# Acceleration

Compared to Theory

$$\sum \vec{F} = m\vec{a}$$

# A Clever Title!

- The purpose of this experiment is to compare the measured acceleration of a freely-ascending balloon to the theoretical acceleration as predicted by Newton's 2$^{nd}$ law.
  - Our hypothesis is that if one releases a balloon, it should obey Newton's Second Law of Physics such that if all forces are constant, the balloon's acceleration should be constant.

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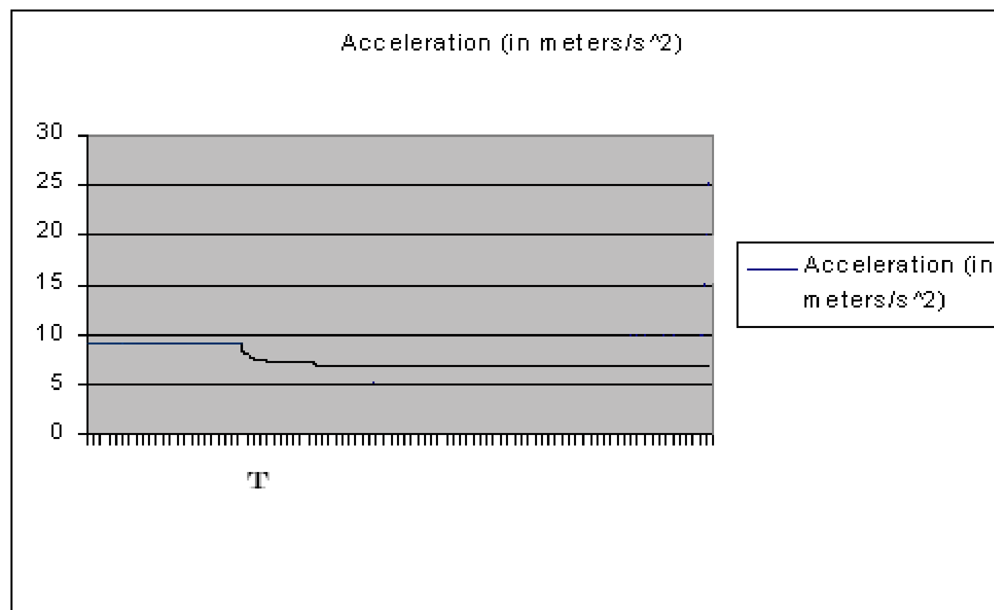
# Techniques Used

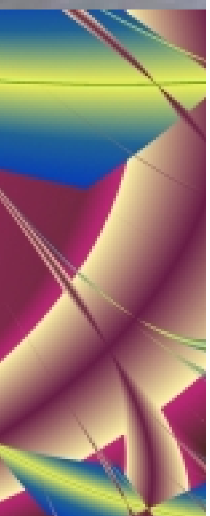
- Materials:
  - Helium balloon, Labpro, 3-axis accelerometer, scale, string, wooden gondola (optional), meter stick, helium.
- Measure the acceleration of the balloon! Set the Labpro to take data 10 times a second and for a duration of 20 seconds. Connect the 3-axis accelerometer to the Labpro and connect it to the balloon using the gondola or try letting the accelerometer dangle below the balloon and attach a decent mass to it so gravity keeps it pointing downward. One way to get the ‘free-ascent’ acceleration is to release the balloon for 5 or 10 seconds, letting it ascend, then slowly adding friction to the string, bringing it to a stop. Do not suddenly jerk the string. Then reel it back in.

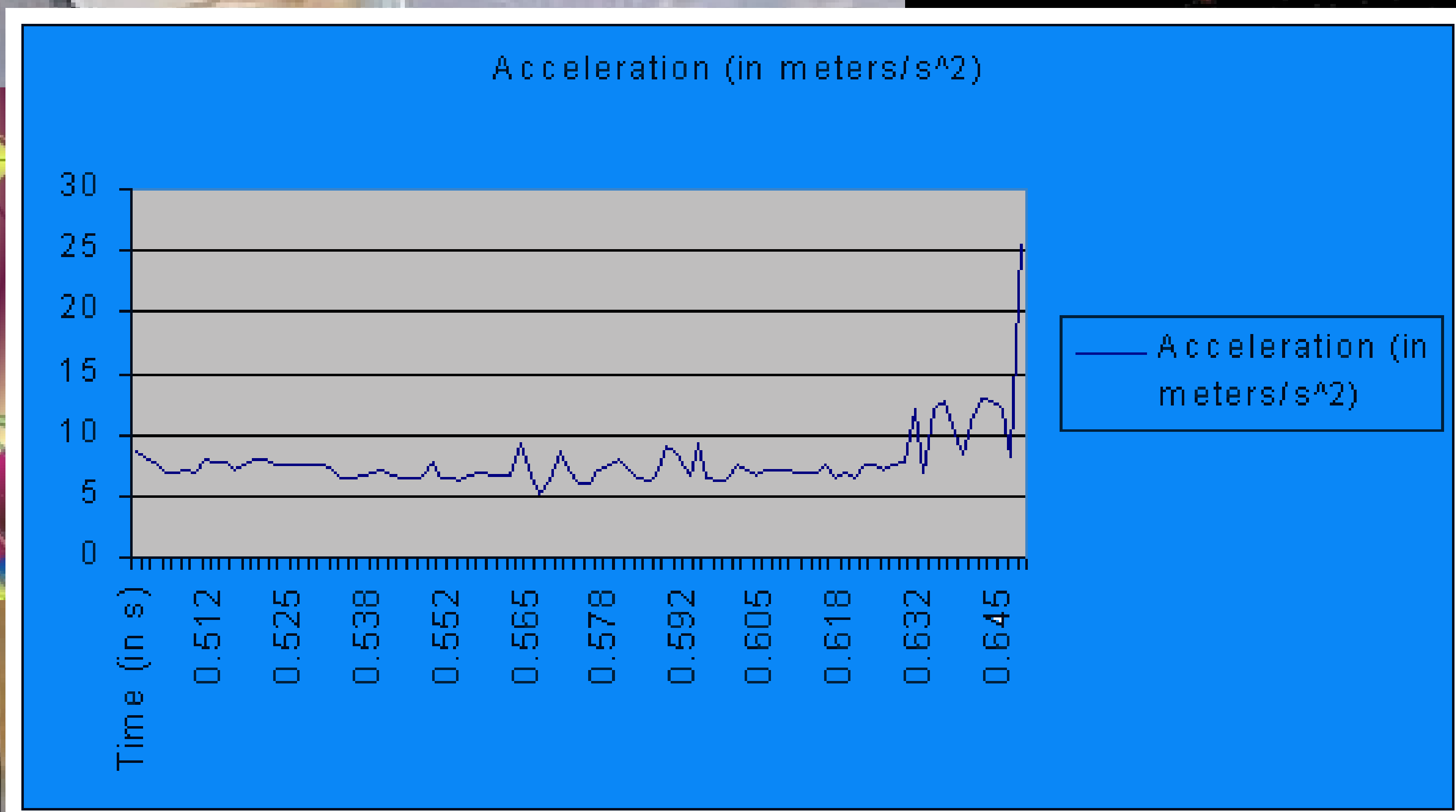
# Let’s Look at Data

- Theoretically, because sum of the forces equals mass times the acceleration vector, if the sum of the forces is constant force and a constant mass such as gravity and buoyancy on a balloon contraption, the acceleration should be constant. Here’s what the data should look like as we release the balloon at time T.



# More Data



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- Well, actually, a little more like this.

# Calculations

*Experimental*

Average Acceleration x total mass + weight of total mass = Force of buoyancy

(6.974m/s^2)0.670kg+(9.8m/s^2)0.670kg = 11.239 N

Results: |(14.142N-11.239N)/14.142N| x 100% = 20.52% error

$H_0$: μ=11.6 m/s^2

$H_a$: μ≠11.6 m/s^2

Graph of acceleration looks roughly normal. Can perform T-Test to check significance.

t=-54.79680249

p=4.45693x10^-62

- Here is a look at the calculations we used to determine the theoretical acceleration.

- And here is a look at the calculations we used to determine the actual forces and acceleration, as well as the calculations for the significance test we used.

# More on the Calculations

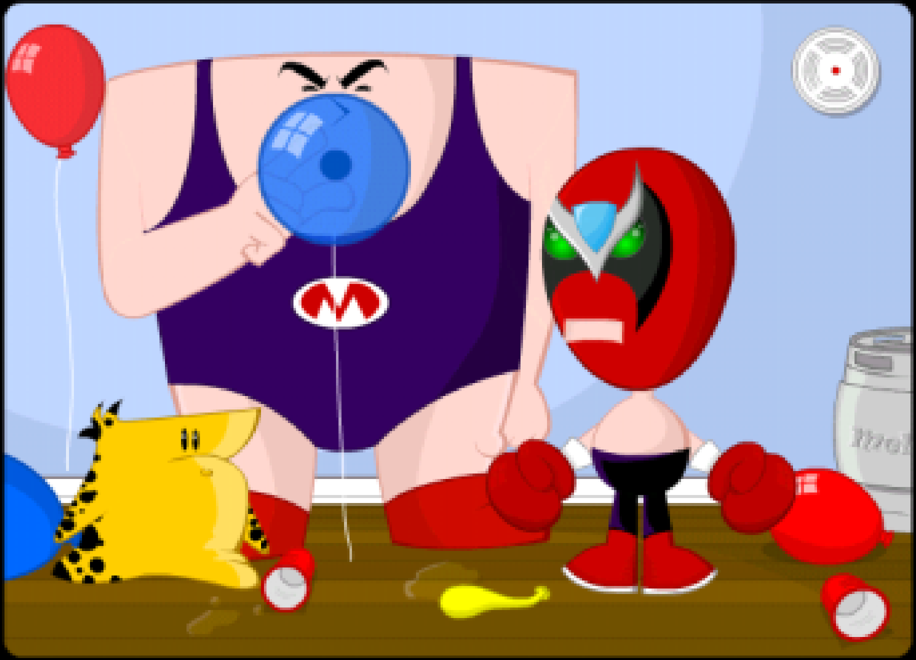
- Calculations for the balloons buoyancy were done by estimating that the shape of the balloon was a perfect sphere, and from there, using spherical buoyancy equations.
- After some complicated calculations involving the T-Test method for statistically calculating the significance of our Data…
  - T-score: -54.79680249
  - P-score:4.45693x10^-62
  - The probability that our acceleration data fits with theory and that the data fluctuated this low by chance alone is roughly 4.5x10^-62 %. That’s practically 0. That’s not very good.
  - This means that something went substantially wrong during the experiment.

# Conclusions

- Not so good. ☹
- The conditions of that particular day were horrendous.
  - There were large turbulent winds.
  - Other second order forces include weight of string and air resistance.
  - Also… there was a small balloon leak.

# What happened!?

- It was very difficult to get this data.  Trying to hold the balloon down created a lot of tension on it which sent it in every direction, almost touching the ground, and hitting every member of our team in the head multiple times.  *note: Annie is allergic to the Talcum Powder found on balloons.
- This tension on the balloon created a small leak.  By the time we got it down, the hole was large enough to breathe the helium coming out.
- So we did



- We had very high voices.
- This was all under proper adult supervision.

# Why We're Cool

- What is so important about our experiment?
- So far, we have been the first people to try the acceleration experiment as prescribed by the Good Doctor, Doctor James H. Dann, Ph.D.
  - However, because this test was so inconclusive and the conditions were so extreme, we will definitely have to retest this experiment.
  - Since we know what conditions to look for and what not to do, we will probably be far more successful next time.