How Surface Area affects Heat Transfer.

Plan.
I will measure out 300ml of water heated up to 80°C, into a beaker, and dip a sphere of Plasticine into the water. Every 15 seconds I will record the temperature of the water and the Plasticine. When the Plasticine and the water are at the same temperature, I will replace the hot water with tap water. Then I will continue to record the temperature of the water and the Plasticine every 15 seconds, again, until they both reach the same temperature.

At this point, I will repeat the experiment so far, but I will change the shape of the Plasticine, so it has a larger surface area, into a star, for instance.

The investigation is intended to demonstrate the way in which surface area affects heat transfer, so I will be varying the surface area of the Plasticine. However, the surface area of the Plasticine is only one of the variables, to carry out this investigation accurately I must keep the other variables under my control (volume of water, starting temperature of the water, and mass of Plasticine), constantly the same.

Apparatus.
- Clamp stand
- 2 thermometers
- 1 beaker
- 1 mass of Plasticine
- Water
- Stopwatch

Prediction.
I predict the star of Plasticine will heat up and cool down (transfer heat) faster than the sphere of Plasticine. This is because the star of Plasticine has a large surface area, which means there is a high number of it's atoms at it's surface, so a high number of it's atoms are likely to collide with the water's atoms, conducting lots of energy. Whereas, the sphere of Plasticine has a small surface area, which means not as many of it's atoms are at it's surface, so only a few of it's atoms are likely to collide with the water's atoms, conducting only a little energy.

Trial Experiment.

My trial experiment proved that Plasticine melted when it reached 53°C. I worked out that 40°C was a more suitable starting temperature for the water, but unfortunately, this means that there will be less energy to transfer.

Trial Experiment Results.

A= Plasticine with small surface area.
B= Plasticine with large surface area.

Time (seconds)	Temp of Water A (°C)	Temp of Plasticine A (°C)	Temp of Water B (°C)	Temp of Plasticine B (°C)
00:00	40	26	40	27
00:15	40	27	40	28
00:30	40	28	40	30
00:45	40	30	40	31
01:00	40	31	40	32
01:15	40	32	40	33
01:30	40	33	40	35
01:45	40	35	40	36
02:00	40	36	40	38
02:15	40	37	40	38
02:30	40	38	40	39
02:45	40	38	39	39
03:00	40	39		
03:15	40	39		
03:30	40	39		
03:45	40	40		

A graph to show how the area of a mass of Plasticine affects heat transfer from water.

A graph to show how the area of a mass of Plasticine affects heat transfer from water.

A graph to show how the area of a mass of Plasticine affects heat transfer to water.

My trial experiment did show what I had predicted. To speed up and increase the heat transfer in my experiment I will be using a 1l beaker instead of a 500ml beaker, I will fill it with 700ml of water instead of 300ml, and I will use a larger mass of Plasticine.

Obtaining Evidence.

A= Plasticine with small surface area.
B= Plasticine with large surface area.

Time (mm:ss)	Temp of Water A (°C)	Temp of Dough A (°C)	Temp of Water B (°C)	Temp of Dough B (°C)
00:00	40	22	40	22
00:30	40	23	40	23
01:00	39	23	39	23
01:30	39	23	39	24
02:00	39	24	39	25
02:30	39	24	39	26
03:00	39	25	38	26
03:30	39	26	38	27
04:00	39	26	38	27
04:30	39	27	37	28
05:00	39	28	37	29
05:30	39	29	37	29
06:00	39	29	37	30
06:30	39	30	36	30
07:00	38	31	36	31
07:30	38	31	36	31
08:00	38	32	36	32
08:30	38	32	36	32
09:00	38	33	36	33
09:30	38	33	36	34
10:00	38	33	36	34
10:30	38	34	36	35
11:00	38	34	36	35
11:30	38	34	36	36
12:00	38	34		
12:30	38	34		
13:00	37	34		
13:30	37	35		
14:00	37	35		
14:30	36	35		
15:00	36	36		

A= Plasticine with small surface area.
B= Plasticine with large surface area.

Time (mm:ss)	Temp of Water A (°C)	Temp of Dough A (°C)	Temp of Water B (°C)	Temp of Dough B (°C)
00:00	20	35	20	35
00:30	20	34	20	34
01:00	20	34	20	33
01:30	20	34	20	32
02:00	20	33	20	31
02:30	20	32	20	30
03:00	20	31	20	30
03:30	20	30	20	29
04:00	20	29	20	28
04:30	20	29	20	28
05:00	20	28	21	27
05:30	20	27	21	26
06:00	20	26	21	25
06:30	20	25	21	24
07:00	20	25	21	23
07:30	20	25	21	23
08:00	20	25	21	23
08:30	20	24	21	22
09:00	20	24	21	22
09:30	20	24	21	21
10:00	20	23		
10:30	20	23		
11:00	20	23		
11:30	20	22		
12:00	20	22		
12:30	20	22		
13:00	20	22		
13:30	20	21		
14:00	20	21		
14:30	20	21		
15:00	20	21		
15:30	20	20		

A graph to show how area of a mass of Plasticine affects heat transfer from water.

A graph to show how area of a mass of Plasticine affects heat transfer to water.

Analysis of my results

When I look at my first graph, I see that as time increases the temperature of the Plasticine with a large surface area and the Plasticine with a small surface area increases, whereas the temperatures of both sets of water decrease. This is because the heat energy from the water is conducted to the Plasticine, causing the Plasticine to have more heat energy and the water to have less heat energy. Not only is the heat energy from the water conducted to the Plasticine, but is conducted to the surrounding atmosphere, as well as the beaker and table. This also lowers the temperature of the water.

When I look at my second graph, I see that as time increases the temperatures of the Plasticine decreases, the temperature of water B increases, but the temperature of water A stays at a constant. The temperature of the water B increases because the heat energy from the Plasticine is conducted to the water. The temperature of water A stays at a constant, even though the temperature of the water decreases, presumably because the heat energy from the water is conducted to something else.

The mass of Plasticine with the larger surface area did heat up and cool down quicker than the mass of Plasticine with the smaller surface area, just as I predicted.

My results show that the larger the surface area, the quicker the heat transfer (see my prediction).

Evaluation.

None of my individual readings seemed to be extremely inaccurate, a few look slightly out of line with my lines of best fit, there is a number of possible explanations for this:

- I could only read whole numbers from the thermometer (I would have read 2° instead of 2.3°, etc).
- Sometimes I was couple of seconds late taking the readings form the thermometer.
- The thermometer was placed at a slightly different distance from the surface of Plasticine A to Plasticine B.

Some of the apparatus I used was not totally suitable for it’s desired purpose. The thermometers did not give the temperature to any decimal places. The Plasticine melted at around 50°C. Some of the water’s heat energy escaped from the beaker.

If I were to repeat the experiment in ideal conditions, I would make some improvements. I would replace the Plasticine with a substance that has a higher melting point. I would measure the surface area of the Plasticine to find the difference between the large and small surface areas. I would use thermometers that give the temperature to two or more decimal places. And I would repeat the experiment several times to produce more accurate figures.