Investigation of rate of cooling.

I am going to investigate the rate of cooling in heated water. In my experiment I'm trying to find out if the rate of cooling and evaporation will change the temperature of the water.
My ideas are that I'll have to see if convection, conduction or radiation will occur in my experiment and if it will affect the rate of cooling and how to avoid it. And see if the diameters of the beaker will increase/decrease the rate of cooling.
The things I am changing in my experiment are:

- The beakers top and bottom surface area by measuring the two different size beakers with vernier callipers.
- I would put insulations on both beakers, if necessarily, to see if the rate of cooling would be affected.

I would keep the investigation safe by wearing goggles because there would be the chance that the thermometers, in the beakers of 80°C of hot water, might explode.
The things I am going to keep the same in my experiment are:

- The amount of water.
- The material of the beakers.
- The colour of the beakers

If I didn't keep any of these the same it wouldn't make a fair test because if the beakers' size was different the rate of cooling would increase or decrease, if I had one big beaker and a small beaker with the same amount of water, the larger beaker's water temperature would decrease drastically and the smaller one slower because of the different surface area (the big beakers surface area is a lot bigger than the small beaker.) so evaporation would have taken place in the big beaker a lot faster than the small beaker.
If I had changed my chosen variables my prediction would be that I would get wrong answers on my experiment and find parallax errors on my line graph. These changes wouldn't make a fair test because the parallax errors would pop up more frequently when you plot the graph and I would have to find out what, during my experiment, caused these errors.
I predict that larger surface areas cool faster than small surface area because there is bigger top surface area so there are more molecules. They gain more energy to leave the beaker and join the rest of the gases and leave the water cooler because having lost the molecules with the biggest kinetic energy, the average kinetic energy of the liquid molecules is now lower than before. Temperature depends on the average kinetic energy therefore the temperature is also lower. To sum it up the bigger the surface area, the more molecules can evaporate, so the cooler the water can be because the smaller the surface, the slower it cools as there is less space for water molecules to evaporate.
The relevant information I found was from the Physics For You book. If you use different material beaker e.g. a metal and plastic beaker, the metal beaker would conduct heat while the plastic beaker insulates it. If one beaker were matt-black and the other covered aluminium foil, the matt-black beaker would absorb more heat and cool faster while the aluminium foil would reflect heat and so cool slower.
To make sure my answers are as accurate as possible I will be check the thermometer every minute for 10 min. and make sure everything goes as recorded. Also to make sure my results are reliable I will do the trial run twice and the actual experiment twice. The extra information I

have found from my 2 trial runs is that the bigger the surface area the faster it'll cool down and that the particles in a liquid are still very close together but are free to move in any direction so liquids are poor conductors (from Longman exam practice kit Physics)

Apparatus

All the apparatus I am going to use are:

- 2 different sized beaker (one with a surface area of 23.1 cm and the other with a surface area of 20.0cm)
- 2 alcohol thermometers
- 60-80 °C (100 ml)
- Stopwatch
- Measuring cylinder.

Method

1. Get 100 ml of water pour it into 2 beakers (a safe distance between them, so no convection currents can occur.)
2. Put the thermometers in the beakers
3. Measure the temperature at the beginning then start the stopwatch. After every minute check the temperature and do this until 10 minutes has gone.
4. Draw the table and record the information once you've finished the experiment draw the line graph.
5. Do your results twice.
6. Record the information on tables for each one.

Results

Results table 1.

Time (minutes)	Beaker with large surface area (23.1 cm)	Beaker with small surface area (20.0 cm)
0	70	70
1	68	69
2	67	68
3	65	67
4	62	65
5	60	63
6	58	61
7	57	59
8	55	57
9	53	55
10	51	53

Results table 2.

Time (minutes)	Beaker with large surface area (23.1 cm)	Beaker with small surface area (20.0 cm)
0	70	70
1	67	69
2	65	67
3	63	65
4	61	62
5	59	60
6	56	58

7	55	55
8	54	54
9	52	53
10	49	51

Analysis.

My results tell me that the water evaporates slowly until the biggest energy molecule leaves. It continues to decrease in temperature at the end of the experiment then the graph begins to show a certain pattern. The pattern is a smooth curve and most plots do not follow the pattern. My explanation for the pattern or relationship is, in the results the biggest energy molecules turn into gas molecules and the temperature and the rate of cooling begins to drop drastically while the large surface area beaker's (23.1 cm) temperature falls more than the small beakers surface area (20.0 cm).
The same happens at the trial runs and the 2 results table. The relationship definitely agrees with my prediction as the biggest energy molecule evaporated and the rate of cooling began. They gain energy to leave the beaker and join the rest of the gases and leave the water cooler because having lost the molecule with the biggest energy the average kinetic of the liquid molecules is now lower than before and temperature depends on the average kinetic energy therefore the temperature is lower.

Evaluation.

My procedure was very good and everything went to as according to plan because I did 2 trial runs to make my procedure was correct. The evidence obtained was just as expected it agreed with the pattern of relationship. The accuracy of the results is very good. I did find some anomalous results on my experiment and found out it caused by the convection current occurring.
The improvements I would have made was to try eliminate the bottom and side surface area by using insulation for the sides and a white heat proof matt at the bottom (it has to be white so it can reflect the heat back in) of the beaker and under both of them. To get those results I would use bubble wrap for insulation. I could have done more work, for example to do more trial runs to provide more evidence to my prediction and conclusion.
The errors I made was because I was out by 4 seconds when stooping the stopwatch as I was looking at the watch and at the thermometer at the same time so my improvement would be to use temperature probes. I have quite reliable results as they are only off by one degree in each results table but what I hoped was that the beaker with large surface area should have cooled faster. In overall I am happy with my conclusion as it proved right in both of my graphs but I could have used 3 or 4 different surface areas.
If I used insulation for the experiment and different layers of insulation (1 layer for the 1st beaker, 2 layers for the 2nd beaker etc.)
This would be the method for it:

1. Get 100ml of water pour it into the 3 beakers (a safe distance between the beakers so no convection or conduction currents can occur) before you do so put 1 layer for the 1st beaker, 2 layers for the 2nd beaker etc for insulation.
2. Put the temperature probes in the beakers.
3. Measure the temperature at the beginning then start the stopwatch. After every minute check the temperature and do this for 10 minutes.
4. Draw your table and record the information once you've finished the experiment draw your line graph.
5. Do your results twice.
6. Record the information.