Analysis of the *Les Elementi* Balloon Fest Experiment

Balloon Fest, 2004

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Purpose of this Experiment

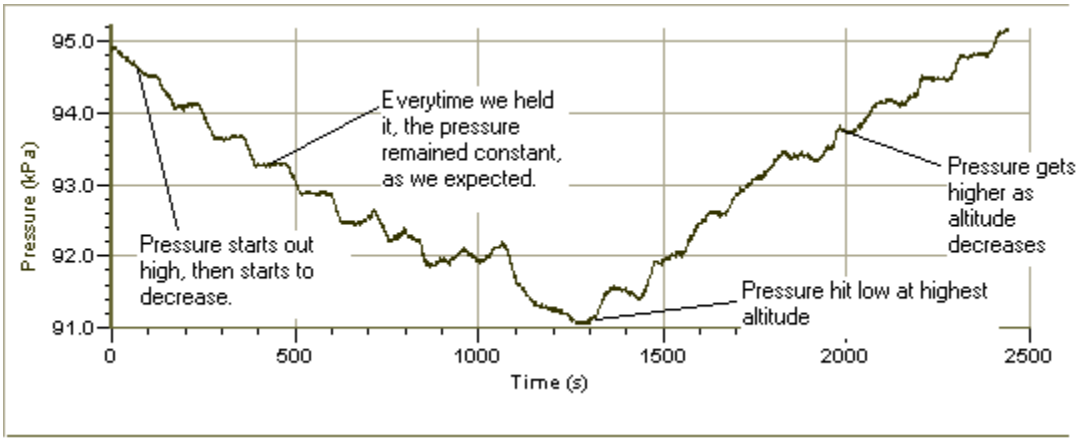
To find the relationship between air movement and the angle of the kite cord. Also, We want to find the relationship between ground pressure and the pressure at different elevations in the atmosphere. We are also comparing the altitude that we find with the angle finder and the altitude that the barometer reads.

Source and Origin of the Data

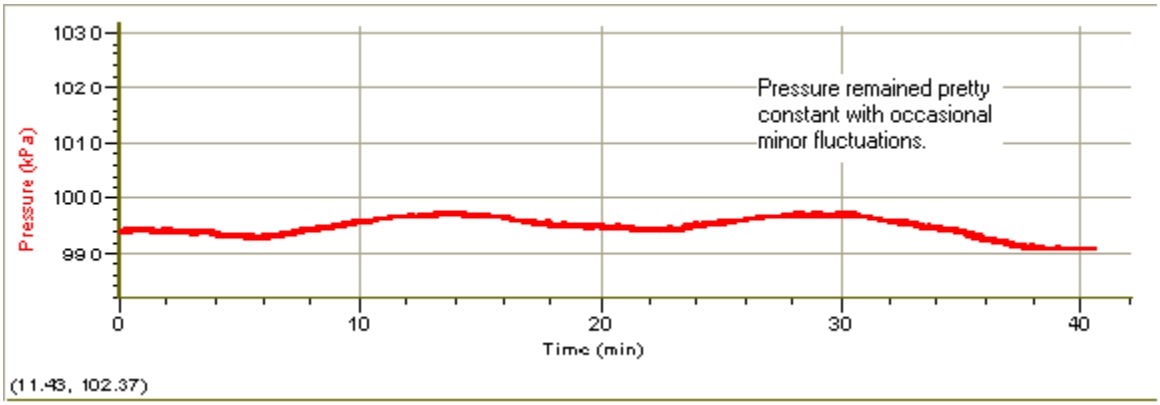
A group of very bright and talented people met on a beautiful sunny day in gorgeous oak-studded Paso Robles at Tobin James Winery where sun shines over the rolling hills. These very bright and talented people launched big white weather balloons up into the azure heavens. Our data came from our gondola with a Vernier Lab Pro on it and a barometer. The barometer was for altitude calculation. We used two other ways to compare the altitude; the amount of line let out and finding the sine of the angle using the rangefinder and calculations.

Graphs

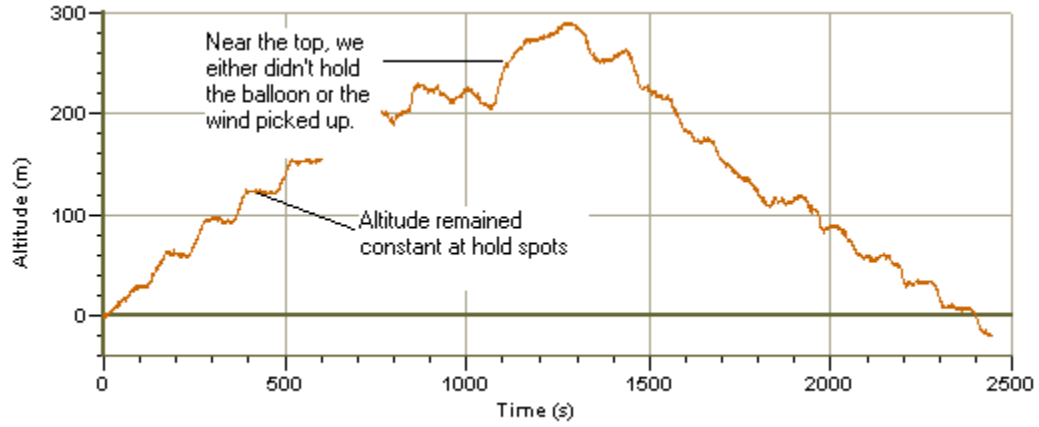
Raw Data
Pressure in the Air



Pressure on the Ground

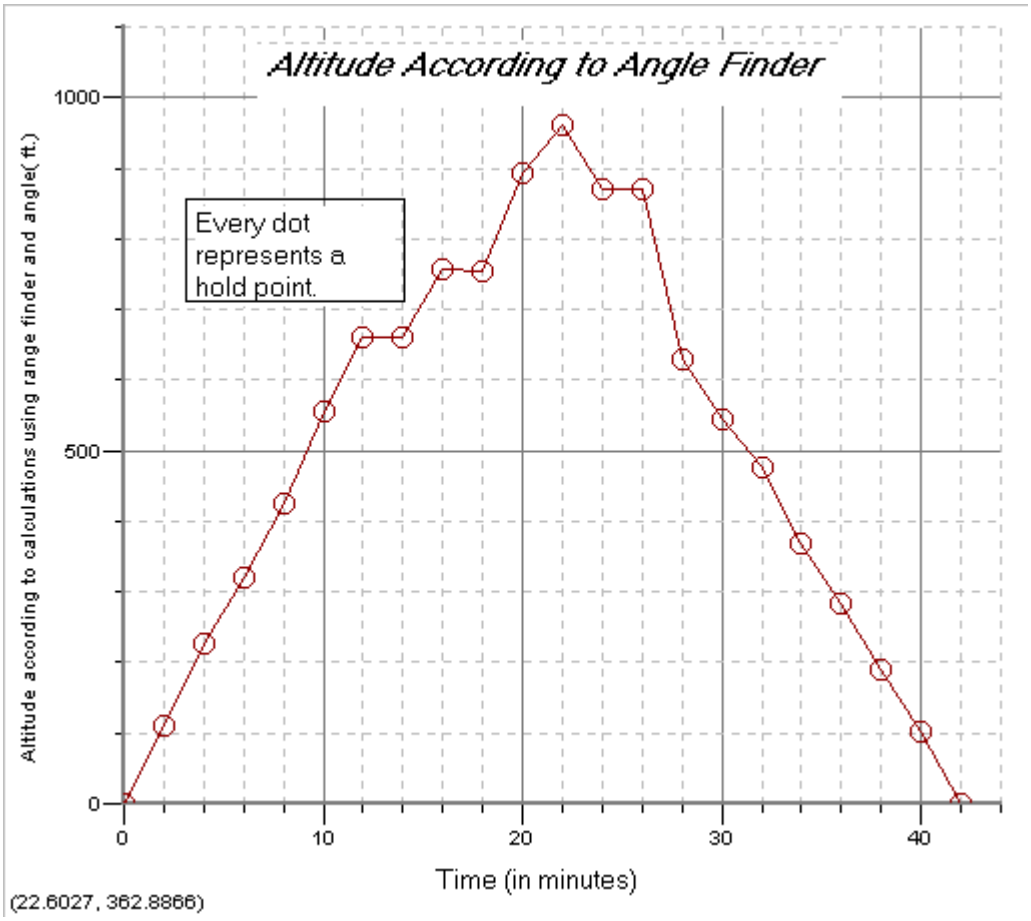


Altitude

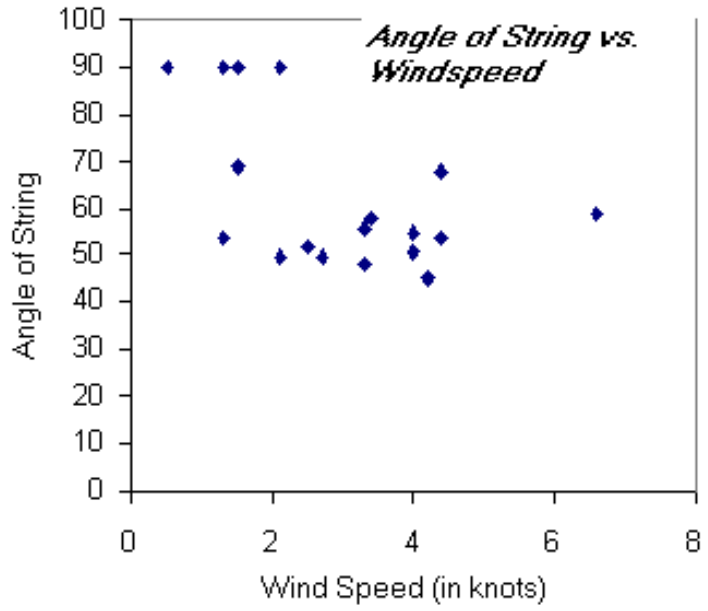


(359, 141)

This is the formula we used to calculate the altitude from the barometric pressure: “LabPro Remote: Pressure”*(-75.25)+7141.56



(22.6027, 362.8866)



Hypothesis A

We used a barometer to accurately measure the altitude.

Tests

Test 1: The pressure will go down as the altitude goes up. Our first graph shows that the pressure did go down as the altitude increased. Where the balloon was held can be seen by the "step like" shape of the graph.

Test 4: The ending altitude should be the same as the beginning altitude. However, the ending altitude shows that it is negative.

Test 2: The ending pressure should be the same as the beginning pressure. According to the graphs, the air pressure at the ground was different in the beginning and in the end. The barometer on the ground was always between 99 kPa and 100 kPa. The pressure according to the barometer on the gondola started at 95 kPa and ended a little above 95 kPa.

Test 4: The altitude was taken in two different ways. One was the angle finder and the other was the Barometer, we were comparing their differences. With the angle and a sighted reading we calculated the sine and that gave us the altitude that was found from the ground. The two graphs don't match up.

Hypothesis A, as stated, failed most of these tests. Possible reasons for the discrepancies are:

- A reason the pressure didn't match would be the fact that we pressed the button to start and sent the gondola up. We didn't wait one minute at the bottom, as we

now know we should have. The first and last readings for barometric pressure on the gondola were at 100 feet or close to 100 feet.

- The altitude would have the same problem as the pressure, because the altitude is found by converting the barometric pressure.
- The angle finder was not accurate. The angle finder's resolution is 2 degrees. That is a lot when you use the sine to find the altitude.
- Another reason for the angle finder problem is user error. We weren't far enough away from the balloon to get accurate readings. Another reason would be that our arms were shaking and moved during the readings.

Alternative Hypothesis and additional tests

Hypothesis A1: The pressure will match that on the ground, if the barometer is held at the bottom. This will also fix the problem with the altitude. (See graph 3)

Test A1: Perform the same experiment except hold the gondola at the ground for two minutes before and after launch.

Analysis of test A1: This will be used at the next launch.

Hypothesis A2: If there is no wind we can rely on the length of the string for altitude. If there is wind, then the Laser Range Finder would be used directly underneath the balloon to site the distance. These should match the barometer.

Test A2: During launch carefully count the line let out. Also, use the Laser Range Finder directly underneath the balloon to find the altitude.

Analysis of test A2: This will be done at the next launch.

Conclusion for Hypothesis A

We conclude that finding the true altitude of the balloon is tricky. The barometer is a better indicator than the angle finder to find altitude. The angle finder was very inconsistent. Every 100 feet a reading was taken, sometimes even after line was let out, it read the same angle. When the line is let out a better job has to be done. That will make it easier to indicate altitude if there is no wind.

Hypothesis B

We used an angle finder, a range finder, and Skymate (equipment to measure the wind) to perform this experiment.

Tests

Test 1: There will be a direct relationship between the angle of the balloon and the wind speed. However, none were found (see graph 5).

Test 2: The faster the wind the lower the angle measurement, but this also had discrepancies.

Test 3: The data from the barometer will be more accurate than the altitude readings from the angle finder, this proved true. The altitude calculated cannot possibly be over the amount of line let out, yet some the readings do.

Hypothesis B, as stated, failed most of these tests. Possible reasons for the discrepancies are:

- We measured the ground wind speed instead of measuring the wind speed on the gondola. The wind speed in the air is different than the speed on the ground. When looking at the line, there were certain spots that the string was more angled than others. It showed that the wind speed was different at different altitudes.

Alternative Hypothesis and additional tests

Hypothesis A1: Use an anemometer, sent up on a gondola with the balloon, to measure the wind speed. With that find a relationship between the angle of the balloon and the wind speed.

Test A1: Send an anemometer up on a gondola and follow the same procedure used for the other experiment. Then plot the information on a graph.

Analysis of test A: This will be done at another launch.

Conclusion for Hypothesis B

The next time this experiment is done, there needs to be an anemometer on the gondola, too. Also it should be a bit windier. This would lead to a more credible experiment for the hypothesis that was set. The distance away from the balloon line on the ground should be greater. This is because sometimes the readings were taken at almost 90 degrees and it is hard if the person taking the reading is looking into the sun.

Conclusion for the Les Elementi Balloon Fest Experiment

Barometric pressure is a good indicator of altitude. We will send a barometer up with our experiment next time to check the altitude. First we will zero it. The angle is not a good indicator of wind speed. It is very hard to get an accurate angle and an accurate wind speed. The speed of the wind is always changing and varies from the ground up. The Range Finder cannot always be used to find the altitude, unless you are directly beneath the balloon. We will learn from our mistakes and next time will have a flawless experiment.