Heat can be transferred in three ways biology essay

Science, Biology

Heat can be transferred in three ways1. Conduction2. Convection3. RadiationConduction is said to be when heat energy is transferred from a source to another without the movement of the source itself. Conduction occurs in solids, for example: metals are good conductors because the bond between electron and atoms are considerably loose due to which they can easily move around and carry kinetic energy. This energy, when meets the another cooler substance, passes on the heat. If there are no free electrons in a substance like that of metals, the heat energy is transferred by collisions between atoms that are tightly packed. Convection is the exchange of heat from a source to content by the movement of the source itself, which happens in liquids. As loosely packed molecules move, heat is transferred. Radiation is the exchange of heat energy from one source to another through electromagnet surf. Rays do not need a conductor to be able for it to take position. The amount at which an source extends heat relies on a number of aspects. These aspects include1. The temperature of the source2. The type of body of the source3. The environment temperatureI estimate from the above scientific knowledge that the 50ml beaker will lose the most heat energy and the 1000ml beaker will lose the least heat energy in a given time. This is because the 50ml is the smallest but has the largest surface area to volume ratio, it will lose heat more quickly compared to the 1000 ml beaker. The 1000 ml and has less surface place to volume ratio, so it will lose the least amount of heat energy as there is less surface area revealed comparative to the quantity for molecules to collide and transfer kinetic energy from in a body. This experiment is in relation to The polar bear (Ursus maritimus); is a bear native largely within the Arctic

Circle encompassing the Arctic Ocean, its surrounding seas and surrounding land masses. It is the world's largest land carnivore and also the largest bear. Hence, in this experiment the 1000 ml beaker is a replication of the small Surface Area/Volume Ratio of a polar bear. [WorldNews, PolarBear, 2012] Less surface area helps them survive in cold climates, it helps them have less heat loss and helps them survive.

Table 1: Showing the surface area to volume ratio

surface area : Volume ratioThe experiment relates to syllabus point 2. 1 that explains that as the organism gets bigger its surface area: volume ratio decreases. This is explained because of limiting cell size. In any organism (as polar bear in this experiment), as surface area: volume ratio decreases, the rate of exchange within the body decreases. For Example: in aerobic respiration, the oxygen volume obtained for each cell unit decreases. In another hand, if the surface area: volume ratio is too small, molecules will not be able to enter the cell quick enough to help in reactions and waste materials will start to collect inside the cell as these are produced at a faster rate than they are removed/excreted from the body of an organism. Also, heat loss will not be quick enough in cells and so it may get too hot resulting to it’s failure. Hence, surface area: volume ratio is very important in respect to the whole body of an organism.

Purpose:

To investigate the effect of surface area to volume ratio in the rate of heat loss from a body. (Liquid representing an organism: Polar bears)Hypothesis: If the total surface area to volume ratio of a beaker is increased, then heat

loss with be greater showing greater temperature change. Justification: Higher surface area results to more body space being exposed to the surrounding. Since the surrounding has less movement of atoms and is not kinetically energized/is cooler, it will get energized as the heat diffuses; the heat is absorbed easily from the body to the surrounding. Thus the body (in this case, liquid) will cool down faster and so the heat loss increases until optimum. (Provided other factors are kept constant)Null Hypothesis: If the surface area to volume ratio of the container is increased, the rate of heat loss will be less.

Predicted graph:

Table 2:

Variables in this experiment:

Independent Variables: The surface area to volume ratioThe change in the independent variable will affect the dependent variable because the experiment focuses on variance of the independent variable to the effect on the dependent variable. Manipulation of variable: There are 5 surface areas being used to show the same organism is different size (i. e Polar Bear). The size of the beakers are: 80, 250, 500, 800, 1000 ml. The surface area and volume of all beakers is measured by the following formulae in cm^3: The volume is measured by length*breadth*height. http://z. about. com/d/math/1/5/F/F/Cylinderr. gifDependent Variable: The temperature change per 20 secondsManipulation of the dependent variable: The dependent variable is measured by a temperature probe. The temperature is

measured in degrees Celsius and is started from 50 degrees Celsius (+/-1) (average body temperature of Polar bear).

Control Variable:

VariableHow it effects practicalHow controlledInitial temperatureIf the starting temperature was higher than the normal body temperature of the organism used, the rate of heat loss would be faster at the beginning few seconds. This variable is controlled by heating the same volume of water together and conducting the experiment in all 5 beakers at the same time. In this way, the initial temperature is same and will remain constant at all starting times. Surrounding temperatureThe cooling rate would differ if the surrounding temperature is warm or cold, the rate of temperature change would differ

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The experiment is done in room temperature, which in this experiment is generally 24 degrees Celsius. Liquid usedIf the liquid used to varied and different, the heat capacity will vary with it. The same type of liquid is used to simulate an organism. Since a body of polar bear has 80% water, water is a appropriate liquid to be used. Flow rate of air(wind speed)If the wind speed is inconsistent, then the air will be ‘ energized’ which will affect the diffusion of heat lossTo keep this constant, no external wind speed is used in the experiment. The total duration of timeThe heat loss may significantly reduce over the period of time due to which having a fixed duration of time is important. A constant time is taken. (5 minutes)Contact of beaker with the table. The temperature may not be decreasing because of heat being loss

but rather the molecules can be diffusing to the coolness of the table in which the beaker was put. This can be avoided by either conducting the experiment on a standing clamp or keeping a cardboard in between to make sure the temperature of the table doesn’t affect the heat loss.

Materials/Apparatus1. Water 225ml approx. (45 used for each beaker)Glass beaker, 5 different sizesAlcohol-in-glass thermometer/ Temperature probeA stop watch/ Logger Pro software (if using a temperature probe)Notepad and pencil (for data collection)

Materials

Quantity

Errors/Uncertainties

Beakers: 50ml, 250 ml, 500 ml, 800 ml, 1000 ml1 each+/-5%Temperature Probe/Thermometer1+/-0. 5 Degrees CelsiusStopwatch1Least count: 0. 5 secondNotepad/Pencil/Excel software1

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Water225ml approx. (45 used for each beaker)

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Light sensor1

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pH paper1Max pH 13

Design Aspect 2:

Procedure: Measure the surface area and volume of 5 different beakers with different measurements. (80, 250, 500, 800, 1000) using the formula in table 1. Mark the beakers 1-5, according to different surface areas. Take the mass of water with the beaker and without the beaker to see the mass of organism and water individually. Record this data on the same table as surface area: volume ratio. Heat the water to 50 Celsius. Pour the water in the beaker. 4) Measure the temperature to make sure it is 50 degrees Celsius using a temperature probe. Software called logger pro is used to help the temperature probe collect data efficiently. Alternatively, a thermometer can be used, however the data may not be as precise. 5) Immediately start the stop watch/collect data in logger pro and measure or fix the data collection of temperature for 5 minutes (300 seconds)6) After 5 minutes, record the temperature according to the surface area. 7) For each beaker, repeat the steps 3-6. 8) Repeat steps 4-6 for 5 times for valid data. http://3. bp. blogspot. com/-J6C5QWobYps/Ta72NqBxZ_I/AAAAAAAAADI/3xI1Q9cR81Q/s400/bio+surface+area. png

Figure 1: Visual of set up during the experiment. The arrow in the diagram represents the heat transfer from the beaker because the intial and final temperature and important and are measured in this experiment.

Design Aspect 3:

The data will be collected 5 times in 5 different test tubes. Even though it is a replication of heat loss in organism, in this case, polar bear, it will not harm

any organism since the practical is a laboratory simulation. The following page contains raw data:

80ml (+/-1)

250ml(+/-1)

500ml (+/-1)

800ml (+/-1)

1000ml (+/-1)

Temperature(degrees)

Time (seconds)

trial 1trial 2trial 3Averagetrial 1trial 2trial 3Averagetrial 1trial 2trial 3Averagetrial 1trial 2trial 3Averagetrial 1trial 2trial 3Average20505050117505050117505050117505050117505050117404847491114749491124949491144949481144948501146049474911247494911249493310949494811449485011480504749113474949112494933109494948114494850114805047491134749491124949331094949481144948501148050474911347494911249493310949494811449485011410033344582344945984548341044849481134948491131203234337734444091404839101484848112484848112140323233753243308530482887484748111474840108160293032703030337133302772304734884734409418025292462293125682529266329343374463338922002429246129222058202822552833327234323879220242523572522054202522522533326933323777240242422552422205320202247203231623331327526022420532422205120202047202331533331327528022212050242219476019202046202131513331317430022212050242220482019204619203049333303073

1144

1177

1169

1313

1430

Table: Raw data showing the temperature loss during the period of 300 seconds

Even though the initial plan was to have 5 repeats, the experiment was only done for 3 repeats because the results, as seen in the table, were similarThe graph shows the temperature loss in every 20 secondsd (mm)hCylinder 1 (80ml)5. 26. 9Cyliner 2 (250 ml)7. 59Cyliner 3 (500ml)9. 512Cyliner 4 (800ml)11. 414Cylinder 5 (1000ml)12. 215. 5

Figure 3: Table showing the diameter, height, volume and surface area.

volumeSACylinder 1 (80ml)11Cyliner 2 (250 ml)12Cyliner 3 (500ml)14Cyliner 4 (800ml)15Cylinder 5 (1000ml)110

Figure 4: Table showing the surface area to volume ratios.

Mass of the beaker (g)Mass of the beaker with water (g)Room Temperature (Celsius)Cylinder 1 (80ml)50. 7131. 824Cyliner 2 (250 ml)111. 8320. 624Cyliner 3 (500ml)222. 5699. 524Cyliner 4 (800ml)281. 6109424Cylinder 5 (1000ml)300208724

Fig 5: Table showing the mass of the beaker with and without water and room temperature

Light control : 293 Illum (lux)

pH (water): 7

Surface area to volume ratio of water in a beakerTrial NumberInitial temperature of water(oC ± 1 oC)Final temperature of water(oC ± 1 oC)Change in water temperature (%)Average change in water temperature (%)Standard deviation(correct to 1 decimal place)1: 115022-56-1741. 625021-5835020-602: 115024-52-1683. 225022-5635020-604: 115020-60-1820. 925019-6235020-605: 115019-62-1629. 925020-6035030-4010: 115033-34-1142. 825030-4035030-40

Processed data:

Table: Showing the average change in temperature and standard deviation for processing the data in graphical format.

Formula for calculating change in temp as a percentage:

Final Temp – Initial Temp x 100

Initial Temp

Volume: Surface areaVolume: Surface area (in decimals)Temperature change1: 10. 04-1741: 20. 08-1681: 40. 17-1821: 50. 21-1621: 100. 42-114

Table: Showing the volume: surface area ratio in decimal in relation to temperature change

Graph: showing the trend of temperature, this graph is shown in the same format as the predicted graph before to show the resemblance (if any exists).

Graph: A graph showing the relation of surface area to volume for average temperature change of water in 5 beakers. The graph also has a trend line.

Graph: showing the effects of changing the Surface area: V ratio from (1: 1 to 10: 1) on the change in temperature of water in 5 different sized beakers over the cumulative 300 seconds. Errors bars ± 1 standard deviation from the mean. Please note that the average change in temperature is cumulative of differences in 300 seconds.

Results

The results attained from the experiment and tabulated and were used to create a graph to show the relationship between surface area: volume ratio and heat loss in each beaker after five minutes. The graph shows that the 80 ml beaker underwent the most heat loss in the five minutes. However, the beakers had fairly similar starting and ending temperatures and thus it is difficult to distinguish between the two in the plotted graph. However, the 50 ml beaker underwent more heat loss as there is a region in the graph where it has a higher temperature than the second. The initial temperatures were similar in value for each beaker. This shows that each absorbed nearly the same amount of heat in the beginning. From the results obtained above, we can agree that if the total surface area of the beaker is increased, then the

rate of heat loss increases. As seen from Graph above, the larger the surface area to volume ratio, the shorter time is needed for temperature to be lost. The 1000ml with the highest surface area to volume ratio retained the most heat and underwent the least heat loss. The 50ml beaker with the lowest surface area to volume ratio had the highest rate of heat loss. My hypothesis stated that the 50ml would have the highest rate of heat loss as it had a small surface area. Even though the datas are fairly similar, the averages support the hypothesis that the beaker with the smallest surface area had the highest temperature change hence the more heat loss. This result agrees to knowledge that we have about cells, which states that the surface area to volume ratio is important in relation to heat loss because if it is too small metabolism in cells will produce heat faster than the surface can lose heat and will cause overheating of cells. This affects the whole body of the organism. The Error bars compare the 5 beaker temperature change visually (if various other conditions are constant). This can determine whether differences are statistically significant. As we can see, the data has a pattern, the 50ml beaker has the highest error bar (spread out data) and the 1000 ml beaker has the lowest. In all experiments the heat was mostly lost through convection; this was due to the hot water being in contact with the cooler air. The cooler air rises and then heats up drawing in more cool air to the hot water, the cool air keeps circulating until the water is cool.

Evaluation

Factor affecting

Effect on data

Improvement

Usage of a lid in the beakerVolume of waterIf the can is insulatedStarting temperatureThe temperature in parts of the beaker. If lid is not used, heat will escape from the head of the beaker by convection. More volume results to more heat content in the water as there are more collisions between molecules and heat is lost only from the surface of the beaker. Insulation can slow down cooling. If insulation is used, this will affect the rate of heat loss in the experiment. The starting temperature affects the experiment because the higher the temp the quicker the water will cool. The temperature may be less at the top of the beaker because heat is directly being loss by radiation and convection. Since the temperature has to be measured using an external equipment (i. e thermometer), the lid should be open (even though it is not the best simulation of an organism, however it is best that can be done in this condition) or a hole can be made through a lid to put the thermometer in. Instead of using different volumes of water for all 5 conditions, an average volume should be calculated and used. A cardboard can be used to reduce heat loss from the table. The starting temperature should be the exact same. Stirring the water constantly to keep the temperature constant.