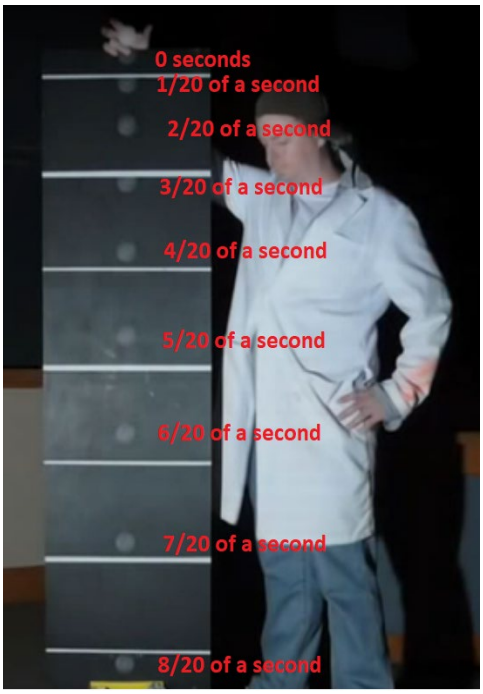
Dimensional Analysis HW 3: Bear and Galileo

In your lab today, you discovered that Bear's formula, **h = t*30**, isn't all that great for figuring out how high a cliff is. That's because that equation's 30 (as you discovered, actually 30 *feet* per *second*) assumes that things fall at the same speed, no matter how long they fall. In fact, as things fall for a longer time, they fall faster (this is called "acceleration").

This is demonstrated in the image at right, showing a ball dropped in front of a strobe light. It took less than half a second for the ball to hit the ground, but the strobe camera was able to photograph the ball at various positions: each image of a ball you see is taken 1/20 of a second apart. See how the ball images get further apart the longer they fall? That's because they're ***accelerating***!



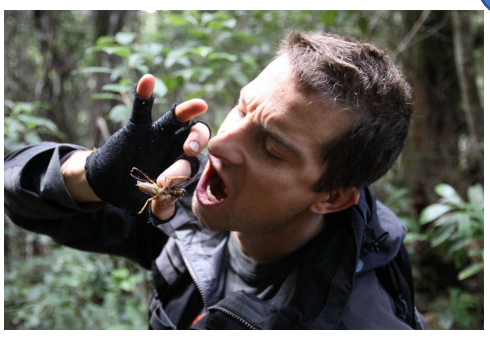
So, Bear's assumption that things fall at a rate of 30 feet per second is incorrect: things fall at varying speeds, depending on *how long they've fallen*. And this was actually discovered way back the in 1500's by Galileo Galilei! So what exactly did Galileo discover? Well, he found that, regardless of how much something weighs on earth, the distance it falls is about equal to

$$h = 16*t^2$$

where ***h*** is how far it falls, in feet, and ***t*** is the number of seconds it's falling before it stops (we'll deal with the 16 in a bit). What we're going to do first is test this model with our data from the lab.

1. **(1 point)** For starters, let's open this Google Sheet. Then watch this video to see what we're up to!

2. **(4 points)** Which model (Bear's or Galileo's) finds a closer value to the ***actual*** heights? Or does it depend on how high? Write a cpouple of sentnces!



Look at Bear's formula again:

$$h = t*30$$

You figured out in the lab that, in order to get the units of our predicted heights to agree, the units on "30" had to be "feet per second", since that's what was necessary to balance the sides of that equation:

$$h = t*30$$

$$\text{predicted feet} = \text{some number of second} * 30(\text{somethings})$$

$$\frac{\text{predicted feet}}{1} = \frac{\text{some number of seconds}}{1} * \frac{\text{30 of some unit}}{\text{1 of some other unit}}$$

You figured out that the numerator unit needed to be "feet" and the denominator needed to be "seconds"…and here's why (in case you forgot):

$$\frac{\text{predicted feet}}{1} = \frac{\text{some number } \cancel{\text{of seconds}}}{1} * \frac{\text{30 feet}}{\cancel{\text{seconds}}}$$

So,

$$\text{"predicted feet"} = \text{"some number"} * \text{"30 feet"}$$

Then you have just "feet" left – which makes sense, since you want to talk about distance!

3. **(5 points) (w)** Using Galileo's formula $h = 16*t^2$, figure out what units must be on the "16". They'll be similar to (but not exactly the same as) the units on Bear's "30". You can use a similar process to the example on the previous page to show your work. Check out this video if you need help!