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Insulation Coursework

Aim: To investigate the best methods to use to stop the hot water tank from cooling down quickly.

Prediction: I think that whatever material we use the outcome of the temperatures will be better than the test, which had no insulation. (Test number 7) I think that that a lid on our small copper beaker will help. Overall I think that the rough polystyrene with a lid will be the best.

Plan: Before we carried out the final test we preformed a plan test to see whether our original ideas would make a fair and correct test. We listed our thoughts for the test. Like the constants, inputs and output variables. (As shown below) We tested our thoughts and in the end changed our minds about some things.   For our plan experiments we tested the water every 15 seconds for a minute. We found this was too short. In the end we changed this so that we tested the water every minute for ten minutes this was more economical. This then all together left us with seventy results where in the plan we would only of had twenty-eight results.

Constants	Variables
• Start temperature (as close as possible)	• Lid/ no lid
• 100ml of water	• Insulation or not
• Testing time 10mins every min	• Different materials
Number of results (10 per test)	• Number of layers
	• Thickness of layers

We decided on testing our experiments by using two different types of polystyrene. A rough and a silky material. We also tried using a lid to see whether the insulation prevents conduction and taps air pockets to ke ep the water temperature constant. We also considered double insulation.
For each test we planned to use the same equipment like the copper beaker, thermometer, stopwatch and the same amount of water each time (100ml). We wanted the start temperature to be the same for each test, but we knew this was going to prove difficult. So this was to be taken into account once graphs etc had been drawn and results were being compared.   In all we were going to carry out seven experiments, six of which to be compared to one.

The Experiments:

For each experiment we collected the equipment as stated in the plan. We filled the copper beaker with boiling water and measured the start temperatures. We then put the beaker into the necessary insulation material. We th en recorded the results every minute for ten minutes. This then gave us an idea of whether the materials being tested were a good insulator. Once the test was finished we started the next recording the results as we went along.

Diagram:

Results:
Test1 – with woollen insulator

Start	87 c
1minute	84 c
2minutes	82 c
3minutes	78.5 c
4minutes	76 c
5minutes	74 c
6minutes	72 c
7minutes	70 c
8minutes	68.5 c
9minutes	67 c
10minutes	65.5 c

Test2 – with woollen insulator and cloth lid

Start	86 c
1minute	84.5 c
2minutes	83 c
3minutes	82 c
4minutes	80 c
5minutes	79 c
6minutes	78 c
7minutes	76.5 c
8minutes	75.5 c

9minutes	74.5 c
10minutes	74 c

Test3 – with woollen insulator with silky textured polystyrene and cloth lid

Start	85 c
1minute	78 c
2minutes	76 c
3minutes	75 c
4minutes	74 c
5minutes	73 c
6minutes	72 c
7minutes	71 c
8minutes	70 c
9minutes	69 c
10minutes	68 c

Test4 – with woollen insulator with silky textured polystyrene no lid

Start	89 c
1minute	84 c
2minutes	81 c
3minutes	79 c
4minutes	77 c
5minutes	75 c
6minutes	73 c
7minutes	71 c
8minutes	69 c
9minutes	67 c
10minutes	65 c

Test5 – with woollen insulator, rough textured polystyrene no lid

Start	89 c
1minute	86 c
2minutes	84 c
3minutes	80 c
4minutes	78 c
5minutes	76 c
6minutes	74 c
7minutes	72 c
8minutes	70 c
9minutes	69 c
10minutes	68 c

Test6 – woollen insulator, rough textured with lid

Start	83 c
1minute	81 c
2minutes	79.5 c
3minutes	78 c
4minutes	76.5 c
5minutes	76 c
6minutes	75 c
7minutes	74 c
8minutes	73.5 c
9minutes	72 c
10minutes	71.5 c

Test7 – No insulation. Just copper beaker

Start	85 c
1minute	82 c
2minutes	79 c
3minutes	76 c
4minutes	75 c
5minutes	73 c
6minutes	70 c
7minutes	69 c
8minutes	66 c
9minutes	64 c
10minutes	60 c

<u>Graphs</u>: My graphs are divided into 3. Each set of results using the same kind of polystyrene whether with or without a lid are compared to (test 7) the test where the copper beaker was tested on its own.

<u>Calculations:</u>

Which combination of materials works out to be the best?
Rate of cooling, (this is worked out by the temperature drops added together than divided by 10)
Test1 =

87-84, 84-82, 82-78.5, 78.5-76, 76-74, 74-72, 72-70, 70-68.5, 68.5-67,67-65.5

$$\frac{3 + 2 + 3.5 + 2.5 + 2 + 2 + 2 + 1.5 + 0.5 + 1.5}{10} = 20.5$$

20.5 / 10 = <u>2.05</u>
Therefore the average temperature drop was 2.05 c per minute measured over 10 minutes.

Test2=

86-84.5, 84.5-83, 83-82, 82-80, 80-79, 79-78, 78-76.5, 76.5-75.5, 75.5-74.5, 74.5-74

$$\frac{1.5 + 1.5 + 1 + 2 + 1 + 1 + 1.5 + 1 + 1 + 0.5}{10} = 12$$

12 / 10 = <u>1.2</u>
Therefore the average temperature drop was 1.2 c per minute measured over 10 minutes.

Test3=

85-78, 78-76, 76-75, 75-74, 74-73, 73-72, 72-71, 71-70, 70-69, 69-68

$$\frac{7 + 2 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1}{10} = 17$$

17 / 10 = <u>1.7</u>
Therefore the average temperature drop was 1.7 c per minute measured over 10 minutes.

Test4=

89-84, 84-81, 81-79, 79-77, 77-75, 75-73, 73-71, 71-69, 69-67, 67-65

$$\frac{5 + 3 + 2 + 2 + 2 + 2 + 2 + 2 + 2 + 2}{10} = 24$$

24 / 10 = <u>2.4</u>
Therefore the average temperature drop was 2.4 c per minute measured over 10 minutes.

Test 5=

89-86, 86-84, 84-80, 80-78, 78-76, 76-74, 74-72, 72-70, 70-69, 69-68

$$\underline{3 + 2 + 4 + 2 + 2 + 2 + 2 + 2 + 1 + 1} = 21$$

21 / 10 = <u>2.1</u>
Therefore the average temperature drop was 2.1 c per minute measured over 10 minutes.

Test 6=
$$\frac{\overset{83\text{-}81,}{2} \overset{81\text{-}79.5,}{+ \ 1.5} \overset{79.5\text{-}78,}{+ \ 1.5} \overset{78\text{-}76.5,}{+ \ 1.5} \overset{76.5\text{-}76,}{+ \ 0.5} \overset{76\text{-}75,}{+ \ 1} \overset{75\text{-}74,}{+ \ 1} \overset{74\text{-}73.5,}{+ \ 0.5} \overset{73.5\text{-}72,}{+ \ 1 \ .5} \overset{72\text{-}71.5}{+ \ 0.5}}{10} = 11.5$$

11.5 / 10 = <u>1.15</u>
Therefore the average temperature drop was 1.15 c per minute measured over 10 minutes.

Test 7=
$$\frac{\overset{85\text{-}82,}{3} \overset{82\text{-}79,}{+ \ 3} \overset{79\text{-}76,}{+ \ 3} \overset{76\text{-}75,}{+ \ 1} \overset{75\text{-}73,}{+ \ 2} \overset{73\text{-}70,}{+ \ 3} \overset{70\text{-}69,}{+ \ 1} \overset{69\text{-}66,}{+ \ 3} \overset{66\text{-}64,}{+ \ 2} \overset{64\text{-}60}{+ \ 4}}{10} = 25$$

25 / 10 = <u>2.5</u>
Therefore the average temperature drop was 2.5 c per minute measured over 10 minutes.

From my cooling rate calculations I can see that test 2 has the lowest average cooling rate meaning this combination of materials is the better insulator.

<u>Conclusion:</u>   From my experiments I can see that that test number 2 was the overall winner from the cooling rate calculations but on the graphs I can see that on graph (tests 1 and 2) the experiment with lid was the best. On the graph (tests3 and 4) the experiment with silky polystyrene and no lid was the best. On the graph (tests and 6) the experiment with rough polystyrene with lid was the best. Overall I think the experiments with a lid insulated the water better.

<u>Evaluation:</u> I found that performing a set of plan experiments very helpful because I found that some of my ideas to find out the overall answer were not correct. If I hadn't of found the faults out then my experiments would have been a waste of time. I found that all results were helpful showing different materials capabilities but I found that working out of cooling rate was more helpful because reading from the graphs was proving difficult due to the differences in start temperatures. If I was to re do this experiment I think if I can more time I could of experimented with a wider range of materials and test further layers to try and improve the insulation. It is hard to keep the experiments fair throughout a range of different tests but on the whole I think our tests were successful.