Lab 01 - Bouncing, Regression, and Analysis

**Objective:** The purposes of this lab are
- to introduce you to various lab and analytical skills that you’ll use throughout the year,
- to allow me to assess your data collection, data analysis, and writing skills,
- to open discussions about inquiry-based labs & learning,
- to introduce you to the idea of learning/note-taking during a lab,
- and to build some cohesion within the class.

**Overview:** Your goal is to conduct an experiment that establishes a mathematical model between the drop height and rebound height of a bouncy ball (or tennis ball or whatever else that works...). You will compare your work/data to the other teams as a means to initiate discussion of developing lab skills.

**Procedure:** You and your partner(s) will use the bricks on the wall as a coordinate system (assuming all of the bricks are identical in height). Thus your length-unit will be “bricks.” You will raise the ball to various heights and measure the maximum height the ball reaches after its first bounce (or rebound). You are to record the drop height and rebound height of the ball (in units of “bricks”). Since the ball itself has appreciable height, you need to be consistent in your measurement techniques.

**Data:** Be sure to record your data in the space below. Compare your means of recording to the other teams. Be sure to write down which team’s data representation you think is the best and list the reasons why.
**Analysis:** We will perform a lot of linear regressions this year and will do so on this lab. I’m not going to offer a lot of guidance on this particular lab. I’m curious what your team will come up with. The objective is to plot your data in a relevant/useful manner. You will draw a line-of-best-fit, calculate its slope, and estimate the y-intercept.

Again, look at the other teams’ graphs. Which one do you think is the “best”? Why?
Making Sense of Your Linear Regression Equation and UNITS!

This section is essentially blank because we will discuss this portion as a group. The blank space is for you to make notes. In case your group made errors when graphing, a second blank graph is on the next page.

Units are vital in physics! **Quantities without units are meaningless!** Mathematically, units behave much like algebraic variables. In Algebra, you can only add “like terms.” In Physics, you can only add quantities that have identical units. Also, saying two sides of an equation are equal in physics is tantamount to saying both sides have equal units as well!

Let’s look at your best-fit equation and analyze the units.
Correlation Coefficient

To oversimplify things, we can view a correlation coefficient as a measure of how “well” a model fits the data. The coefficient is typically represented by the variable $r$. The values of $r$ range from -1 to 1, inclusive. The closer $|r|$ is to 1, the “better” our model fits the data. We will mostly concern ourselves with the square of this coefficient, $r^2$. If $r = 0.998$ and $r^2 = 0.996$, we (roughly) conclude that 99.6% of the variance on the rebound height is due to the variance in the drop height. In other words, 0.4% of the pattern in the data is due to some other factor. This greatly oversimplifies things, and those of you who take a stats course will learn more about this later, but such a view of $r^2$ suits our purposes. **In short, the closer $r^2$ is to 1, the more reliable our model is as a descriptor of our data.**

**YOU WILL NOT CALCULATE OR INTERPRET $r^2$ values on the AP Exam!!** However, this information is useful for higher levels of study and transferable to any field that utilizes data collection and data analysis.

What is your team’s correlation coefficient? __________________________________________
Model Limitations
You will eventually be responsible for understanding the underlying assumptions of a particular model and the inherent limitations of the model. We’ll make some notes about models here.
Sources of Error
All measurements have error and uncertainty associated with them. Suppose one of your rebound heights measured 3.4 bricks. How sure are you in that measurement? Was it exactly 3.4 bricks? For example, did it rise to a height of 3.400000 bricks? Or was it 3.42 bricks? 3.35 bricks? You “eyeballed” your measurement – a highly imprecise technique. We’ll make some notes about measurement error/uncertainty here.

*You are responsible for identifying sources of error and their qualitative effects on the data! You will not do specific quantitative error calculations on the AP Exam.