Experiment to find the relationship between the size of the surface area to volume ratio of a container and the rate heat is lost

Biology Sc1: Planning

Aim

- I am investigating the relationship between heat loss and surface area to volume ratio. The variable I am testing is the surface area to volume ratio by measuring the heat loss of hot water from different sized containers and therefore different surface area to volume ratios. I will investigate the rate of heat loss in the different containers using a thermometer, to test the hypothesis stated below.

Variables

- The variables: the size of the container, the source of the water, the starting temperature of the water, the room temperature and atmospheric pressure, the shape of the container, the thickness of the glass, the capacity of the container, whether the container has an open top or a bottle neck.

- The independent variable is the size of the container and therefore the surface area to volume ratio.

- The dependant variable is the rate of heat loss measured by temperature and time taken.

Hypothesis

- I think that the rate of heat loss will increase with a larger surface area to volume ratio and decrease with a smaller surface area to volume ratio over a period of time. Also I think that the rate of heat loss will decrease over a period of time.

Justification

- I think the above will happen for the following reasons. In the case of the elephant on the African plains it has a small surface area to volume ratio but with very large ears it releases heat to combat the problem of being too hot. This means that it keeps itself cool in very hot conditions. It also cools itself by spraying itself with water. This encourages evaporation, the loss of heat through convection, conduction and radiation having increased its surface area to volume ratio again. An opposite example is the dormouse. The dormouse has a large surface area to volume ratio and therefore loses a lot of heat in relation to its much colder habitat compared to the elephant. The mouse must consciously decide to increase its heat by eating more food and increasing its metabolic rate.

  In humans heat is lost to the air from exposed surfaces of the body by conduction, radiation and convection. Evaporation from the skin takes place all the time and is a

cause of heat loss. The body regulates its temperature by internal thermo-regulators losing more heat by vaso-dilation and conserving heat by vaso-constriction; also there are conscious decisions like moving into the shade to keep cool.

Preliminary Work

- In my preliminary work I carried out an experiment to test what happens to the temperature of warm water when it is left exposed to open air. The temperature drops, quickly at first at about 5°C per 15 second recording time and then slows down to about a drop of 1°C per minute, thus verifying my prediction that heat is lost and that the rate drops over time. The work showed me that a range of different containers needs to be used to investigate thoroughly the rates and such like and also that multiple trials must be carried out in order to ensure a fair test is performed.

Apparatus List

- 100ml beaker, 200ml beaker, 250ml beaker, 500ml flask, 1l flask, 5 thermometers, hot water, stopwatch.

Method

- This is the procedure I used. Firstly I heated some water in a boiling water bath until it reached 90ºC. I collected together 5 different containers (a 100ml beaker, a 200ml beaker, a 250ml Pyrex bottle, a 500ml Pyrex bottle and a 1000ml Pyrex bottle). I filled the first beaker with the hot water, put it on the desk and inserted a thermometer. As soon as this happened I started timing with the stopwatch. For every 15 seconds for the first minute and for each of the following 10 minutes I took the temperature of the water from the thermometer. I recorded the times in a table and repeated the experiment with the same size container again. I poured the water out at the end of the timing into a measuring cylinder in order to measure the volume to let me work out the surface area to volume ratio. I repeated this procedure with the different sized containers, each time taking the water at 90ºC and timing for 11 minutes, then recording the volume of water contained. After recording my times in a table I put my data onto a line graph and a bar chart so they could be analysed and conclusions could be drawn.

Diagram