Rate of Heat Loss

Introduction

My investigation is to find out the factors that affect rate of which heat transfer happens. Heat transfer is a process in which energy in the form of heat energy is exchanged between materials that are at a different temperature. Heat is generally transferred by conduction, convection, radiation and evaporation. All of these processes can all happen simultaneously but it is likely that one will give the greater heat exchange. Heat is exchanged through the brick wall by conduction. The surfaces of a high-speed aircraft are heated up by convection. The earth is heated by heat that is being radiated from the sun.

These experiments involve the temperature of water taken at regular intervals from various different cups of different materials.

Here is a description of the following processes that will affect my experiment:

Conduction

This is where heat energy passes through the walls of the can by making the particles of the can vibrate and then they will make the particles next to them vibrate causing the heat to pass through the walls of the can and out to the surroundings.

Convection

This is where the cooler water particles sink down to the bottom and the warmer water particles float up to the top. Convection will only affect my experiment if I did not have a lid. This is because the warm water will float up to the top and the heat energy will escape out of the top.

Radiation

This is when the warm water particles vibrate the water particles next to them. This will give them more energy and will make the water therefore warmer. The water particles at the top of the can will radiate the heat energy into the surrounding air. For heat to radiate it does not need to be in contact with matter. Heat can radiate for some thing to another body through a complete vacuum, this is how the sun heats up the earth. This process can also be called the Wave Motion.

Evaporation

This could cool down the water, as when the water evaporates it will

take the heat away with it in the same way evaporating sweat cools down our bodies. If I use a lid this could slow down this process. As the water vapor will not be able to escape into the air as quickly as it would normally keeping the heat in for longer.

Factors

There are many factors, which can affect my experiment. The factors are:

If a lid is used

There will be a great difference in the speed of heat loss if I use a lid. This is because a large amount of heat will escape form the top of the container by convection and evaporation. Therefore if I use a lid it will slow down these processes.

Also what the lid is made of will make a difference. If a lid is made of paper or card then its insulation properties will not be as affective as if I were to use polystyrene or bubble wrap as these materials will decrease the rate of reaction.

Volume of water

When the volume of water is higher, it will stay warmer for longer than if there was a low volume of water. This is because when there is a high volume of water then the outside of the water will cool down, but the inside will stay warm.

Insulation

If the inside of the container is painted it will make a difference. If it is painted silver then it reflect some heat back to the water, but if it is painted black it will absorb the heat and pass it out the other side.

If the container is covered in bubble wrap or cotton wool it will have an affect on how fast the water cools as these are good insulators and will stop the container from losing heat as quickly by conduction.

Room temperature

If the temperature of the room is near the starting temperature of the water then heat process of heat loss will not be as fast. This is because if there is a bigger difference in temperature then the more heat will try to escape.

If the starting temperature is high then the more heat will try to

escape.

The factor that I have chosen to investigate is the material of the container. I have chosen this because there are many different materials that I could use in my investigation.

Question

The question that I have chosen is
' If I change the material of the container, will the rate of heat loss increase or decrease?'

Prediction

Out of the four materials that I chose to investigate I think that the polystyrene container will have the slowest rate of heat loss decrease. I am saying this because inside the polystyrene there are many small pockets of trapped air, and air is a very good insulator in small pockets.
I also am suggesting that the copper container will be the worst insulator, because it is a very good heat conductor therefore passes the heat away.

I also think that with all three containers the rate of heat loss will start of fast and over time will slow down.

Plan

I have chosen three different materials:

- Copper
- Polystyrene
- Glass

I will then boil some water and when it is boiled I will carefully pour it into a measuring cylinder up the chosen volume. 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 three containers. I will then repeat the whole experiment once more time to be sure that my results that I will obtain are reliable and as accurate as I can get them.

To make this experiment a fair test I will have to keep the following factors the same:

- Volume of water
- Starting temperature of water
- Material of container

- Where the thermometer is placed in the water
- Be careful to protect eyes by using safety goggles

If I keep all of these the same my experiment will be a fair one.

Safety

Safety precautions are needed because I will be using hot water, which can burn. The following things must be considered, in order to keep this experiment safe:

- Be careful not to knock over the containers with the hot water in
- Care is needed when pouring hot water
- Do not run with the container of hot water
- Keep bags under the table
- Wear safety goggles

Apparatus

Below is a list of the things that I can use, whiles conducting my experiments:

- Three containers 150ml of different materials
- Bunsen burner
- Safety goggles
- Stop watch
- 100ml measuring cylinder
- thermometer
- a heat proof matt
- gauze
- 500ml beaker

Method

1. Put on safety goggles

2. Collect all the equipment that is needed as shown in apparatus list above

3. Place Bunsen Burner on heat proof matt and cover with gauze.

4. Place beaker with 300ml of water on gauze and boil with the Bunsen.

5. Pour 100ml of boiled water into measuring cylinder

6. Pour this into one of the three containers.

7. Put the thermometer in the water

8. Wait until the water cools down to 80oC

9. Start stop clock

10. Record the temperature every minute for 10 minutes

11. Repeat procedure for the other 2 containers

12. Repeat the whole set of experiment again to ensure accuracy

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 polystyrene container. Altogether I tested 3 materials and I have discovered which have the best insulating properties. In order from the best insulator to the worst:

- polystyrene
- glass
- copper

In my prediction I had said the polystyrene would be the best insulator, because it has many air pockets trapped within it and air is an excellent insulator.
I had also said in my prediction that copper would be the worst insulator as the material conducts heat away. I was correct in my prediction.

In conclusion, heat loss is reduced depending on the material of the container and that small pockets of air make an excellent insulator.

Evaluation

I feel that I was accurate when measuring volumes of liquid and the temperature. I measured the water with a measuring cylinder and measured the liquid so that it just touched the line.
Also I measured the temperature with a thermometer to the nearest .5 0C. I also measured the starting temperature accurately.
I measured the time to the nearest second with the stop clock.

As an improvement to my experiment I could have repeated the experiment for further accuracy.