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Investigating heat loss from huddling penguins

In my investigation, the one thing that I shall change by equal amount each time is the position of the test tube been assessed. (The position in a huddle)

In my investigation, the thing I shall measure, will be the temperature.

The make the investigation a fair test, here is a list of things that I'm going to keep the same:

- Test tubes sizes
- Amount of water in the test tubes
- Time at which we start the clock
- Starting time

Apparatus – here is a list of everything I shall need to do my investigation:

- Test tubes (penguins)
- Hot water
- Thermometer
- Water heater
- Stop watch
- Beakers
- Elastic band
- Goggles
- Kettle

My prediction – what I think will happen:

I think that the difference in position will affect the temperature. Therefore I think that the penguin positioned in the middle will have the greatest temperature all the way threw the experiment.

Why I think this will happen:

A penguin will lose heat in 3 different ways. One, by conduction – where heat moves threw a solid by the particles vibrating (creating the knock on effect). Two, by convection – this is where hot air/particles rises and cold air/particles rush to take its place causing convection currents. And three, by radiation. Radiation can travel through empty space and needs no form of median.

The penguin stood on its own will lose heat faster, than the penguins in a huddle, as its temperature (heat source) is greater than the penguin's environment. The process is similar to diffusion, where there is a net movement of particles from a region of high concentration to an area of low concentration. Except, this is where heat moves more rapidly to an area where it's colder. The greater the difference between the temperatures, the faster it travels. So the heat will be transferred faster from the penguin on its own into the environment than the penguins in a huddle. However in a huddle the penguin in the middle will lose heat very slowly as its environment is the other penguins and they all virtually have the same temperature. The penguins surrounding the penguin in the middle, will lose heat, not as much as the penguin stood on its own but greater than the penguin stood in the middle. This is because some of their heat will be transferred to each other and some into the environment. Also, penguins have small feathers which they "fluff up". By doing this, they trap air which acts as an insulator – keeping heat in. So, the test tube in the middle will be insulated because of the warm air surrounding it.

Plan – here is what I plan to do:

First I shall set up my apparatus as shown in the diagram, and then I shall fill each test tube with 10 cm of hot water with a temperature of about 70 degrees C. I will then measure the temperature of the water, immediately, in the test tube in the middle of the huddle. At the same time, I will measure the temperature of the water in the test tubes around the huddle and the test tube standing on its own. While doing this I will make sure that everything will be kept fair, to ensure a fair test. I will record the temperature results in a results table. I will repeat the above two minutes after for 10 minutes. I will repeat the whole experiment twice to ensure correct and accurate readings. To guarantee that I have accurate readings, I will try and get the starting temperature to be the same both times. I will then make a graph from the results.

Results

What I changed: Number of test tubes

What I measured: temperature Units: C (degre es)

	Start	2mins	4mins	6mins	8mins	10mins
Own	76	61	57	54	49	45
Middle	76	67	64	63	61	60
Edge	76	67	64	61	59	57
Own	76	60	58	50	50	49
Middle	76	71	69	67	61	59
Edge	76	70	68	65	60	47
Own	76	59	57	54	52	48
Middle	76	73	69	67	65	62
Edge	76	70	66	63	59	54
Average 1	**76**	**60**	**57.3**	**52.6**	**50.3**	**47.3**
Average 2	**76**	**70.3**	**67.3**	**65.6**	**62.3**	**60.3**
Average 3	**76**	**69**	**66**	**63**	**59.3**	**52.6**

Conclusion

What I have found out by looking at my graph is that the penguin (test tube) standing on its own loses the heat fastest, while the penguin in the middle of the huddle loses heat more slowly. This is because the differences in the temperature between the penguin (test tube) and its environment was getting smaller, causing the heat to move more slowly. Also, the penguin in the middle was insulated better therefore surrounded by warm air. You can see this by the gradient of the graph decreases as the time passed showing that the rate is decreasing. Even though that the "edge position of the huddle" reading of the graph shows the temperature increasing slightly (gaining heat which obviously isn't going to happen) and the decreases rapidly. I feel that this happen due to human error.

Evaluation

My results were not entirely accurate as when I carried out each experiment and the results didn't turn out the same every time when I repeated it 3 times. I got an anomalous reading for the "edge position of the huddle" as it gained heat; this is due to human error. Yet the results that I got did support my prediction.

Accuracy

My results were not entirely accurate as I didn't get the same readings after repeating the investigation 3 times – as I have said before. Also, that I had an anomalous reading due to human error. I could have gotten more accurate readings by having 3 people check the readings on the thermometer instead of one person, as the readings could have been different because even 3 seconds could have made the results different. I could have gotten more readings and done the experiment over a longer period of time. I also could of used cotton wool pushed in the top the test tube has it would of stopped heat escaping as quickly. The results I got were accurate enough to make a firm conclusion. The only pattern, in which I could see, was that the penguin stood on its own, lost the most heat and was the fastest to lose it.

Improvements

I would have changed the method to suit the experiment more, by doing the investigation over a longer period of time as this would make a clearer conclusion with more evidence. I would also get more people to read the results off the thermometer as one person can only read one result at a time and the time difference between reading each one; this could affect the overall conclusion and would be more accurate. I would have decreased the time taken in which I transferred the water from the water bath to the test tubes. And I would have used cotton wool at the top of the test tube so the heat couldn't of escaped.