Mansoor Khan Physics Coursework: cups

Heat loss
Planning (method and plan)

Aim: my aim is to find out which container is the best insulator and which can retain heat the longest.

Method: I am going to collect my results by setting up a clamp that will hold a thermometer, which will give me my temperature recordings. The thermometer will be in the middle of the container. The container will contain boiling hot water and I will get the boiling water from a kettle. Before I put the water in the container I will measure 50ml of water. I will use a stopclock for the time. I will record the temperature, every 20 seconds for 5 minutes. I will use a lid made of cardboard with a hole pierced directly so thermometer can pass through and it also be held in an upright position. I will do this 6 times with 6 different materials of china, plastic, polystyrene, paper, card and glass. I will firstly record the temperature before I start the stopclock. I will use 2 thermometers and change each one after each experiment.

Equipment:
1. Thermometer - for recording temperature.
2. Stopclock - for the time
3. Containers - copper, polystyrene, glass, paper, plastic and glass.
4. Kettle - for boiling water
5. Cardboard - for use of a lid and holding thermometer in a upright position
6. Clamp – for holding thermometer
7. Measuring cylinder – for measuring water
8. Water - ?

Why did I choose to use each piece of equipment?
The thermometer because it is accurate and practical. The stopclock because it is I will be able to look at the large digits very clearly and start and stock the instrument easily. I used the measuring cylinder because it is light and transparent so I can observe the units clearly. Water because it is the best substitute for coffee because coffee is made mainly out of water.

Range of results:
I am giving to take 16 results; these will be taken after every 20 seconds, for five minutes. I will take the temperature at 0 seconds before I start the stopclock.

Variables: variables are factors, which can affect my experiment if I do not control them for a fairer test will try and control them these are:

Prediction
I predict that copper will lose heat the fastest because metals conduct heat and are poor insulators and also because the copper container is shiny. The best insulator is the polystyrene because it has tiny pockets of air that will trap heat and stop convection.

Conclusion
My results show that the paper container loses heat at the fastest rate because every minute it loses 3.6 degrees of heat every minute and the best insulator was china because it loses 1.7 degrees of heat every minute. Polystyrene, which I predict would be the best insulator, was not that good at retaining heat because every minute it loses 3.3 degrees of heat, which is twice as much as china.

Evaluation
My results were alright but could have better so it correlated with my prediction, I did not expect the china container to be the best insulator, I expected polystyrene to be the best insulator because of its tiny pockets of air and these tiny pockets of air act as a insulator that prevents convection currents from passing through.

If I could do the experiment again than I would make sure that all the containers were the same size because than the amount of fluid in each container would be the same because and the would be the same amount of air and so the rate of which air is lost through convection is the same with all of the containers.

I would also make sure that the room temperature was not too hot or cold so the amount of heat loss is an even rate and there is not a rapid decline through convection.

Planning (method and plan)
I am giving to take 16 results; these will be taken after every 20 seconds, for five minutes. I will take the temperature at 0 seconds before I start the stopclock.

Prediction:
I predict that of all my six materials that the copper container will lose heat at the fastest rate because according to my research, metals are the best conductor of heat. Being a 'conductor of heat' means that copper will transfer the heat energy from the water; by making the molecules of the copper vibrate more, when it vibrates more the heat energy is passed from one molecule to the other at a very fast rate. Also because the container is a solid, the amount of heat loss will be great because solids have molecules tightly close to each other, so the heat energy will not have to travel far to get to the next molecule.

I have completed some preliminary experiments in the classroom, which will help me with my prediction, one of these was finding out which metal is the best conductor of heat by putting hot water into a metal container, on the other end of the container was 5 five different metal wires, which had wax rubbed onto them, then there was a spring on each metal wire. The five different metal wires were shiny copper, aluminium, brass, steel and matt copper. The heat from the water would transfer by conduction to the different metal wires and melt the wax, which would in turn slowly make the spring fall down. The aim of this experiment was to find out which is the best metal conductor and which is the best metal insulator. I would find this out by observing which spring feel off the different wires first, the best conductor would drop its spring first and the best insulator would drop its spring last or not at all. The outcome was the matt copper wire was the best conductor of heat and the brass was the worst conductor of heat. The matt copper drops its spring first because matt (dull) surfaces absorb and emit heat a much faster rate than object with shiny or white surface like the shiny copper wire.

I predict that the polystyrene container will lose heat at the slowest rate, because polystyrene is the best insulator of heat because it has many pockets of air trapped in, trapped air can acts a great insulator especially to convection like for example, a layer of air between double-glazing window, this layer of air prevents convection currents from passing through..

I have seen a experiment in the classroom about matt surfaces by completing experiment called Lelies cube, this was a test for radiation. This had hot water in a cube, which had four different coloured sides, which included a matt black surface, shiny black, silver and lastly a shiny white surface. The matt surface and the black surface was warmer then the silver and the shiny white surface, this was because matt surface had absorb the heat from the hot water and radiated it at a much faster rate than the rest, the matt surface made the water cool down by losing the most heat. The surface with silver had relatively the same temperature as the beginning of the experiment because it had kept the water the warmest by reflecting the heat back into the water. This tells me that any dark surface container will lose heat at a faster rate than any light coloured surface container.

I have done an experiment in class conduction, by using a rod made up of two different metals on either side of the rod, one side was copper and the other side was steel. The rod was heated by a naked flame, a Bunsen burner which made the rod expand the copper side expanded the more than the steel side and this shows that the copper surface is the better conductor of heat because when any metal is heated it expands, so whatever metal expands the most and the quickest is the best conductor of heat because the heat is transferred by conduction across the steel rod. This all adds further weight to my theory that the copper container will lose the most heat and the quickest.

I predict that the china container will not lose at lot of heat because it is very thick and shiny and stops heat being lost through
I predict that my paper container retain a certain amount of heat but at the same time lose heat steadily because the paper cup is very thin and heat loss through conduction will be easy. Paper is made out of wood and wood is a poor conductor of heat and a good insulator. Being an insulator of heat means that heat is unable to pass through by means of conduction and heat is retained.
When you put a solid between a hot place and a cold place, thermal energy has to travel through the solid this is called conduction.

Water in a kettle is a liquid because liquid can flow, the heating material at the bottom of the kettle heats up the water, the warm water becomes dense and rises and because it rises it uses a certain amount of energy and becomes less dense and cools down and falls down. This is called convection current; water and gases, which are known as fluids. Birds use convection currents to help them fly or to be more precise soar, they do this by finding the warm air and use it to glide along, there are many convection currents on uneven pieces of land.

When you stand at a cooker you can feel the heat, this is radiation, radiation happens by sending out waves. In radiation no solid, liquid or gas is needed (substance) is needed and so radiation can pass through empty space like for example the sun's heat to earth, this is like vacuum.

I predict that the glass and plastic containers will lose heat than slower rate than to the copper container because the material they are made of are good insulators of heat. Glass will also lose heat at as slower rate because fundamentally it has air trapped between, which can act to prevent convection currents and reduce heat loss.

Variables:
Thermal energy moves from places of hot areas to cold places, so if the room temperature is 10 degrees because it is a cold day and my containers have water which is about 80 degrees than the heat lost from the container would be faster than a day when the room temperature is 30 degrees because heat likes to move from area high temperature to areas of low temperature. This is a variable that I cannot control but I will be aware of during my experiment and if I have any anomalies than I will consider writing about this variable in my conclusion.

My containers having lids is an important variable for me to control because if don't then heat could be lost through convection by evaporation,
If I stir the water during my experiment with thermometer then this will not give me a accurate reading of the temperature because when you stir water, you are actually forcing the hot areas of the water to mix with cool areas of the water increasing the rate of convection, this is known as forced convection. This is sort of like stirring a hot cup of tea with a spoon to cool it down.

I have done a preliminary experiment where I recorded the temperature of a cup of tea, which had a lid and another, which did not a lid during a ten-minute period. Here are the results:

| Time in minutes | 0 | 2 | 4 | 6 | 8 | 10 |
|---|---|---|---|---|---|---|
| Tea covered | 80 | 73 | 66 | 61 | 56 | 52 |
| Tea uncovered | 80 | 67 | 56 | 48 | 42 | 37 |

From the above results it tells me that if a tea cup it will affect the rate of heat loss.

Volume
I need to control the volume of the water; I have done this my using a measuring cylinder to measure 50 ml of water before I put the water in the container. Volume control is important because if they is more concentration of water in one container than another than there will be more air for convection and could affect my results. The size of my container is important because if one container is bigger than the other than they will be more room for heat loss through convection. I thought about if the containers are different sizes I could fill each one to the brim with hot water but that would mean the is more water and more heat loss by conduction, because they will be more fluid and more molecules bumping into one another and greater heat loss.

I want to make sure that when I boil the water from the kettle that the kettle switches off by itself. So I can make sure that the water has boiled properly because if does I take the water before it has boiled the heat loss will be slow because the particles are colliding slow whereas if I take the water if it has boiled properly the heat loss will be

fast because there are many molecules bumping each other and these molecules have much more energy than before and the energy is passed on at a much faster rate to the edge of the container and heat will be lost through conduction.

The variables that I have listed are those which are factors that can affect my experiment if I do not control them, some of the variables I have listed I am able to control others I am not, the ones that I am able to control I will, the ones that I cannot I will be aware of them when writing up my conclusion.

Evaluation

The way I collected evidence was good but I could have done it better, by firstly using a digital compass, which would have collected more accurate results because when I collected the results I could been looking at the units at a angle instead of a parallel angle and I could have read off in corrected. When I first looked at the temperature before I started the experiment I took the temperature of the water at 0 seconds, it takes about ten seconds to record the temperature the water could have cooled down a during ten seconds, so my experiment could have actually gone for an extra ten seconds from when I put the water in the container and so my recoding at twenty seconds would have been at thirty seconds, and so my results would have been inaccurate.

By inserting a thermometer into to the lid, heat will travel up the thermometer from the hot water and heat is lost from the thermometer, I could have prevented this by using a digital thermometer, by using digital I could have avoided heat loss. By doing my experiment on a nice warm day would have been better because heat loss would have been gradual and not as fat as a cold day as heat likes to move from a hot area to a cold area.

If I could do the experiment again I would do the each experiment three times so I can work out the averages of the temperature recordings for accuracy. My results may have not been reliable because I used different containers sizes this may have affected my results, so if I was toy do the experiment again I would use the same sized containers, so I could have the same amount of water in each container.
I would also use the same coloured cups so I could prevent heat loss by radiation.