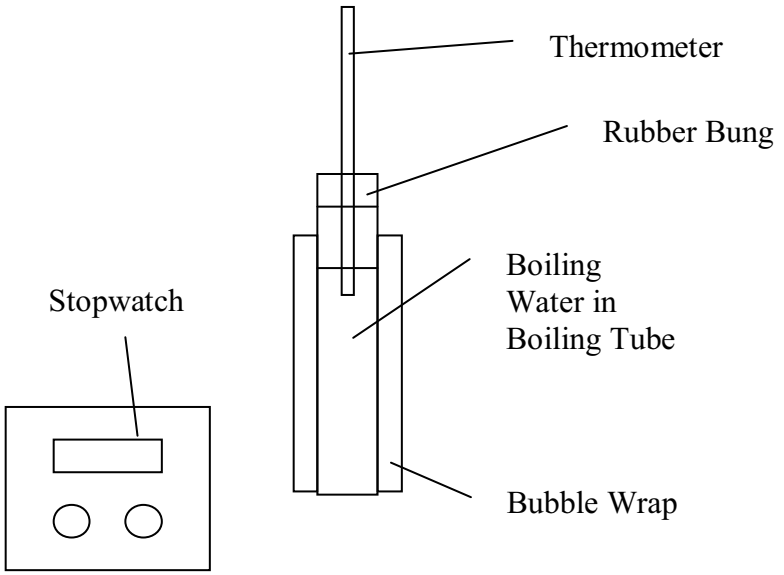
COURSEWORK ASSESSMENT – ALL SKILLS – Sc4
Lagging Pipes

Planning

Purpose

During the colder months of the year, the water in unprotected water pipes can freeze. As it does this it expands causing the pipe to split. I have been asked to investigate how different numbers of layers of an insulating material can affect this process using boiling tubes as a model.

Diagram



Apparatus
1 Test Tube Rack
5 Boiling Tubes
5 Rubber Bungs with holes
Bubble Wrap
5 Thermometers
1 Stopwatch
200 ml Water to fill each Boiling Tube with 40ml

Method

This experiment is to investigate how the thickness of the insulation affects the rate of cooling of the water in the pipe. I will set up the apparatus as above with 1 layer of the bubble wrap that covers most of the boiling tubes fastened with elastic bands to hold it in place. I will set up four more sets of apparatus as the above diagram. Each with an extra layer of bubble wrap up to a maximum of 5 layers. I will then fill the boiling tubes 40ml full of boiling water. I will place the rubber bungs into the tops of the boiling tubes fitted with the thermometers, wait until they settle and take the temperatures. I will only fill the tubes with 40ml because then the water will not be in contact with the bung, which is also an insulator that may affect the results. Immediately after taking the temperatures of the water I will set the stopwatch going. I am using a rubber bung to stop the heat escaping out the top of the tube making the experiment more accurate. Also I am using a boiling tubes rather than test tubes because it is a closer diameter to regular household water pipes.

Fair Test

To keep this a fair test I would need to measure the temperatures as accurately as possible to make my conclusions more accurate.

I would need to use the same capacity of water each time so that I can compare the results. It would also be fairer if the initial temperatures were the same each in each tube.

Prediction

I predict that the boiling tubes with the thick layers will stay the hottest the longest. This is because there are more air layers of still trapped air pockets inside. Still air is a good thermal insulator and therefore the heat cannot escape very fast. As the layers get thinner and thinner, the rate of the heat loss will be greater.

Obtaining Evidence

Results

	Temperature (˚C)					
Number of layers	0 mins.	2 mins.	4 mins.	6 mins.	8 mins.	10 mins.
1	69	66	63	60	58	56
2	66	64	62	60	58	57
3	67	65	62	60	58	56
4	58	57	55	54	52	51
5	63	61	59	57	55	54

	Temperature Difference From Start (˚C)					
Number of layers	0 mins.	2 mins.	4 mins.	6 mins.	8 mins.	10 mins.
1	0	3	6	9	11	13
2	0	2	4	6	8	10
3	0	2	5	7	9	11
4	0	1	3	4	6	7
5	0	2	4	6	8	9

Graph

(On attached sheet)

Analysing and Considering Evidence

The evidence and results that I have collected show that the thicker layers of bubble wrap do in fact insulate the water much better than the thinner layers. In my first table, I have simply entered the temperatures that I read off each thermometer at the appropriate time. I have done this to show my original evidence and to also compare with the second table and graph. The second table shows the differences from the start results for each boiling

tube, which is the total amount of heat lost during the ten-minute period. I drew this table to make the comparisons on the graph easier. I plotted these results onto the attached graph. Here is my analysis of these results.

After plotting my graph, I examined it and noticed certain trends in the results. They all sloped upwards to the right meaning that as time went on, the more heat was lost. What surprised me was that my predictions according to my results were incorrect. In fact the boiling tube with four layers of bubble wrap seemed to be the most effective. After ten minutes, it had only lost 7 ˚C whereas the tube with five layers of insulation (the one I predicted would work best) lost 9 ˚C. I looked further and I found that the best insulated boiling tubes were as follows: the best was 4 layers, then 5 layers, 2 layers, 3 layers and finally 1 layer.

This made me think, had I done the experiment properly and accurately? I was sure I had taken care in taking down the correct temperatures, so I thought I could do the experiment again. If I did this, I could compare the results from the two experiments to see whether I went wrong or whether it was actually true.

From the results of this experiment however, I have concluded that 4 layers of bubble wrap is the most effective thickness out of the range that I have tested. This is because as it is quite thick, the heat cannot conduct as easily through it. There is a lot of material for the heat to conduct through so the heat stays close to the water. It also cannot convect through the air pockets in the bubble wrap as easily as there are many of them squashed together which helps prevent this from happening.

I also think that it may have worked better than the boiling tube with five layers because more of the air chambers in the bubble wrap might have been full and not popped. The bubble wrap I used was not of the best quality and was quite worn. If a lot of the bubbles had been popped, then the heat could convect through it much more easily.

My conclusion does not support my prediction because I think to get more accurate results I would need to re-do the experiment to check that my collected results were similar.

Evaluation

I think that the method that I used for this experiment was a valid one. I t enabled me to collect the information that I needed to draw up my conclusion. The evidence that I obtained could have probably been a bit more accurate.

I could have improved my method by using thermometers of the entire same brand. That way even if the temperature displayed is inaccurate, they should all be the same. Also I could have used newer, better quality bubble wrap to make sure that popped bubbles didn’t affect my results. I could have improved the accuracy by using electronic thermometers.

To be absolutely sure of my results, I would need to almost definitely do the experiment for a second and maybe even third time to check that the results are constant and not as anomalous as the ones I have collected here.