Investigation to see if water can be boiled more quickly using different methods of insulation

Introduction

We are finding out if we can make water boil faster using different methods of insulation, taking into account conduction, convection and radiation. We know that dull black surfaces are best for absorbing radiation (conduction) and that shiny silver surfaces are best for reflecting radiation. This will be proved in the investigation.

Prediction

I think each time we improve our insulation the time it takes to boil the water will be shorter based on the information I know about conduction, convection and radiation.

Method

Equipment

- Candle
- Test tube
- Stand
- Heat proof mat
- Stop clock
- Thermometer
- Tin foil (shiny silver)
- Tin can
- Pipe insulation (black)
- Weights

First of all, we put 30ml of water in a test tube with the bulb of the thermometer in the water and the height of the test tube on the stand was just so the flame touched the bottom of the test tube. Every 30 seconds after the candle was lit the temperature of the water was noted. We made three modifications for the burner:

- **Modification 1** – No change.
- **Modification 2** – Tin can with dull black pipe insulation around the outside, as dull black absorbs radiation best, was place around the candle and the bottom of the test tube. The can was propped up with weights to allow oxygen in. Shiny foil was laid around the inside of the can because shiny silver reflects radiation best.
- **Modification 3** – Same as modification 2 but added a foil chimney, for the head to go up, from the top of the tin can to the bottom of the test tube.

Overall the investigation was fair, the only thing that was a problem was the candle, which obviously shrunk as the wax melted, and the flame size did not always stay constant, but this will not have made a great difference in temperature as it was reasonably the same size throughout the experiment.

Results

The temperature after every half a minute was recorded in a table as follows.

Modification 1:

Time(minutes)	0	.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5
Temperature(C°)	23	29	40	47	51	63	70	77	83	88	91	97
Difference in C°	6	11	7	4	12	7	7	6	5	3	6	-

Underlined = Boiling point Mean difference in C° each 30 seconds = 7

Modification 2:

Time(minutes)	0	.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5
Temperature(C°)	20	36	44	55	64	73	82	88	95	-	-	-
Difference in C°	6	8	11	9	9	9	6	7	-	-	-	-

Underlined = Boiling point Mean difference in C° each 30 seconds = 8

On modification 2 when the water boiled the water bubbled to the top and went back down several times. Also, the candle, when using modification 2 and 3, melted much more wax even though the time it was lit for was less.

Modification 3:

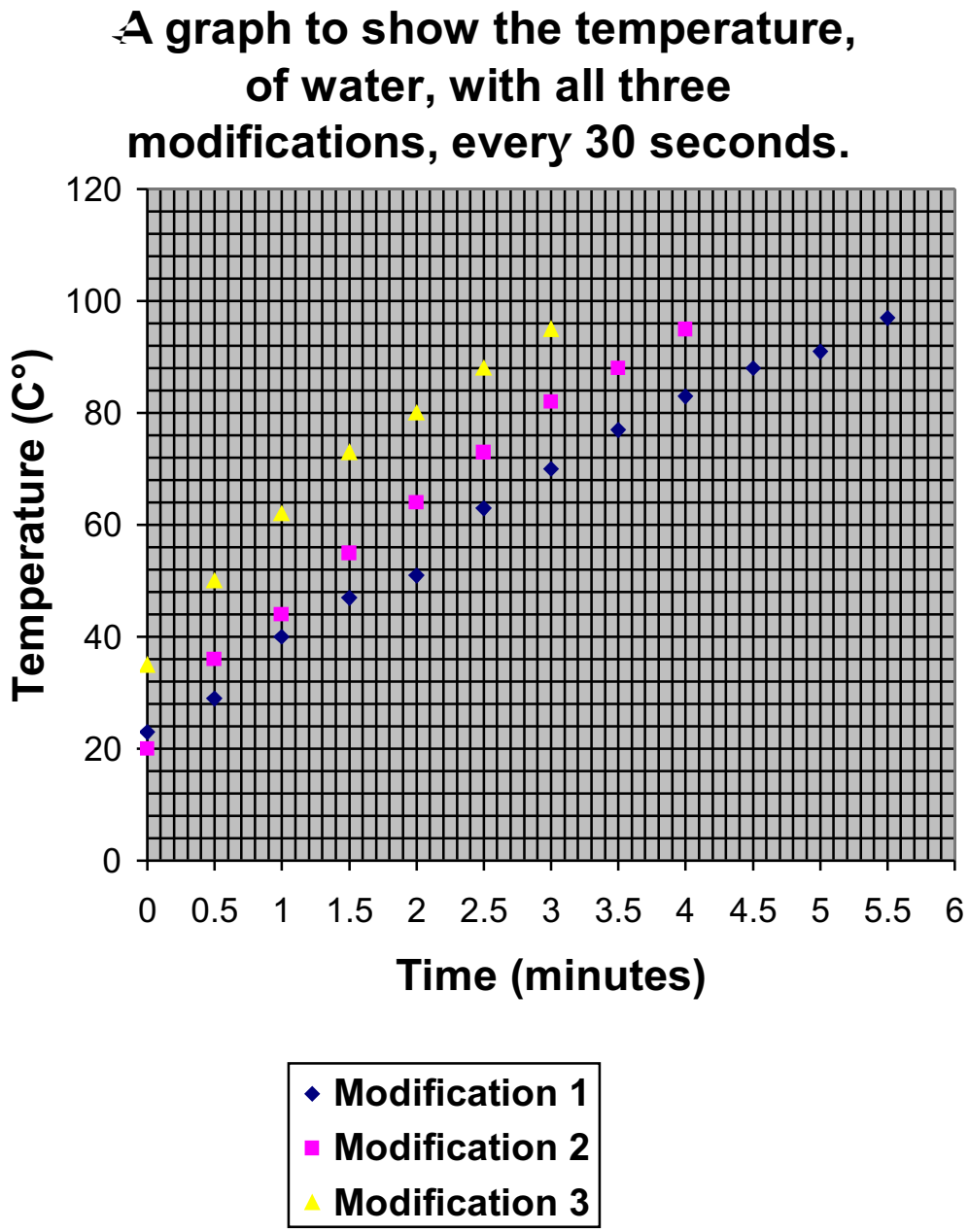
Time(minutes)	0	.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5
Temperature(C°)	35	50	62	73	80	88	95	-	-	-	-	-
Difference in C°	15	12	11	7	8	7	-	-	-	-	-	-

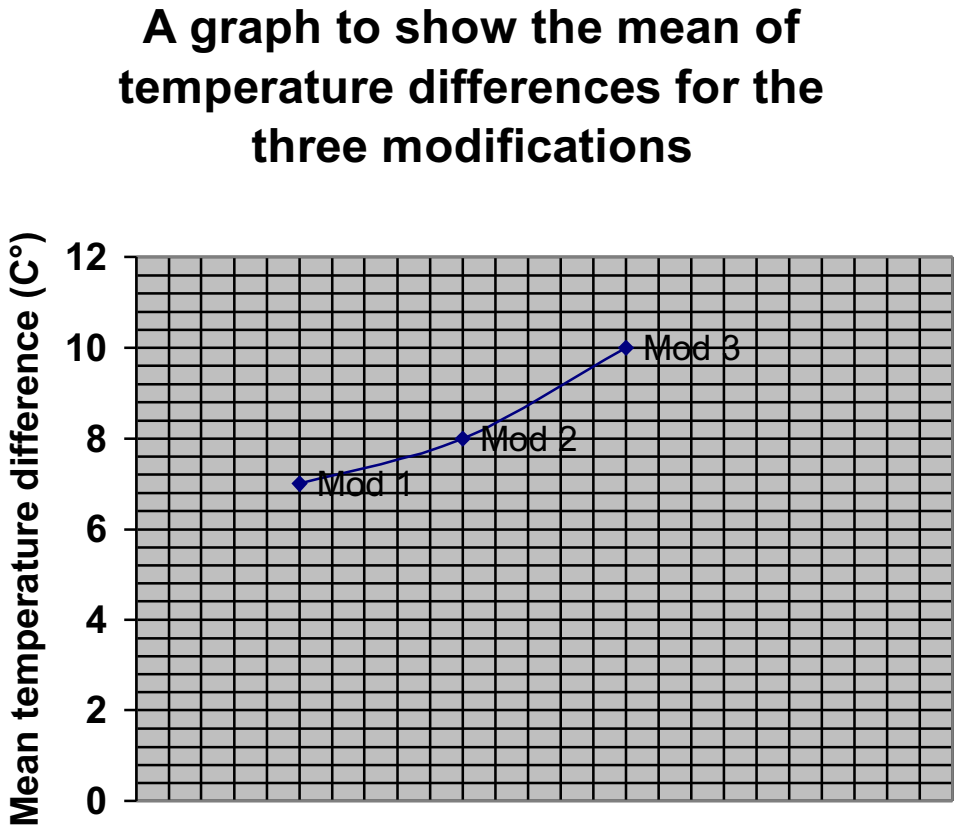
Underlined = Boiling point Mean difference in C° each 30 seconds = 10

As you can see the average difference of temperature increased as we added more efficient modifications.

Analysis

The information from the past three tables has been plotted on a graph.





The graph to show the temperature of water with all three modifications shows that the rate at which the water came to boiling point was faster as I improved my methods of absorbing heat and keeping heat in. The line of best fit goes through most of the points on the graph so my measurements are not wrong.
The graph to show the mean of temperature differences for the three modifications shows that the average temperature increase every 30 seconds for modification 1 is 7, for modification 2 it is 8 and for modification 3 it is 10. This also proves that the speed at which the water boiled greatly improved due to the modifications and insulation. This proves my prediction.

Conclusion

The investigation worked and everything happened as I expected. My prediction was right, '*I think each time we improve our insulation the time it takes to boil the water will be shorter based on the informati on I know about conduction, convection and radiation*.' During the experiment many things stayed the same.

Things that stayed the same:

- Test tube
- Test tube height
- Candle
- Thermometer
- Thermometer height

- Amount of water
- Stop clock
- Thermometer reader

This was a very good example of how insulation works depending on the colour of insulation, black for absorbing radiation and shiny silver to reflect radiation, so black is good for external insulation and shiny silver for internal insulation. If I was to do this investigation I would check the amount of water each time I boiled the water as some will have evaporated, I would also adjust the thermometer height and test tube height after each modification because the candle lost size, especially in modification 2 and 3. I would also be curious to measure how much fuel was used by measuring the weight of the candle before and after.

By
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