INTRODUCTION

For this piece of coursework, I am investigating the rate at which heat energy is lost and heat transfer happens when a beaker of boiling water is wrapped in different materials. These experiments involved the temperature of hot water being recorded at different times in a glass beaker. Heat is generally transferred by conduction, convection and radiation.
Energy transfer in solids is by means of CONDUCTION.

CONDUCTION

Materials that allow thermal energy to transfer through them quickly are called CONDUCTORS. Those that do not are called INSULATORS. If one end of a conductor is heated the atoms that make up its structure start to vibrate more vigorously. As the atoms in a solid are linked together by chemical bonds the increased vibration can be passed on to other atoms. The energy of movement (kinetic energy) passes through the whole material.

Metals are particularly good conductors because their structure contains freely moving electrons, which transfer energy very rapidly. Air is a good insulator and reduces thermal transfer by conduction. As air is a gas there are no bonds between the particles and so energy can only be transferred by the particles colliding with each other. To obtain the best results the air needs to be trapped so that energy cannot be transferred by convection. Conduction cannot occur when there are no particles present, so a vacuum is a perfect insulator.

Examples of good conductors are metals such as gold, silver and copper - they will conduct heat readily. Materials that are good thermal conductors tend to be good electrical conductors also. Materials such as glass have much smaller heat transfer values and are poor heat conductors.

CONVECTION

Convection occurs in liquids and gases because these materials flow (which is why they are described as 'fluids'). Convection occurs when hot fluids rise and cold fluids sink. The circulation of fluids that this causes is called a CONVECTION CURRENT. The particles in a fluid move all the time. When a fluid is heated, energy transferred to the particles causing them to move faster and further apart. This makes the heated fluid less dense than the unheated fluid. Consequently, the less dense warm fluid will rise above the denser, colder fluid. This is how the thermal energy id transferred.

If a fluid's movement is restricted, then energy cannot be transferred. That is why many insulators, such as ceiling tiles, have trapped air pockets. Wall cavities in houses are filled with fibre to prevent air from circulating and transferring thermal energy by convection.

RADIATION

Radiation, unlike conduction and convection, does not need particles at all. Radiation can travel through a vacuum. All objects take in and give out infrared radiation all the time. Hot objects radiate more infrared than cold objects. The amount of radiation given out by an object depends on its temperature and on the object's surface. The surface of an object also determines how good it is at absorbing infrared radiation.

Type of surface	As an emitter of radiation	As an absorber of radiation	Examples
Dull black	good	good	Cooling fans on the back of a refrigerator are dull black to radiate away more energy
Bright shiny	poor	poor	Marathon runners wrap themselves in shiny blankets to prevent thermal transfer by radiation. Fuel storage tanks are sprayed with shiny silver paint to reflect radiation from the sun

SAFETY

Safety precautions are needed because I am dealing with hot water, which can scald.
To ensure that safety is maintained whilst performing this experiment, safety measures have to be emplaced to reduce the risk of harm and dangers when carrying it out.
The following things need to be acknowledged to, in order to keep this experiment safe:

- Be careful not to knock over the beaker, which will be filled with hot water.
- Be careful not to knock over anybody else's beaker.
- Care is needed when pouring hot water.
- Do not run with the beaker of hot water.
- Make sure not to smash the thermometer as it has mercury in it.

FAIR TEST

To ensure that the experiment is made fair, I shall:

- Start the experiment at the same temperature each time.
- Use the same volume of water. This is because a greater volume of water means more energy, which would be unfair.
- Make sure that the amount of beaker covered by material is kept the same.
- Use the same bubble wrap so that the thickness and size of bubbles are kept the same.
- Use the same colour bubble wrap.
- Carry out the experiment twice and take the average – this will make the results more accurate.

EVALUATION

On completion of my experiment it can be seen that I could have improved the experiment, however I was pleased with what I had done.

I felt that I was precise when measuring volume of water and the temperature. I slowly and carefully, poured in the boiling water, however it was difficult to see measured amounts on the beaker when it steamed up and when I added more layers of bubble wrap.

Also when using the thermometer to measure the temperature, I took great care when obtaining my readings and ensured that I measured the starting temperature accurately. When timing my experiment, I made sure that I recorded the temperature at exactly the right time.

During the experiment, I took a reading every two minutes for ten minutes, which gave me five readings. At the time I felt that these five readings were enough. I repeated the experiment twice and took the average, I felt that this made the readings much more accurate yet not as time consuming as it would have been had I done the experiment three times.

I feel that although I was happy with what I had done, I could have made the experiment a lot better if I had done certain things. One factor that I feel probably would have made a significant difference to my experiment and readings would be a lid. If a lid were used there would probably be a great difference in the rate of heat loss. This is because a large amount of heat would have escaped from the top of the beaker by convection and evaporation. Hence, a lid would 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 be at a minimum, however if the material used for a lid is polystyrene or bubble wrap then the heat loss through the top of the beaker will slow down.

To improve my experiment, I could have used a measuring cylinder to measure the boiling water before putting it into the beaker. However, I think that I did it accurately without, but to be exact it probably would have been better.

To get better results, I feel that maybe I could have experimented with other materials to see which was the better insulator. By doing this, my graphs would differ, rather than being extremely similar when using different layers of bubble wrap.

I also could have conducted my experiment without any insulation so I could compare the results between insulated and non-insulated to find out if there is a distinct difference in heat loss.

HYPOTHESIS

I have chosen to use one material for my experiment. I will then use this material to surround the beaker and add extra layers in order to see what results I get when increasing the quantity of the material. The material I have chosen to use is bubble wrap.

After deciding to use bubble wrap for my experiment, I had to make a prediction about what I thought would happen.

Because bubble wrap is made up of many bubbles of trapped air I thought that it would be a good material for reducing the rate at which heat is lost. I am saying this because air is a very good insulator in small pockets.

I was sure that the more bubble wrap surrounding the beaker the less escaping heat.

My prediction was that each time we added an extra layer of bubble wrap; the results would show a higher temperature as there was less heat being lost.

I thought that the more bubble wrap around the beaker of boiling water, the better the insulator.

CONCLUSION

After completing my experiment, it can be seen that my prediction of what would happen to the rate of heat loss was incorrect. My results show that adding layers of bubble wrap to my beaker made almost no difference at all.

The results show that when the first couple of layers were added to my beaker, there was a very slight difference in the results however as we see the rest of the results, the bubble wrap seems to have had next to no effect on the heat loss.

Although my prediction was wrong and there is not really a difference between the results, I feel that if the experiment was longer, then there would have been more significant differences in the results and therefore in the graphs also.

I conclude that the layers of bubble wrap added make no real difference to the rate of escaping heat. I think this could be related to convection as I did not use a lid on my beaker and so a lot of heat was lost through the top of the beaker.

However, I feel that the time in which an experiment is performed can have a huge effect on the results, especially when not enough time is allocated for the temperature to drop.

I have come to the conclusion that if I had measured the heat loss without using an insulator then I would be able to see the effect the bubble wrap actually had on the rate of heat loss because from looking at my results it does not seem as if the material has had an effect, whereas it may have had a huge effect and not need more than one layer to trap all the heat to slow the rate at which heat is lost from the beaker.