Deliverable H: Prototype III and Customer Feedback

Team Jeff

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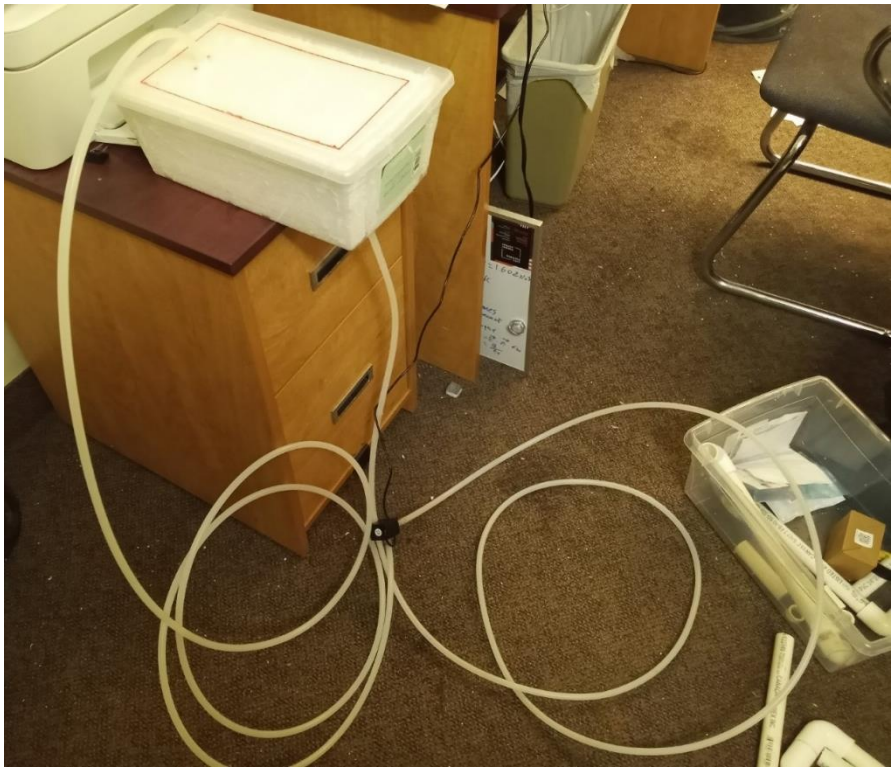
1 Introduction

This document outlines the third and the last prototype. It will contain all critical components outlined in the previous deliverable (G). The final prototype will function as a model to simulate extended use of the design and see whether the design is successful. The document also contains detailed descriptions and analysis of heating tests that was conducted after building the final prototype. During these tests, we evaluated the rate of heating using a thermometer to periodically measure the temperature of the water in the system.

2 Prototype III

This prototype is comprised of a single component of our final prototype. The prototype is made from 25 ft of partially clear vinal tubing, and an electric water pump, with 8 out of the 25 ft serving as the main solar water heating coil.

Figure 1 - Prototype 3.0



3 Tests conducted

3.1 Test 1

Test 1 was to measure the efficiency of the solar water heater. The test was done on the heating subsystem exclusively before its integration into the final prototype, measuring the temperature of the water as a function of time compared to the ambient temperature.

3.1.1 Results

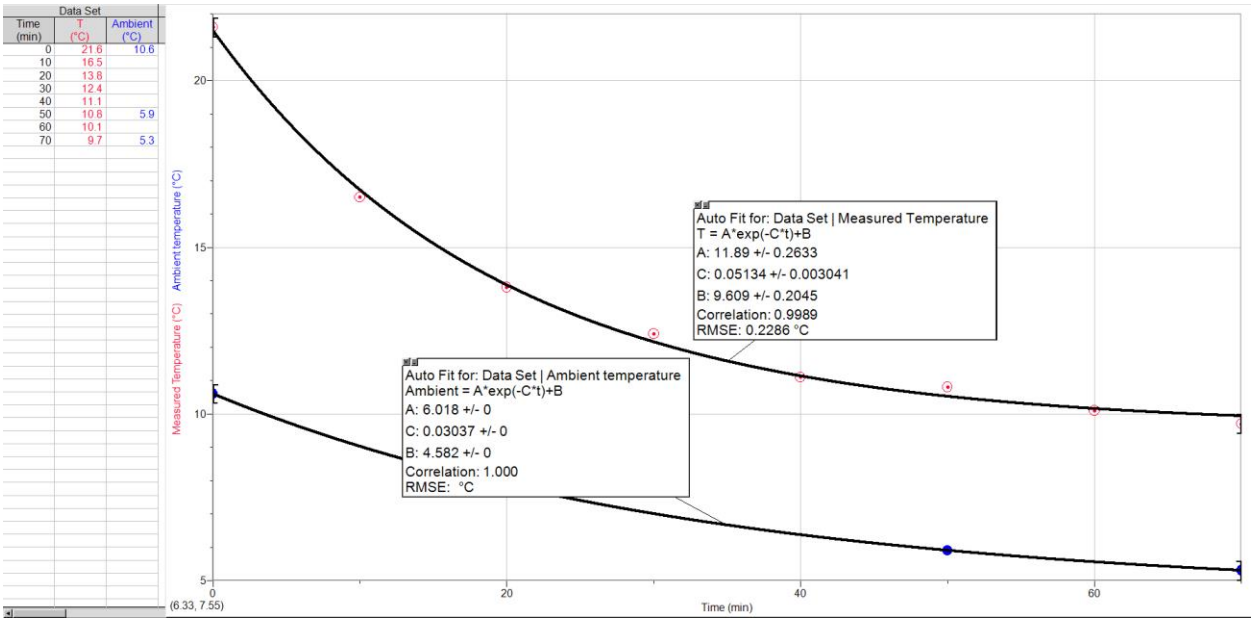
Table 1 - Temperature measured and ambient temperature as a function of time

time (min)	Ambient	Temperature (°C)
0	10.6	21.6
10		16.5
20		13.8
30		12.4
40		11.1
50	5.9	10.8
60		10.1
70	5.3	9.7

This test was conducted during cloudy weather and was only stopped prematurely because of rain.

3.1.2 Analysis

Graph 1 - Temperature measured and ambient temperature as a function of time



Results do not look too promising for the temperature is constantly decreasing. However, there are some adjustments to be made to help the prototype to retain heat better.

3.2 Test 2

The second test was conducted on the final prototype and was a fully functional simulation of typical operation. The test measured air output from the THEC with our integrated heating system. The initial water was around room temperature and was not measured as part of the test. The purpose of the test was to determine whether our design could work in practice.

3.2.1 Results

Table 2 - Temperature measured and ambient temperature as a function of time

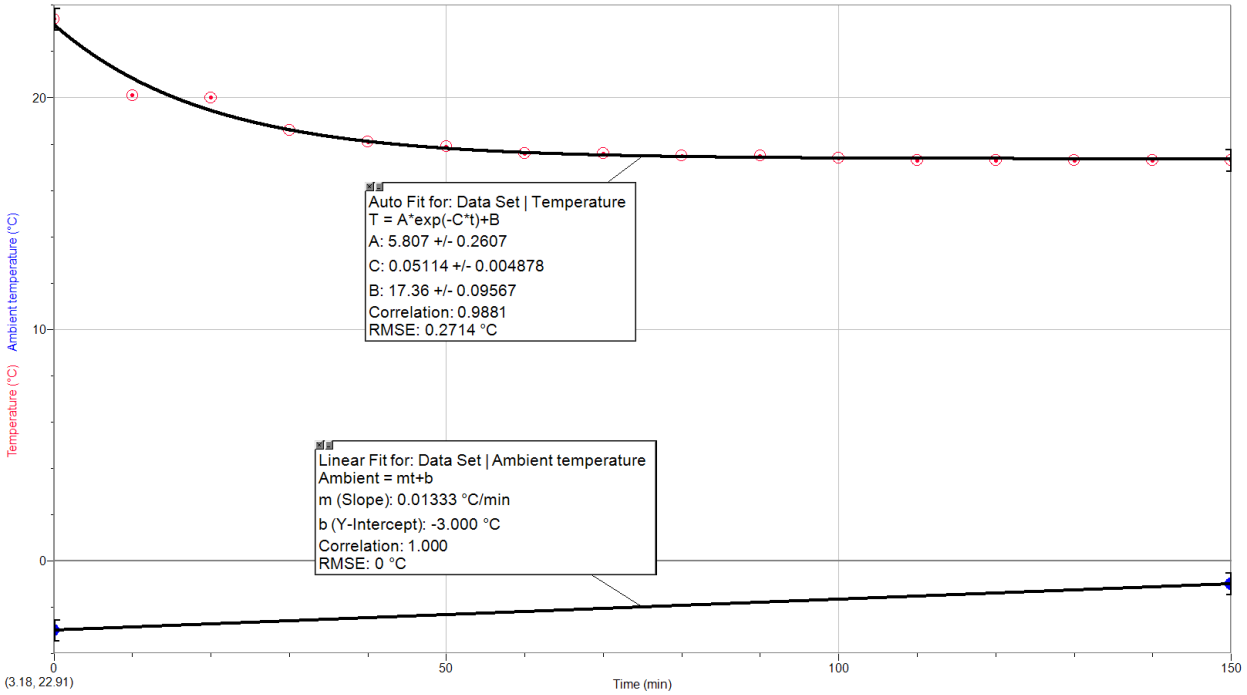
Time (min)	Output Air Temperature (°C)	Ambient Temperature (°C)
0	23.4	-3
10	20.1	
20	20	
30	18.6	
40	18.1	
50	17.9	
60	17.6	
70	17.6	
80	17.5	
90	17.5	
100	17.4	
110	17.3	
120	17.3	
130	17.3	
140	17.3	
150	17.3	-1

This test was conducted in doors from 18:00 – 20:20 (6 pm – 8:20 pm) with the prototype located next to a wide opened window. The air fan position was changed slightly, and duct tape was used to make it sturdier and stop water leaking. But the general plan is still the same.
Figure 5 – Prototype 3.2

Figure 2 - New location of the air fan

3.2.2 Analysis

Graph 2 - Temperature measured and ambient temperature as function of time



The temperature dropped relatively drastically in the first 30min. However, after 30min into the test, it reached equilibrium with value measured of 17.3 – 18.1 °C.

Remarks:

The temperature dropped until an equilibrium point was reached, and we believe the better results were due to a tighter seal on the insulation and having previously exposed coils now enclosed in THEC.

4 Potential User Feedback

Feedback from a construction contractor

We had a discussion with a construction contractor regarding our design. The major concern is to make sure the solar water heater is whether it is installed properly or not. Also, since solar water heating is relatively heavy, the roof must be capable of holding the weight of the solar water heater. It may be required to add some reinforcement to the roof. Another concern is that trenching the underground soil may affect the stability of the building, but this depends on the geological setting of the building.

5 Conclusions

With the first test performing relatively poorly, the team decided to slightly tweak the prototype. After making some minor adjustments to the position of the air fan and sealing the pipes more efficiently, we confirmed with a second test that the prototype does indeed retain heat well and does perform to the results that were expected.

6 Annex: further images of the prototype 3.2

Figure 3

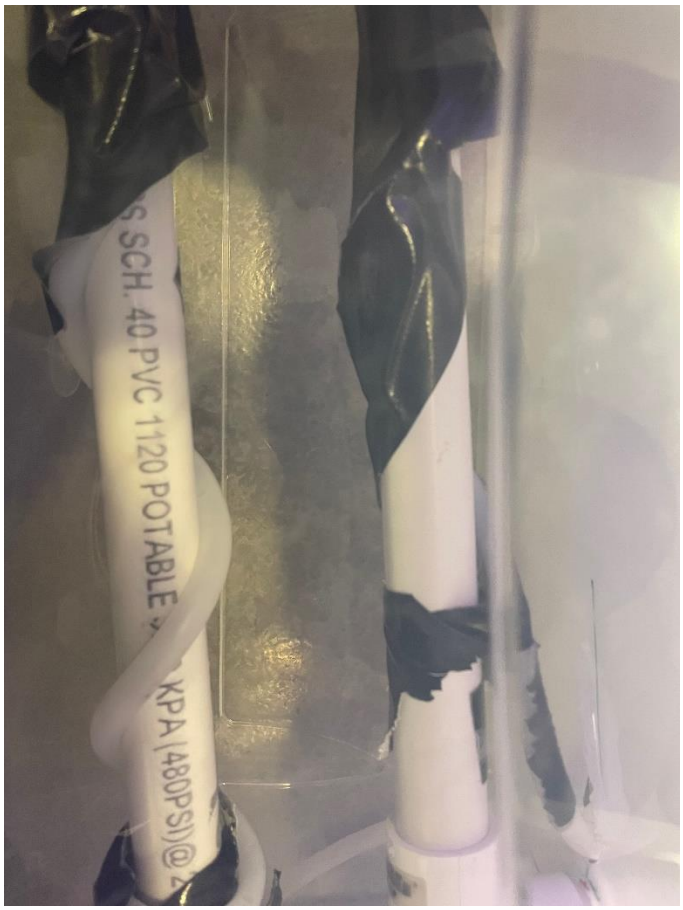


Figure 4

Figure 5 – Prototype 3.2

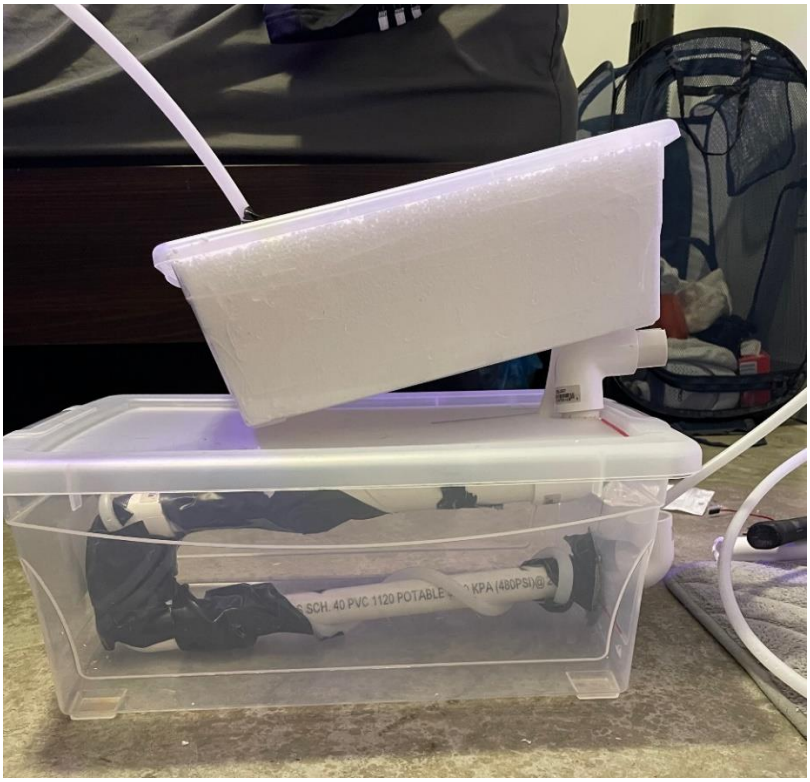


Figure 6

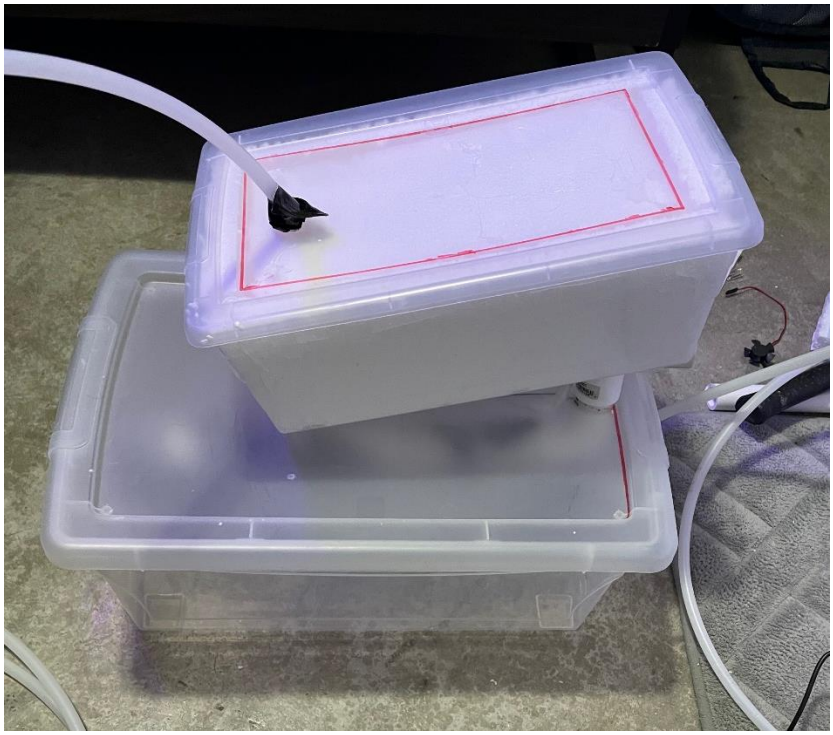
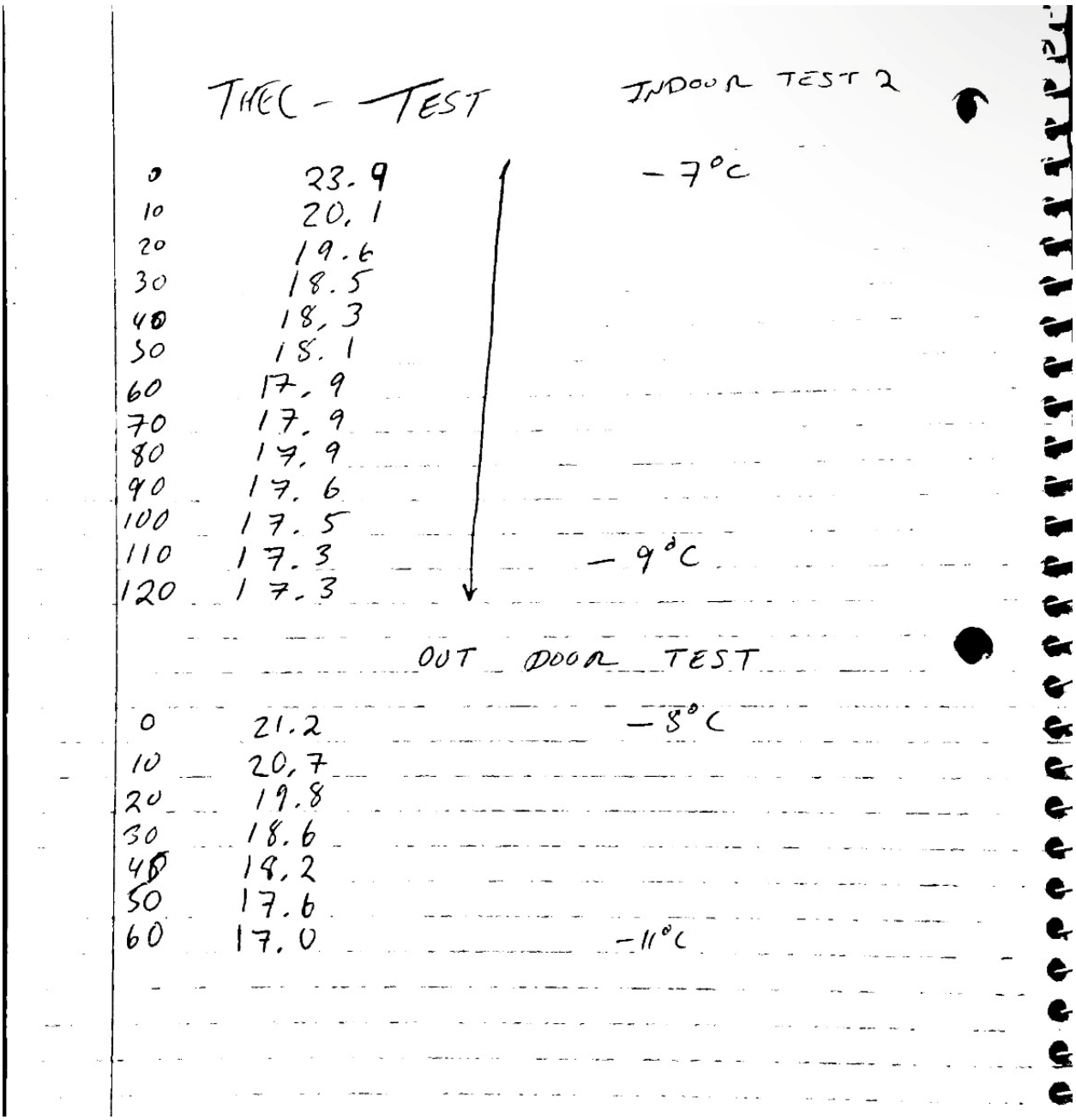


Figure 7

7 Appendix B: Post Submission Test Results



THEC - TEST

INDOOR TEST 2

0	23.9
10	20.1
20	19.6
30	18.5
40	18.3
50	18.1
60	17.9
70	17.9
80	17.9
90	17.6
100	17.5
110	17.3
120	17.3

−7°C

−9°C

OUT DOOR TEST

0	21.2
10	20.7
20	19.8
30	18.6
40	18.2
50	17.6
60	17.0

−8°C

−11°C

Figure 8: Test 2 - Trial 2 and 3 Results

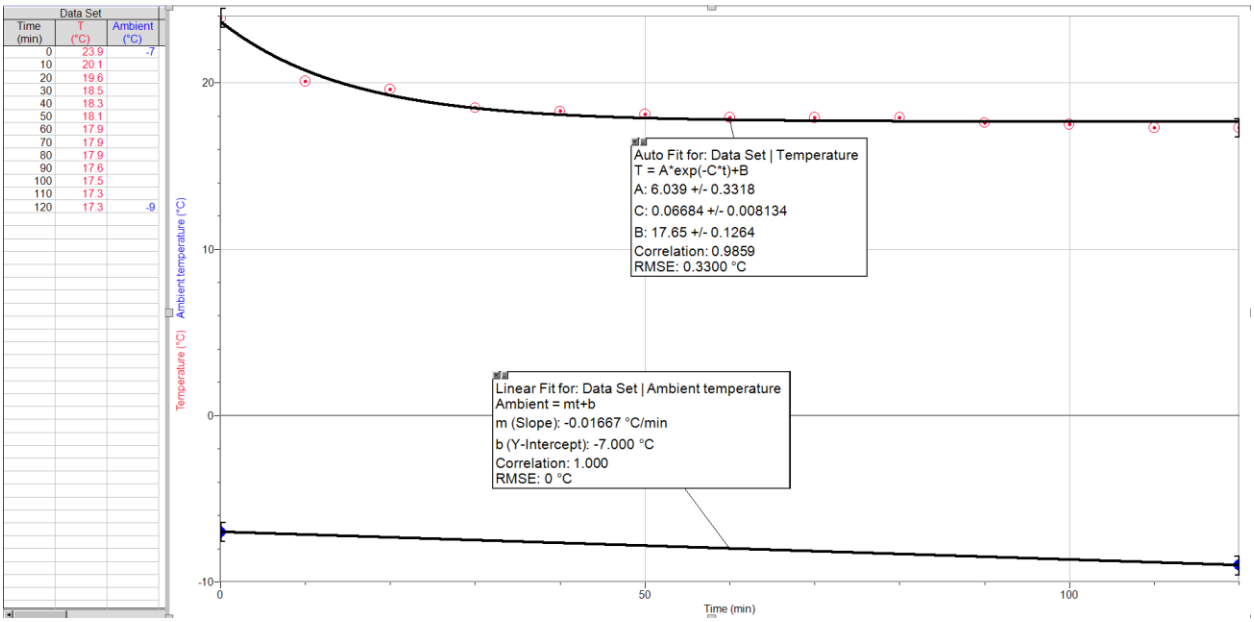


Figure 9: Graph 3 Trial 2 Results

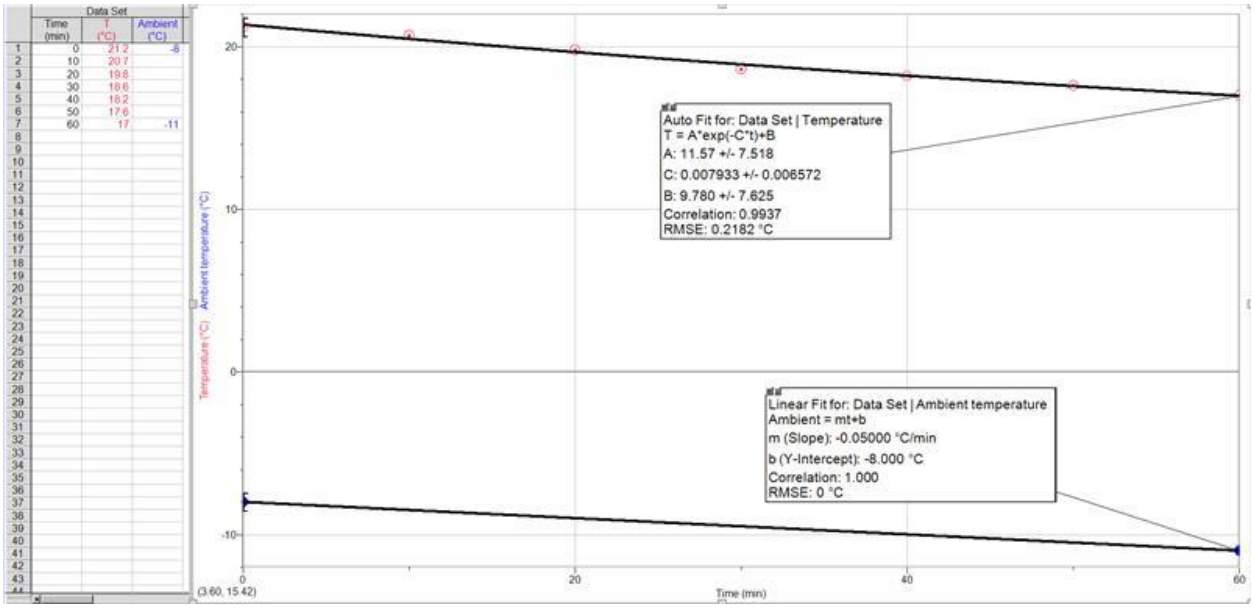


Figure 10: Graph 4 Trial 3 Results