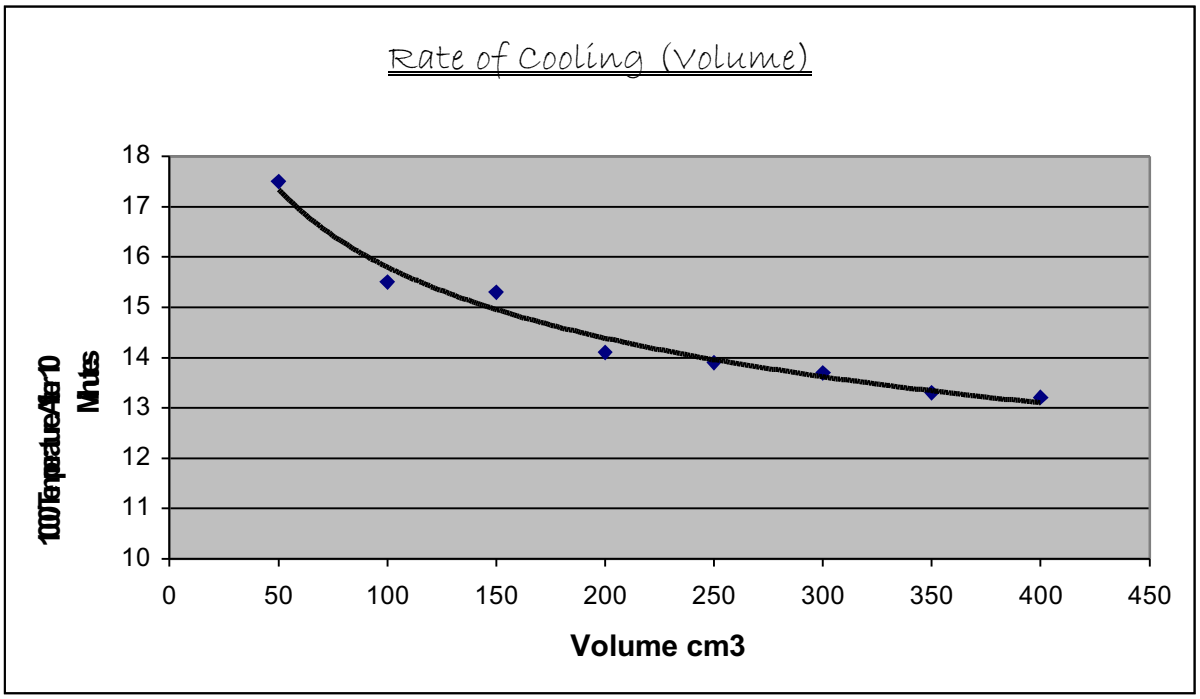
Results

Experiment Number	Area of Beaker Cm^2	Capacity of Beaker	Time (Minutes)	Average Time (Minutes)	$\frac{10000}{\text{Average Time}}$ (to 1 decimal place)
1	13	50	18:51	18:51	8.8
2			-		
1	23	100	16:04	16:04	10.4
2			-		
1	47	250	10:08	10:08	16.4
2			-		
1	55	400	9:48	9:48	17.0
2			-		
1	65	800	9.34	9.34	17.4
2					
1	102	800	5.32	6.40	25
2			7.47		

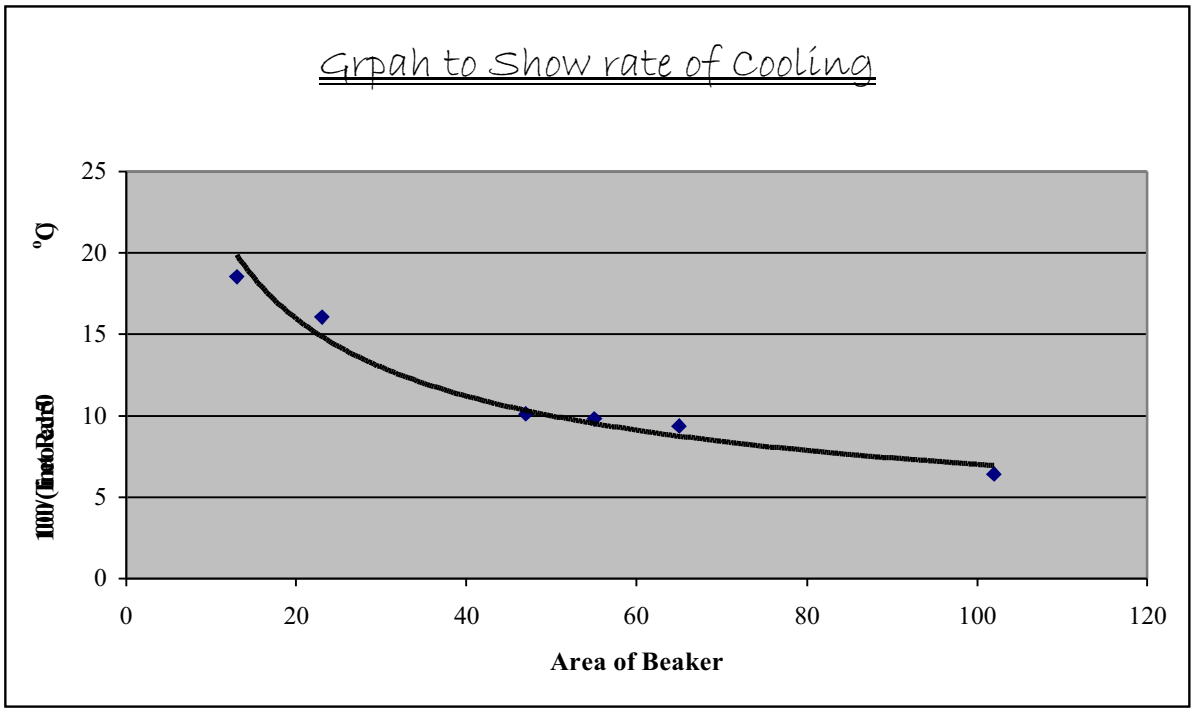
Experiment Number	Volume Cm^3	Temperature ^{o}C	Average Temperature ^{o}C	$\frac{1000}{\text{Average Temperature } ^o\text{C}}$ (1 decimal place)
1	50	57	57	17.5
2		-		
1	100	64.5	64.5	15.5
2		-		
1	150	65.5	65.5	15.3
2		-		
1	200	71	71	14.1
2		-		
1	250	72	72	13.9
2		-		
1	300	73	73	13.7
2		-		
1	350	75	75	13.3
2		-		

1	400	76	76	13.2
2		-		

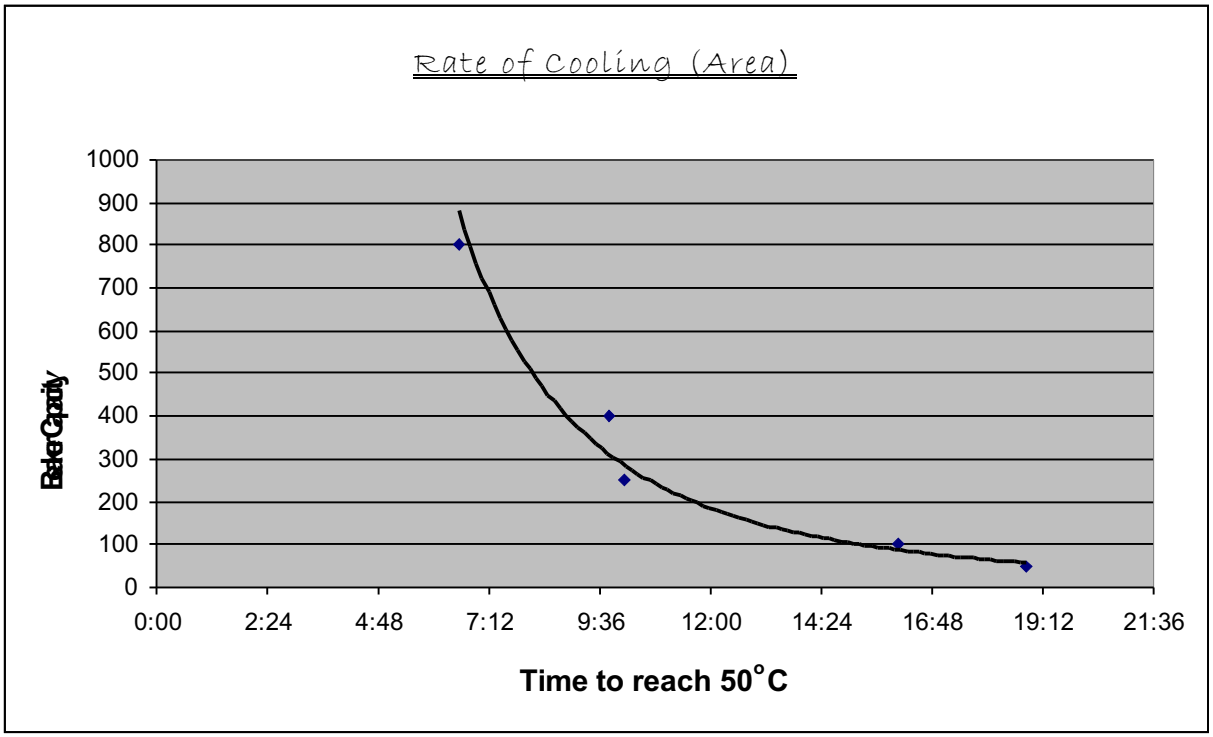
Conclusion



When looking at the graph above it is quite obvious to see that the speed of the cooling decreases as the volumes is increases. It is therefore safe to make the assumption that the speed of the cooling is directly proportional to volume.



When looking at the graph above it is quite obvious to see that the speed of the cooling decreases as the surface area is decreases. It is therefore safe to say that the speed of the reaction is directly proportional to the surface area.



This graph shows the cooling curve to a greater effect. This graph shows clearly that the capacity of the beaker and the time it takes for the liquid to cool are directly proportional. It also shows that the smaller the area of the beaker the slower the cooling.

Through gathering results from the two experiments it is quite obvious to me that as the surface area increase then the cooling also increases proportionally. Therefore it is clear through my results tables and graphs that speed of cooling and surface areas are directly proportional to each other when using water. I.e. when the surface area increases the cooling time decreases and when the surface area decreases the cooling time increases. This links into what I predicted before the investigation.

Evaluation

Through the duration of my experiment I attempted to take as many precaution as possible to create a fair and accurate test within the time limit and environmental conditions provided. However my results and patterns in my graphs show that not all the tests were accurate, as some points do not fit the pattern.

One of the main problems that I encountered was estimating how much water to put into the beaker before heating; this was not easy as the water evaporated off and on several occasions we were left with not enough liquid in the beaker. To help with this problem I could have heated more than enough water and the poured the correct amount into another beaker, however, a lot of heat my have been lost in this way. A

waterproof container may have also been helpful as it was have meant that no water to could be lost through evaporation.

Another factor could have been the humidity within the room on different days. This would have effected the cooling slightly but enough to make a difference. The slight humidity difference would have meant that the molecule s would have had more energy and therefore speed up the cooling. A possible solution to this problem would be to have completed all experiments on the same day. This way it would be less likely for humidity levels to fluctuate too much. Another alternative may have been to use a sealed off laboratory

Finally, visibility was a problem. Light in the room and eyesight quality could have made a difference. Light in the room changed several times as the experiments were carried out on different days and therefo re light would have been different. This could have been overcome lighting the lab with a certain light in order to keep the light a constant; also the same person could have been used to measure the thermometer. When considering eyesight, it is easy for m istake to be made as different people have different eye quality and perceptions of when visibility is none existent. Therefore the only way to overcome different perceptions is to use an electrical thermometer. This would overcome human error.

Overall I was pleased with how the experiments ran and how the results turned out. If I were to perform this experiment again I would attempt to use as many mechanical aids as possible so that I could exclude human error wherever possible.