INSULATION COURSEWORK

BY

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Aim: We are trying to find out what insulator is the best from cotton wool, bubble wrap and plastic foam.

Plan: The factor I will be changing is the type of insulator. The factor I will be recording is the temperature of the water in degrees for a total of six minutes. To record the temperature I will use a thermometer. The factors I will keep the same so it is a fair test are:

- Starting temperature of the boiling water
- Same amount / volume of water
- Measuring the temperature at the same interval
- Covering the same amount of surface area, length and width for each insulator.

I intend to wrap three testubes with the chosen insulators, but leave the last one plain for control.

- Cotton wool
- Bubble wrapping
- Plastic foam

I have also chosen to do a control experiment without insulation to see if there is a great difference in the heat loss if the container has insulation.
I will then boil some water and when it is boiled I will carefully pour it into a measuring cylinder up the chosen volume (20cm^3). I will pour it into the containers and allow it to cool to the chosen starting temperature. Once it reaches the chosen starting temperature then I will start the stop clock and record the temperature at chosen intervals. I will repeat this procedure for the next two containers. I will then repeat the whole experiment one more time to be sure that my results that I will obtain are reliable and reproducible.

Equipment: I will be using the following equipment:

- Boiling tube
- Measuring cylinder
- Test-tube rack
- Thermometer
- Cotton wool
- Bubble wrap
- Plastic foam
- Sellotape
- Stopwatch
- Rubber band

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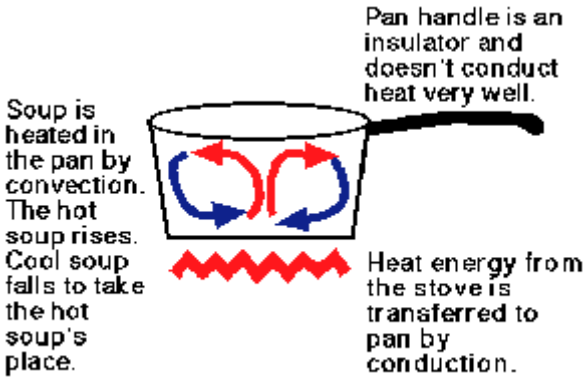
Prediction and hypothesis: Out of the four materials that I have been given to investigate I think that cotton wool will be the best insulator because of the heat loss. I am saying this because inside cotton wool there are many small pockets of trapped air, and air is a very good insulator in small pockets. This helps prevent convection because air is trapped into the small pockets.
The next best insulator I think is the best is bubble wrap. I think that bubble wrap is the next best insulator because bubble wrap have bubbles, which is trapped of air. Therefore, conduction or radiation cannot take place. This can not take place because air is trapped into the pockets.
The next insulator I think will be good is plastic foam. This is because plastic foam is made from sponge and it has many pores. Heat is prevented from being lost is that it has little holes which then can trap air. However, little conduction and radiation can still take place. I base my prediction on the following

Scientific Background: All metals are good conductors and most non- metals are good insulators. The best insulators are insulators that trap air if the air can't move then it can't move then it can't transfer the heat energy by convection and a bad conductor. Things like blankets. String vests, loft insulation, polystyrene and foam are all good insulators. The more surface area there is on the boiling tube the more of the hot water will be in contact with the air and so the quicker it will cool.
Insulation such as cotton wool and bubble wrap traps air that is a bad conductor this means that heat is trapped and the test tube stays hot.

Conduction: **Conduction** is when energy is passed directly from one item to another. If you stirred a pan of soup on the stove with a metal spoon, the spoon will heat up. The heat is being conducted from the hot area of the soup to the colder area of the spoon.

Metals are excellent conductors of heat energy. Other things like wood or plastics are not good conductors of heat energy. These "bad" conductors are called insulators. That's why a pan is usually made of metal and the handle is made of a strong plastic.

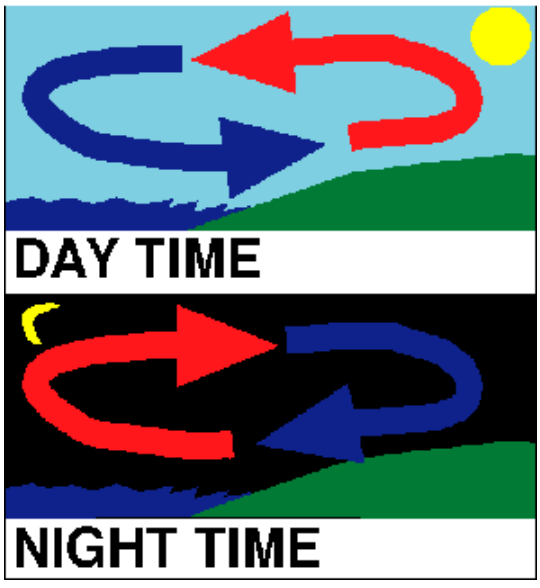


Convection: **Convection** is the movement of gases or liquids from a cooler spot to a warmer spot. If the soup pan above was made of glass, we could see the movement of convection currents in the pan. The warmer soup moves up from the heated area at the bottom of the pan to the top where it is cooler. The cooler soup then moves to take the warmer soup's place. The movement is in a circular pattern within the pan (see picture above).

Convection currents often cause wind. During the daytime, cool air from over water moves to replace the warm air over land that rises. During the nighttime, the directions changes and the water are warmer and the land is cooler.

Radiation: **Radiation** is the final form of movement of heat energy. The sun's light and heat cannot reach us by conduction or convention because space is almost completely empty. There is nothing to transfer the energy from the sun to the earth. The sun's rays travel in straight lines called heat rays. When it moves like that, it is called radiation.

When the sunlight hits the earth, its radiation is absorbed or reflected. Darker surfaces absorb more of the radiation and lighter surfaces reflect the radiation. So, if you wear light or white clothes outside during the summer, you would be cooler. The below diagram relates to my prediction because I am not investigating colour or day or night.



INSULATION COURSEWORK JINNEL PATEL 10BY

I think that cotton wool would be the best insulator because cotton wool has little pockets, which can trap air into the pockets and air, wouldn't be released because air is a very good insulator.

The next insulator I think is going to be the best is bubble wrap. I think this is going to be the next best because it has little bubbles, which can trap air, so no conduction radiation or convection can take place. So therefore, no air can be released.

The next insulator is plastic foam. I think that this is a good insulator because it has many pores that can trap air. In addition, air is a very good insulator. Therefore, no conduction convection or radiation can take place.

Conduction of heat is the process where vibrating particles pass on their extra vibration energy to neighbouring particles like shown below:

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Safety

Safety measures are needed because I am dealing with hot water, which can injure. The following things need to be recognized, in order to keep this experiment safe:

- Be careful not to knock over the testube with the hot water in
- Be careful not to knock over other people's testube
- Care is needed when pouring hot water

Method: I will be taking the readings of the temperature of water for a total 6 minutes. I am planning to repeat the experiment twice to get an average results.
I was shown a preliminary experiment by my teacher. This helped me because it helped me understand the coursework more clearly. There was also some research I did for myself it also helped other people.
I will do the following to construct my investigation as the following:

- First, collect the equipment
- Wrap insulator around the boiling tube
- Get hot water into beaker
- Measure $20cm^3$ of water pour water into boiling tube
- Wait until it reaches 65^{0c}
- Measure temperature every minute
- Repeat experiment twice

Empty results table:

Table showing results of temperature taken every minute for each insulator

	Bubble wrap	Cotton wool	Plastic foam	Control
Time in min				
0				
1				
2				
3				
4				
5				
6				

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Experiment 1 Table showing results of temperature taken every minute for each insulator

	Bubble wrap	Cotton wool	Plastic foam	Control
Time in min				
0	65	65	65	65
1	62	62	60	59
2	59	60	58	55
3	57	59	57	52
4	55	56	55	50
5	53	55	52	48
6	52	54	51	46

Experiment 2 Table showing results of temperature taken every minute for each insulator

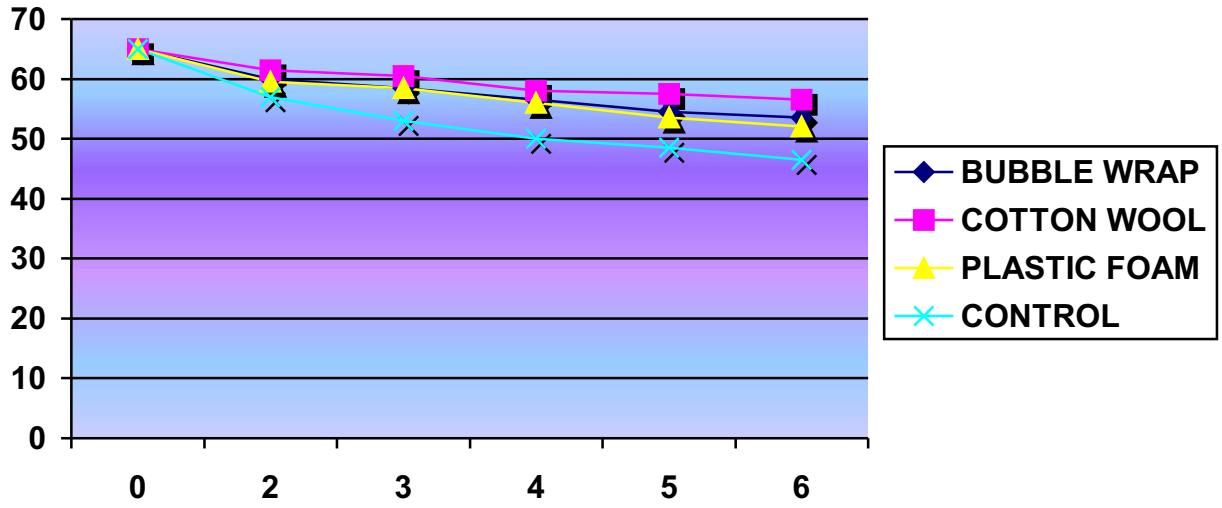
	Bubble wrap	Cotton wool	Plastic foam	Control
Time in min				
0	65	65	65	65
1	62	64	62	60
2	62	63	61	59
3	60	62	60	54
4	58	60	57	50
5	56	60	55	49
6	55	59	53	47

INSULATION COURSEWORK JINNEL PATEL 10BY

Average results table showing temperature taken every minute

	Bubble wrap	Cotton wool	Plastic foam	Control
Time in min				
0	65	65	65	65
1	62.0	63.0	61.0	59.5
2	60.5	61.5	59.5	57.0
3	58.5	60.5	58.5	53.0
4	56.5	58.0	56.0	50.0
5	54.5	57.5	53.5	48.5
6	53.5	56.5	52.0	46.5
Average temperature lost	11.5	8. 5	13	18.5

A line graph to show average temperature lost every minute for different insulators



Conclusion: From looking at my graph and results table I conclude that there is a change at the rate at which the heat transfers through the plastic foam. Altogether I tested three materials and I have discovered which have the best insulating properties. In order from the best insulator to the worst:

- Cotton wool – many air pockets trapped inside with air and air is a good insulator
- Bubble wrap – many bubbles trapped inside with air and air is a good insulator
- Plastic foam – many pores that can trap air and air is a good insulator

In my prediction I had said the cotton wool would be the best insulator, because it has many air pockets trapped inside it and air is an excellent insulator.

I was correct in my prediction. From these statements I therefore conclude that:

- Heat loss is reduced when there is an insulator wrapped around the testube
- Small pockets of air make an excellent insulator

I did obtain several anomalous results. These results may have been in error because I may have recorded the time at slightly different times when writing down the temperatures. Another reason for the inaccurate results is that I may have moved the thermometer from the middle of the thermometer higher or lower or a little to the left or right.

Evaluation: My method was not 100% a fair test as you can see from my graph. Some of the reasons why there might be errors are:

- The water might not have been measured properly because numbers might have been rubbed off from the measuring cylinder
- The timing might have been wrong
- The insulation might not have been wrapped properly
- The water might have lost heat before starting the experiment
- Same testube might have been used for the experiment
- The same surface are might not have been covered

The equipment and procedures that could have been used to get accurate results are:

- Digital thermometers
- Digital clocks

The results were good to support my conclusion. Even though there were some errors. Some of the reasons why there might be errors are:

- The water might have lost heat will we were waiting to reach the temperature wanted
- The timing might have been wrong
- Different surface area might have been covered

If I was to do this experiment again I would:

- Make sure the same surface area was covered
- The same thickness of each insulator

If I were to do the experiment I would use different factors some of the different factors are:

- Material – foil, paper, plain copper
- Colours – black, white and other colours.

I got my information from

1. www.homeworkhigh.com
2. www.studentcentral.com
3. CGP physics book
4. www.google.com

A Bar Graph to show average temperature lost