Biology Coursework Investigation - Heat Loss

Aim

To investigate how variations in surface area and volume ratios in organisms lead to variations in heat loss and retention.

Introduction

Large animals have the ability to retain heat more easily than smaller animals because they have a larger surface area to volume ratio. This is the what I am trying to prove in the experiment. There are examples of this in nature. In winter the robin fluffs its wings up in order to retain more heat. When it does this, it forms a more spherical shape and this also gives better heat retention. But as I am unable to use live animals in the experiment I am using beakers full of hot water. The reason that an animal with a lower surface area to volume ratio retains heat more efficiently is because there is a greater volume to keep the heat and a smaller surface area that is open to outside elements.

Apparatus

- Diagram (see below)
- 2 x 500ml Beaker
- 2 x 100ml Beaker
- 2 x Tripod
- 2 x Bung w/ Thermometer
- Water Bath
- Ruler
- Insulating material

Method

Having set up the equipment as shown in the diagram, heat up the water to around 70^{O}C and fill both 500ml beakers with water. Then leave them in the tripod and allow them to cool, taking care to ensure that the beakers are both at the same height above the desk. Take a reading of the temperature every minute for fifteen minutes. Then repeat with the 100ml beakers. Also repeat again with a 100ml and 500ml beaker with a certain form of insulation covering them.

Predictions

330/500 = 0.66:1

115/100 = 1.15:1

1.15/0.66 = 1.742

I predict that the smaller beaker will lose heat around one and a half times faster than the larger beaker.

Controlling the Variables

To ensure that this was a fair test several measures were taken in the experiment. Two runs were done at the same time and an average temperature was taken. The heights above the desk were also the same for all flasks and they were done at the same time to make sure they stayed in as similar as possible a room temperature.

Results

Tables

500ml Non-Insulated Beaker

Time	Temp
1	67.5
2	67
3	66.5
4	66
5	65.5
6	65
7	64.75
8	64.5
9	64
10	63.5
11	63
12	62.5
13	62
14	61.5
15	61

100ml Non-Insulated Beaker

Time	Temp
1	65.75
2	64.75
3	63.75
4	62.75
5	61.75
6	60.75
7	59.75
8	59
9	58.25
10	57.25
11	56.25
12	55.75
13	55.25
14	54.75
15	54.25

500ml Insulated Beaker

1	73
2	72.75
3	72.5
4	72
5	71.95
6	71.5
7	71

100ml Insulated Beaker

1	73
2	72.5
3	71.75
4	71
5	70
6	69.25
7	68.5

8	70.5	8	68
9	70.25	9	67
10	70	10	66.5
11	69.75	11	65.75
12	69.25	12	65
13	69	13	64.5
14	68.75	14	63.75
15	68.5	15	63

Heat Loss/ Minute

100ml Beaker = 0.76

500ml Beaker = 0.43

100ml Insulated Beaker = 0.66

500ml Insulated Beaker = 0.3

Analysis

In order to work out if the results match the predictions the heat loss per minute of the 100ml beaker must be divided by that of the 500ml beaker.

0.76/0.43 = 1.767

The predicted difference between the two was 1.742, so from that I can conclude that the experiment was fairly precise.

In the insulated results, I can, by again taking the heat losses per minute, see what effect insulating material has on the beakers.

0.66/0.3 = 2.2

The insulation seems to make the larger flask even more heat retentive than before, but the 100ml flask is still not very heat retentive. It also gained less retention capabilities than the larger flask did.

Conclusions

I can conclude from these results that the original predictions were fairly accurate. So this means that it is true that the lower the surface area to volume ratio the better the heat retention.

Evaluation

There are a number of factors that could be improved the next time I do this experiment. I could have been more precise in my measurements and timekeeping. Also, I could have made sure that the insulating material was the same thickness on both beakers.