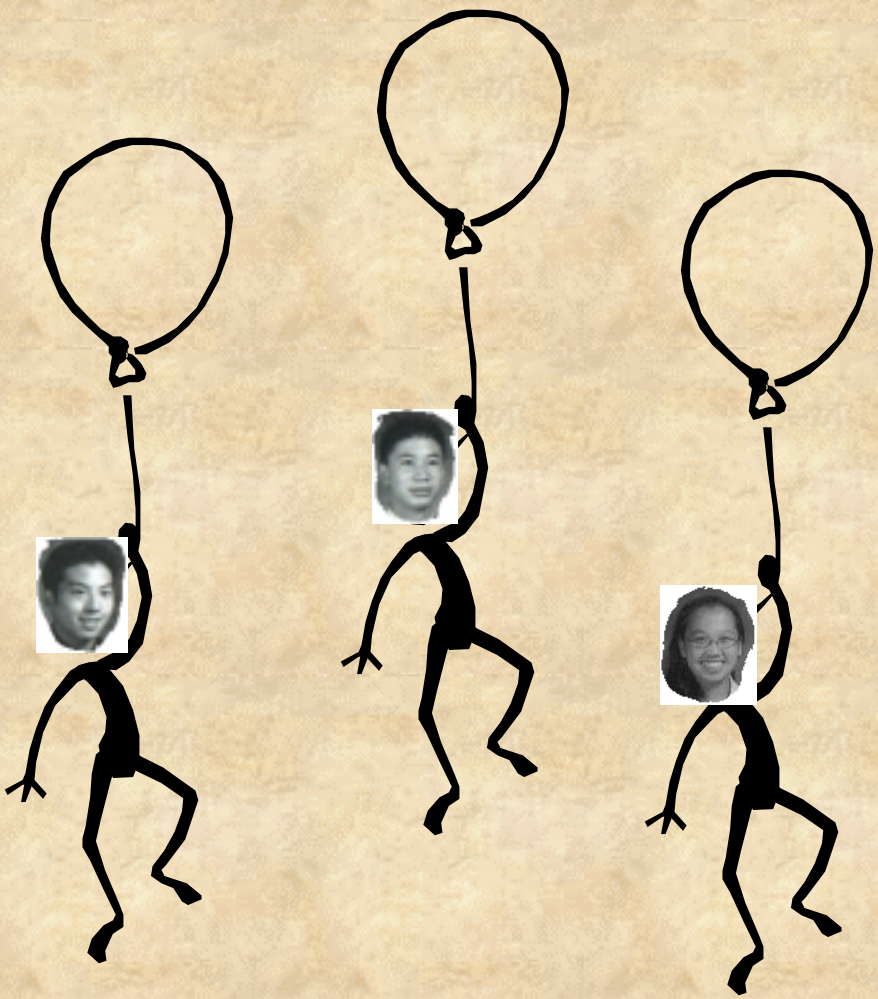
Balloon Fest 2003



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March 29,2003

Purpose

- measure pressure, temperature, and acceleration at different altitudes
- analyze the data we have gathered
- compare our data to NASA's models.

Procedure – The Launch

- Setup gondola – with the labpro and 3 probes:
  - Accelerometer
  - Thermometer
  - Barometer
- Set labpro to take data every second for 3600 seconds (one hour)
- Blew up balloon on roof and tied gondola to bottom of balloon.
- Simultaneously started labpro and stopwatch
- Let it rise for 1000 feet into air with increments of 100 feet
  - Recorded height and took angle measurements for each height

NASA Empirical Model

$$P = P_o(1 - h/145442\ ft)^{5.255876}$$

$$T = T_0\ (1 – h\ /\ 44329\ m)$$

Our Data

$$P = P_o(1 - h/145442\ ft)^{6.77}$$

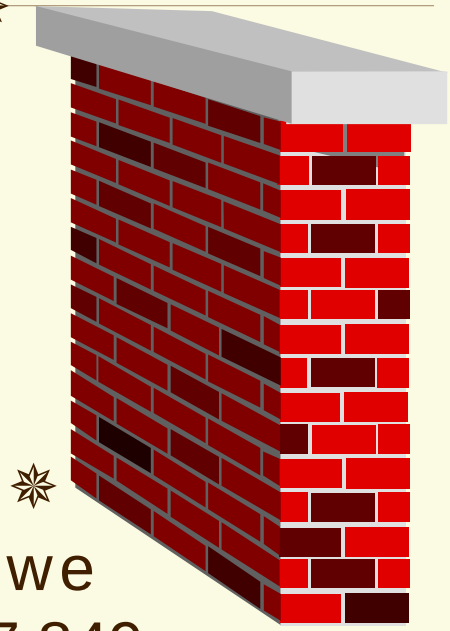
These are the projected values for the pressure and temperature data collected and the values that we received.

Calculation of Actual Height from the Roof

Feet of Rope	Angle of Rope*	—>	Height from the Roof
0 ft	0˚	0sin87˚	0 ft
100 ft	3˚	100sin87˚	99.86 ft
200 ft	3˚	200sin87˚	199.73 ft
300 ft	3˚	300sin87˚	299.58 ft
400 ft	3˚	400sin87˚	399.45 ft
500 ft	5˚	500sin85˚	498.09 ft
600 ft	5˚	600sin85˚	597.72 ft
700 ft	7˚	700sin83˚	694.78 ft
800 ft	8˚	800sin82˚	792.21 ft
900 ft	8˚	900sin82˚	891.24 ft
1000 ft	10˚	1000sin80˚	984.81 ft

** We lost our data, so we do not know the exact angle for each hundred-foot mark. However, we do know that the angle remained consistent until four hundred feet and increased up to 10° at one thousand feet. We are certain that the angle never exceeded 10 °.*

Height of the Roof from Sea Level (Surface of the Earth)



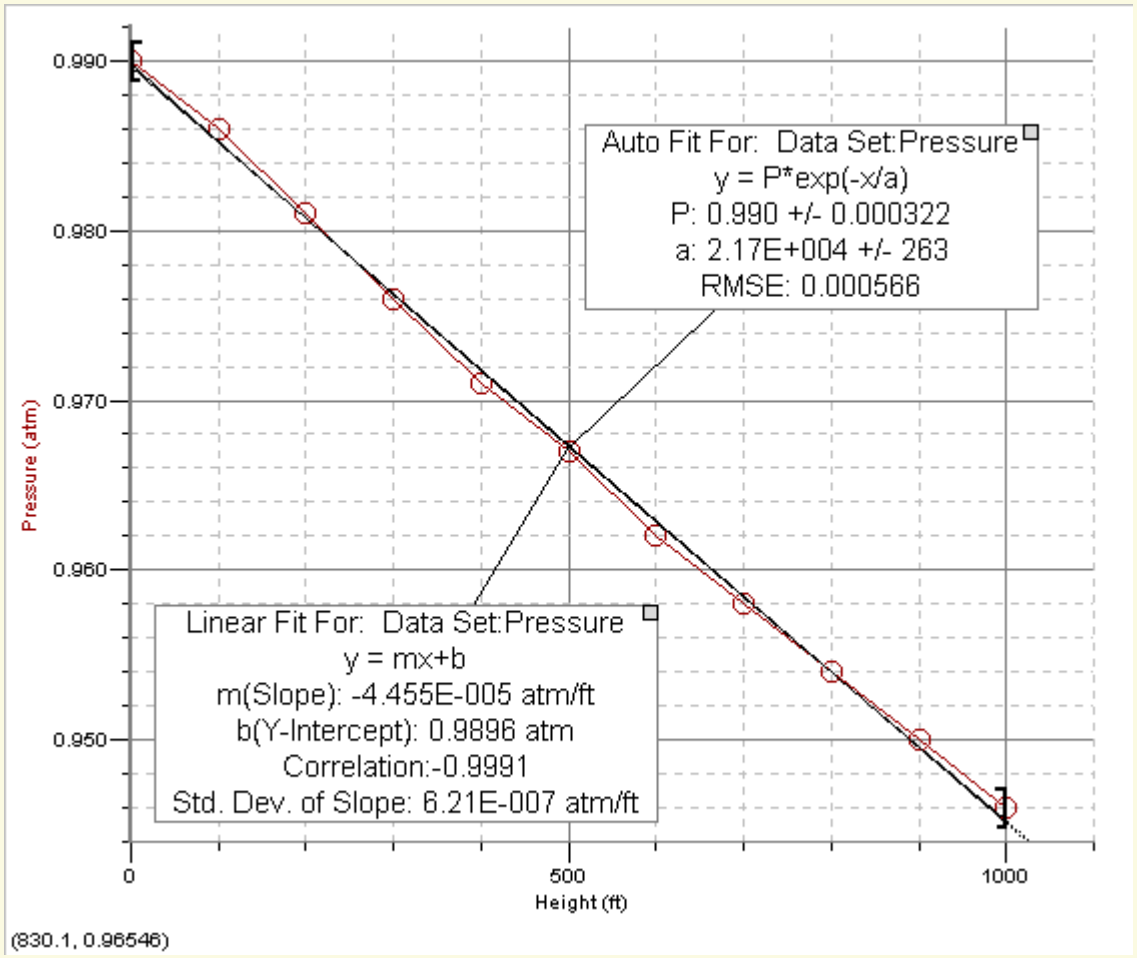
Using the $P = P_o e^{(-h/27600)}$ we found the height of the roof to be 277.389 ft or 84.544 m

Using the $P = P_o(1 - h/145442\ ft)^{5.255876}$ we found the height of the roof to be 277.849 ft or 84.684 m

These heights are relatively similar in physics terms!!

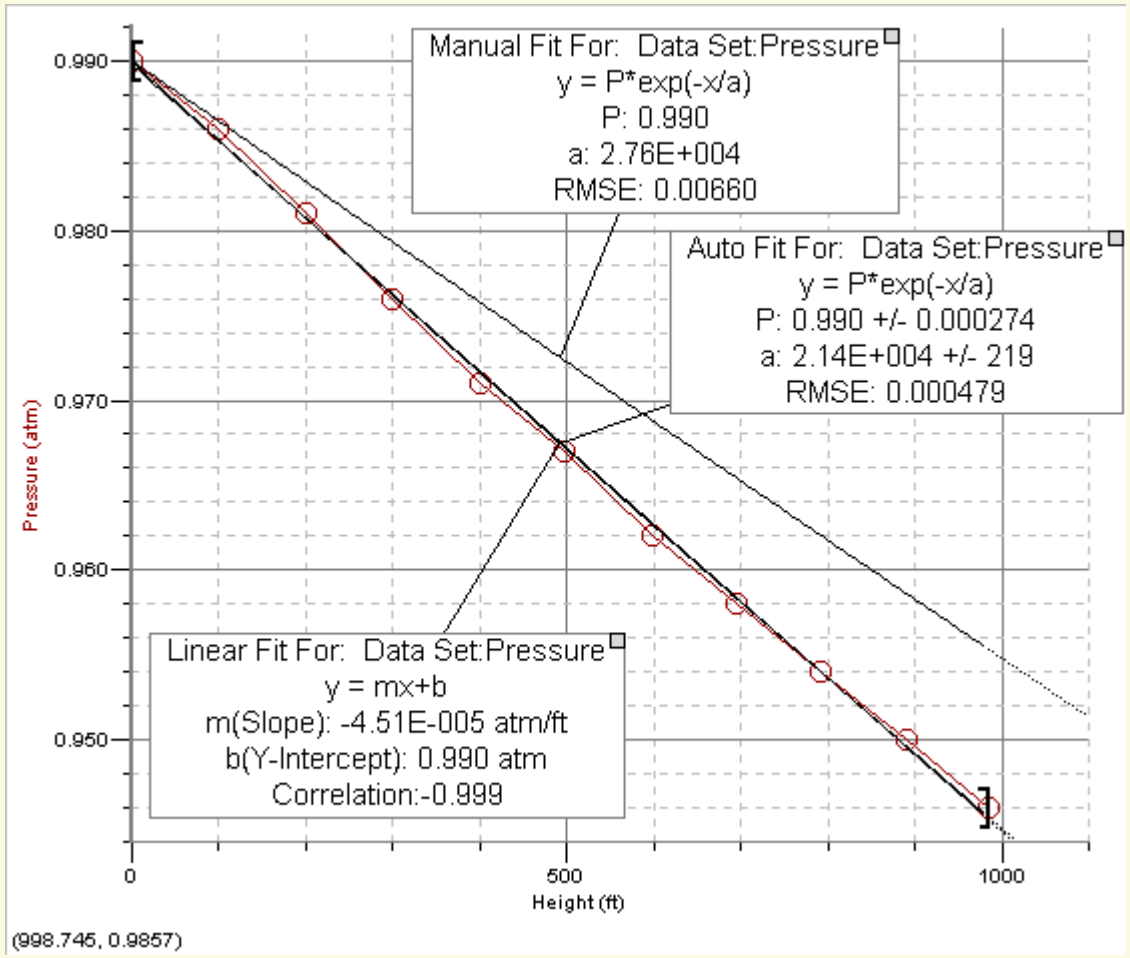
Height vs. Pressure

	Data Set	
	Height (ft)	Pressure (atm)
1	0	0.990
2	100	0.986
3	200	0.981
4	300	0.976
5	400	0.971
6	500	0.967
7	600	0.962
8	700	0.958
9	800	0.954
10	900	0.950
11	1000	0.946
12		



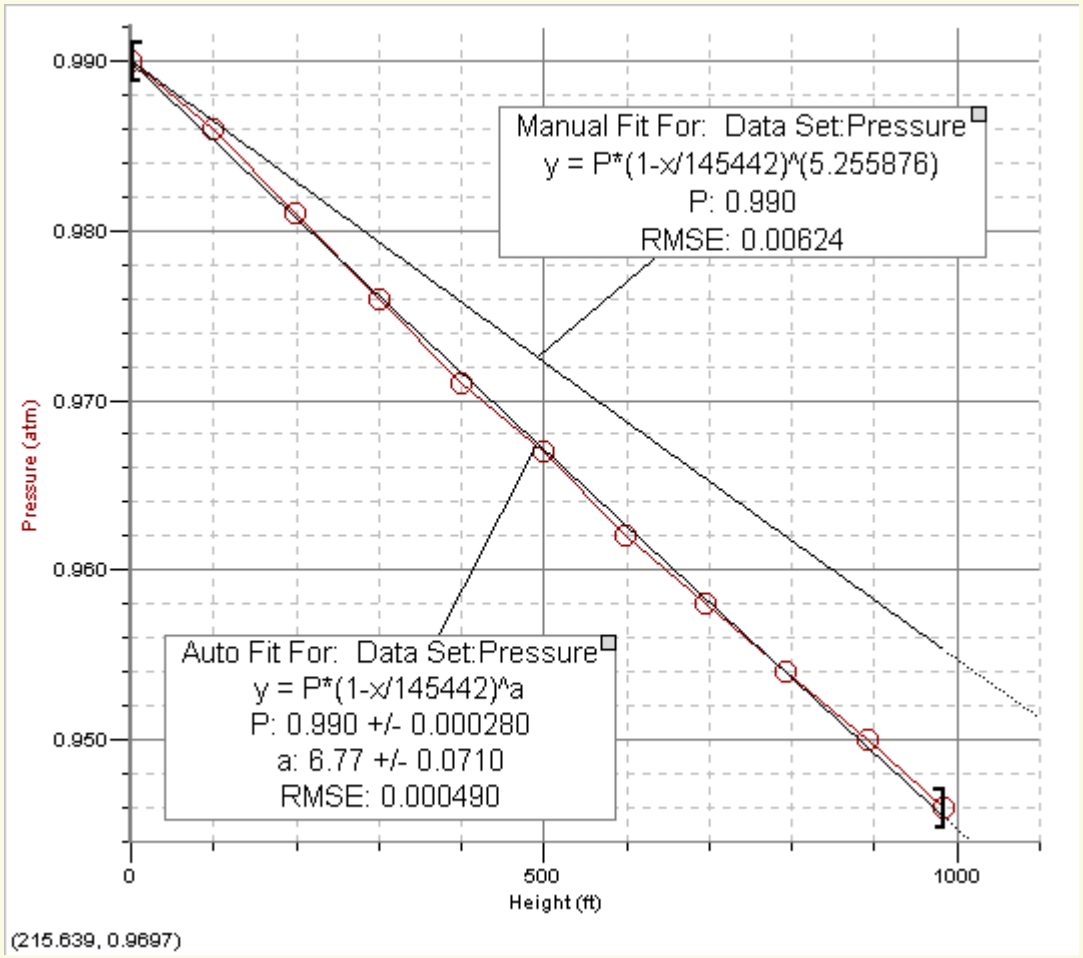
Height vs. Pressure (Fixed Heights)

	Data Set	
	Height (ft)	Pressure (atm)
1	0.00	0.990
2	99.86	0.986
3	199.73	0.981
4	299.58	0.976
5	399.45	0.971
6	498.09	0.967
7	597.72	0.962
8	694.78	0.958
9	792.21	0.954
10	891.24	0.950
11	984.81	0.946
12		



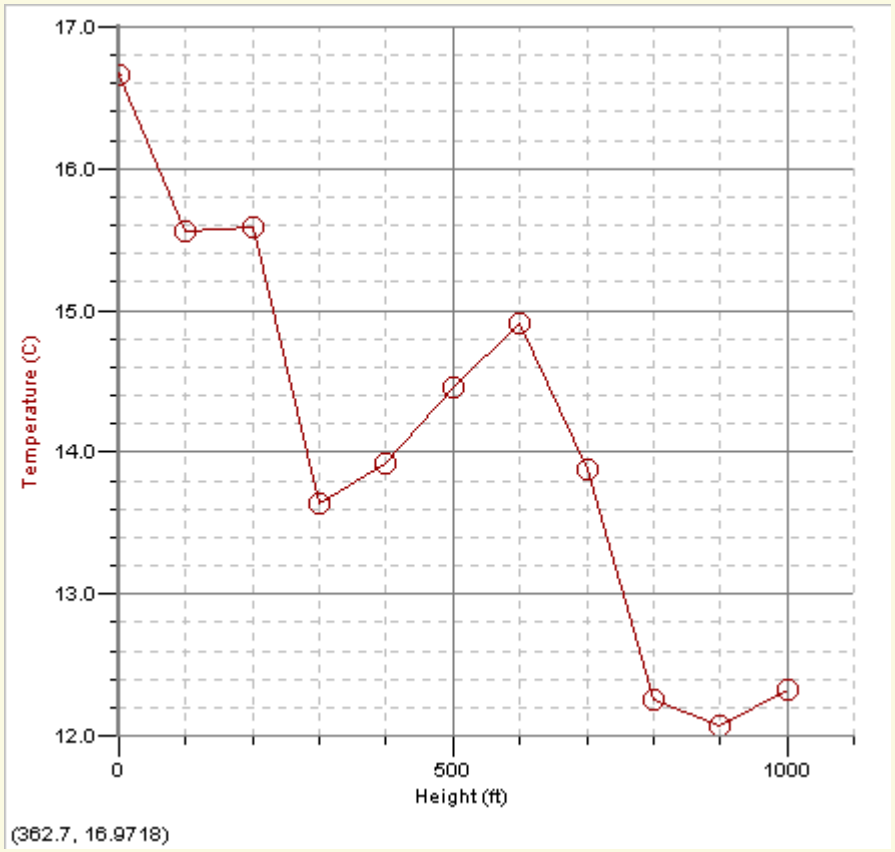
Height vs. Pressure (NASA Model)

	Data Set	
	Height (ft)	Pressure (atm)
1	0.00	0.990
2	99.86	0.986
3	199.73	0.981
4	299.58	0.976
5	399.45	0.971
6	498.09	0.967
7	597.72	0.962
8	694.78	0.958
9	792.21	0.954
10	891.24	0.950
11	984.81	0.946
12		



Height vs. Temperature

	Data Set	
	Height (ft)	Temp (C)
1	0	16.667
2	100	15.566
3	200	15.592
4	300	13.639
5	400	13.916
6	500	14.453
7	600	14.903
8	700	13.877
9	800	12.253
10	900	12.064
11	1000	12.329
12		



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	Height (ft)	Temp (C)
1	0.00	16.667
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5	399.45	13.916
6	498.09	14.453
7	597.72	14.903
8	694.78	13.877
9	792.21	12.253
10	891.24	12.064
11	984.81	12.329
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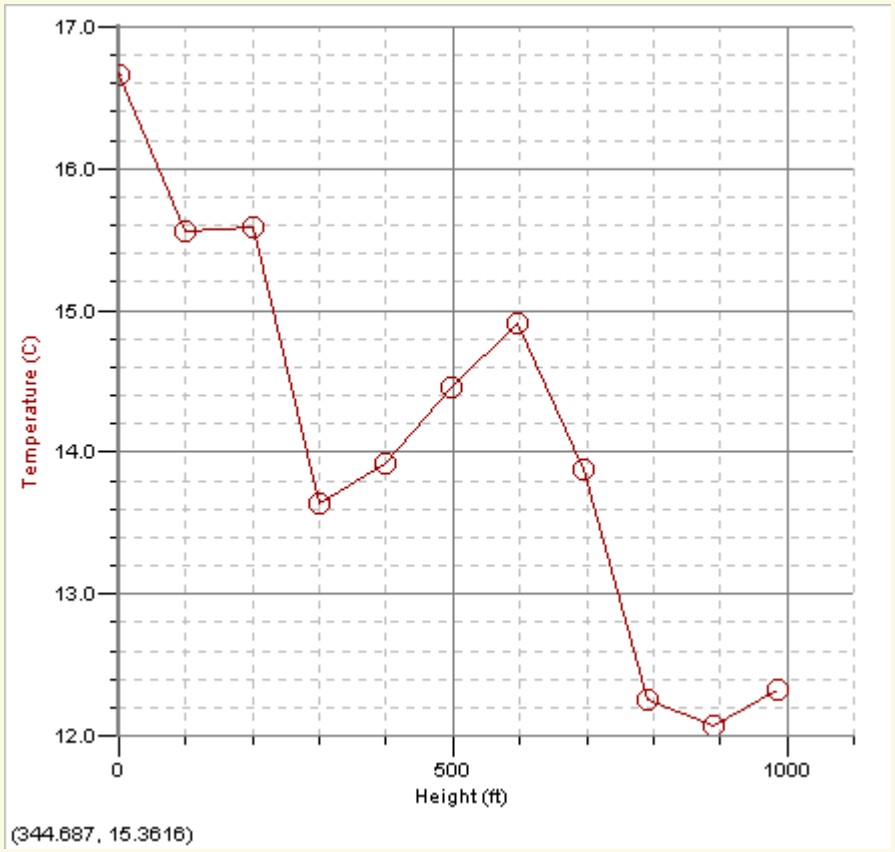

Height vs. Temperature (NASA model)

	Data Set	
	Height (ft)	Temp (C)
1	0.00	16.667
2	99.86	15.566
3	199.73	15.592
4	299.58	13.639
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8	694.78	13.877
9	792.21	12.253
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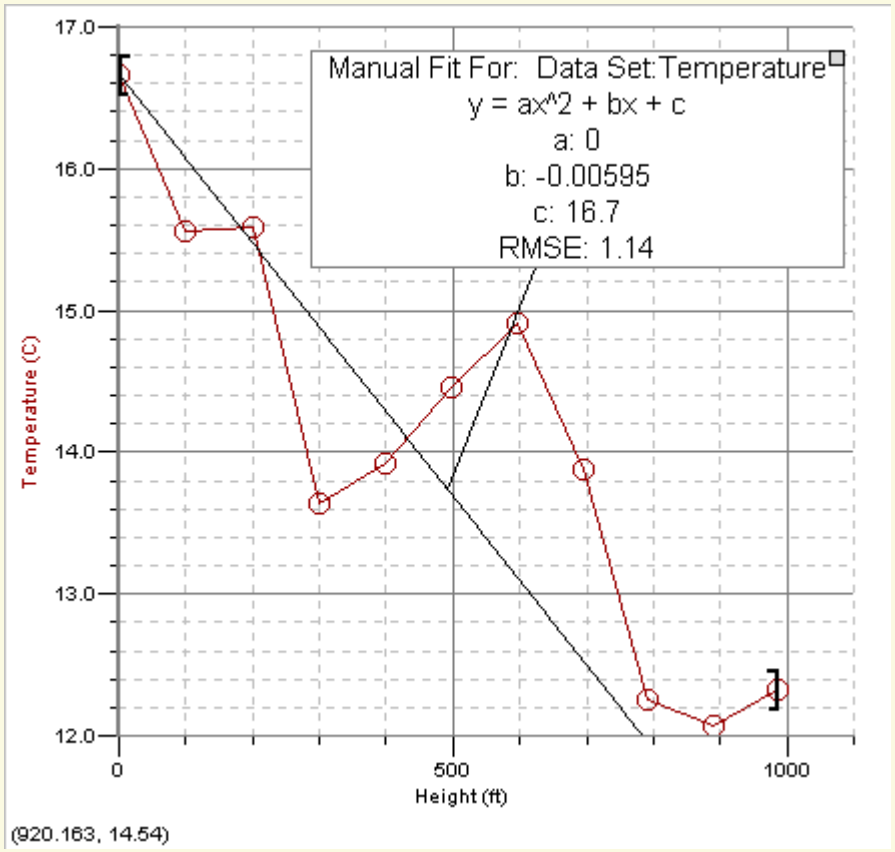
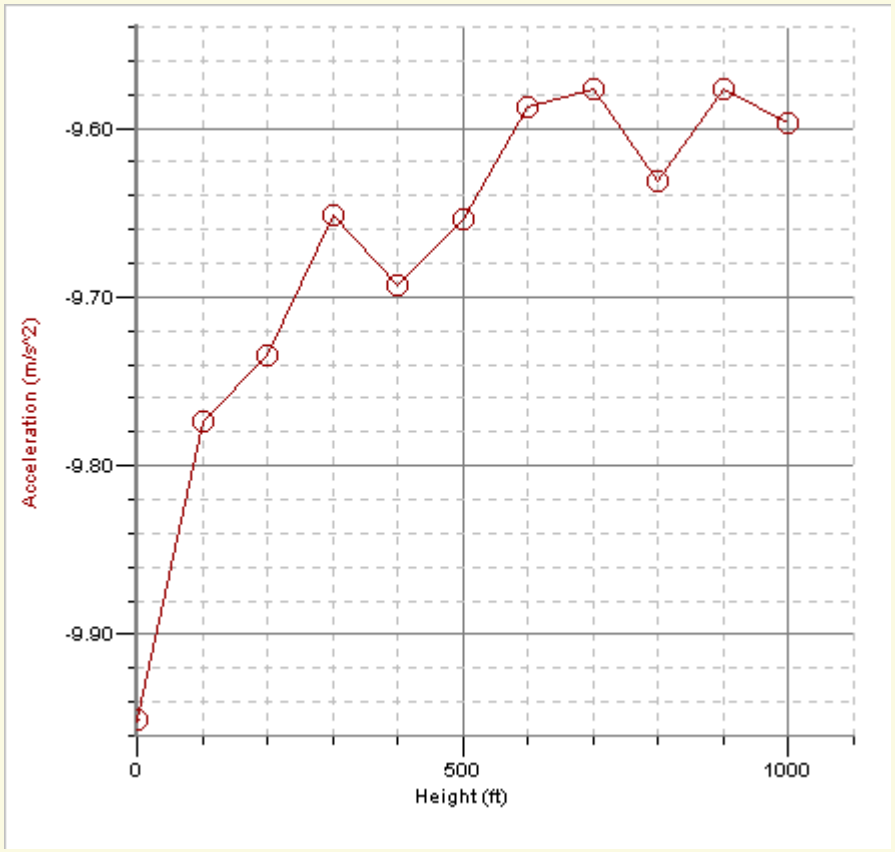


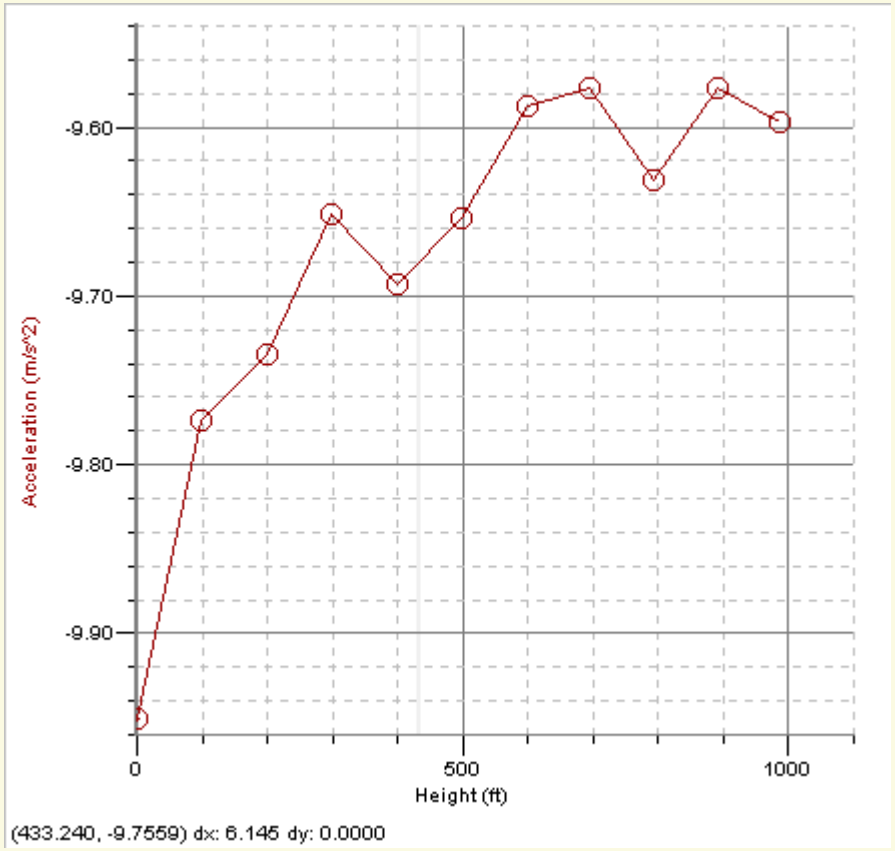
Height vs. Acceleration

	Data Set	
	Height (ft)	Acc. (m/s^2)
1	0	-9.951
2	100	-9.774
3	200	-9.734
4	300	-9.652
5	400	-9.693
6	500	-9.654
7	600	-9.588
8	700	-9.577
9	800	-9.631
10	900	-9.577
11	1000	-9.597
12		



Height vs. Acceleration (Fixed heights)

	Data Set	
	Height (ft)	Acc. (m/s^2)
1	0.00	-9.951
2	99.86	-9.774
3	199.73	-9.734
4	299.58	-9.652
5	399.45	-9.693
6	498.09	-9.654
7	597.72	-9.588
8	694.78	-9.577
9	792.21	-9.631
10	891.24	-9.577
11	984.81	-9.597
12		



Theoretical Acceleration Values

$a = - Gm_e/r^2 = - (6.67 \times 10^{-11})(5.97 \times 10^{24})/(6.38 \times 10^{6} + 84.544 + h)^2$

height (ft)	height (m)	theoretical acc. (m/s^2)	recorded acc. (m/s^2)
0.00	0.00	-9.7824	-9.951
99.86	30.43	-9.7823	-9.774
199.73	60.87	-9.7823	-9.734
299.58	91.30	-9.7822	-9.652
399.45	121.74	-9.7821	-9.693
498.09	151.81	-9.7820	-9.654
597.72	182.17	-9.7819	-9.588
694.78	211.75	-9.7818	-9.577
792.21	241.45	-9.7817	-9.631
891.24	271.63	-9.7816	-9.577
984.81	300.15	-9.7815	-9.597

Error Analysis

- The angles/heights were not exact due to curvature of the string
- We calculated only the theoretical height of the roof, not the real height
- Spikes in temperature due to clouds and sunset
- The accelerometer was not always facing straight up and down
- We….lost our angles

Results/Conclusions

- We have the BESSSSSTEST data
- We have proven with all of these:
  - Pressure decreases exponentially as height increases
  - Temperature decreases linearly as height increases, with variations due to weather
  - Acceleration does decrease with distance from the center of the earth, but not as much as our data shows


THE END