Is Air a Good Insulator?

This experiment investigates the loss of heat through different insulating materials. Heat is loss through conduction, convection and radiation these three procedures could be acting on the experiment whilst I am working on it.

Conduction: conduction usually occurs in metals they allow energy to spread through them quickly. It is the transfer of heat energy without the substance itself moving.
Convection: Convection mainly occurs in liquids and gases. As the liquid or gas rises up it replaces the colder, dense regions. Convection is the transfer of heat by the movement of the substance itself.
Radiation: Hot objects releases infra-red radiation, the hotter the object gets the more infra-red it radiates. How much given out or taken in depends on the surface of the object. For examples dark matt surfaces emits more radiation than light shiny surfaces even if there are at an equivalent temperature. Also, dark matt surfaces are better absorbers (poor reflectors).

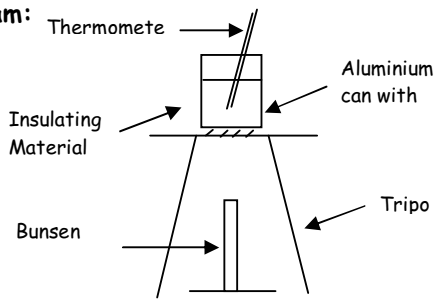
Planning:

Hypothesis:
I think air is a good insulator, this experiment will show us if this is true and how this effects to amount for insulation. Before carrying out this practical, I think that less air gives out less insulation, I believe the material with the most air will be affective at insulation. I think air is a poor conductor of heat because the particles in air are quite far apart and this makes it a good insulator, so whilst air is trying to escape from one particle to another it would take longer. I know particles in the air are spread out because air is a gas.

Equipment:

- Bunsen Burner
- Stopwatch
- 3 Aluminium can
- Thermometer
- Plastic bag
- 2 sizes of bubble wrap
- 3x150ml of Water

Diagram:



Firstly, each aluminium can was covered in a different insulating material, the three different insulating materials were plastics bags, small bubble wraps and large bubble wraps. The first can we tested was not covered with a material, we placed 150ml of hot water at a starting temperature of 77°C and then measured the temperature of the water for 10minutes every minute this was our trail experiment. We felt that measuring the temperature for 10mins did not give an obvious change therefore, we altered the experiment and decided to measure the temperature for a minimum 20minutes. We also decided to calculate the amount of air that was inside each covering of insulting material, we did this buy measuring the volume of air that was in the small and large bubble wrap. This same method was repeated with each aluminium can and its insulating material. The experiment on the hole was carried out twice this produced us a record of an average result.

In our experiment, the input variable will be the three different types of insulting material and the output variable will be the change of temperature. Another factor that must be considered is the room temperature, if the room temperature is close to the starting temp this could force the water to not decrease in temperature. The aluminium can we use is a shiny silver coloured surface this will reflect heat back in to the water but if the container was a dark black colour it would absorb the heat and let it pass straight through.

Whilst carrying out this experiment the things that will stay the same are:

- Starting temperatures of water 77°C.
- 150ml of water in each can
- Measuring the temp every minute for 10/20 minutes

These things must be kept the same throughout the experiment because if there are not it would not be a fair practical this could affect the results I collect.

Things that may vary:

- The time it takes for each can to cool down
- The different coverings of each can
- The different amounts of air trapped

The above things will vary during the experiment this is because the different coverings of each can will vary the amounts of air, for example a plastics bag with larger bubble wrap will have more air trapped than a plastics bag with small bubbles. This was the aim of the experiment to learn if air gives or effect insulation.

Working out the amount of air:

Each insulating material contained some air, to show how much air was inside each material we worked out a formula.

4 ÷ 3 x π x radius cubed

4÷3= 4.188790205

4.188790205x π= 13.16 (2 decimal places)

Radius= 0.5 0.5x0.5x0.5= 0.125

13.16x0.125= 1.645 this is the volume of air in a sphere the bubble wrap is half a sphere

1.645÷2= 0.8225 this was the volume of air in each bubble wrap, the material was made up of 215 half bubbles.

0.8225x215= 176.84 (2 decimal places)

The volume of air in the small bubble wrap was 176.84cm3, repeating the same method with the large bubble wrap I learnt that it had up 197.37cm3.

Analysing:

The results I collected from carrying out this practical suggests that the temperature it took for the water in each different material did not affect the time dramatically, the differences of each results apart from the no insulation can are not very noticeable The aluminium can with no insulating material cooled down the fastest with a temperature of 45°C at 20 minutes whilst the slowest to cool down was the plastic bag at 51°C. My second table shows an average, we only carried out the experiment twice therefore the average results in this practical are reliable but not very obvious, I think by producing an average result by repeating the experiment more than two times gives and you clearer idea and more accurate results to support conclusions.

By looking at the graph I produced from my results, the trend I can identify is that all the points on the graph follow a strong line with a negative gradient (follows downhill) The water inside the no insulation aluminium can seemed to have decreased quicker in temperature than any other insulating material, this is shown on the graph whilst the other three materials which were large bubble wrap, small bubble wrap and plastic bag followed behind at 49°C, 50°C and 51°C

Conclusion:

After completing this experiment, the conclusion I can come up with is that the can with no insulation cooled down the quickest because it had no air covering like the other cans therefore I can say my prediction was correct and air is a good insulator. The three air insulating materials all have different amounts of air inside them. To show how much air may be needed for insulation we decided to count the volume of air approximately that may be trapped inside each covering. We worked out a formula for the air that was allocated in each different size bubble wrap. The formula showed us the amount of air that was inside each bubble wrap, this helped to tell us if the amount of air effected the temperature, from looking at my graph my results suggests that the larger bubble wrap insulated better than the smaller bubble but did not insulate a dramatic amount compared to the smaller bubble wrap there was only a 1°C difference at the end of the 20mins.

Evaluation:

This experiment was carried out to show if air was a good insulator, I think the results I collected were reliable and accurate but not very easy to notice the differences, I collected enough results to reach a suitable conclusion. I did not have any unexpected results but only with the plastic bag covering there were two stages where temperature did not change for over a minute.
If I was to repeat this practical again I would do many parts of the experiment differently, to improve the experiment I would collect more results by repeating the experiment more than twice maybe at least three times to show an average result. In addition, I could have recorded the temperatures for a longer period of time this would also give me a wider range of results. The experiment on a hole was a success