Physics 200 (Stapleton) Name: ________________________________

Trajectory Contest Project

Handout #2

Today's Important Points:

- Be safe: you really could hurt an eye with these launchers.
- Be respectful: at best, the sound of people launching little oak logs in the hallway is annoying.
- This is an application of physics, but it is also an engineering challenge. There are many things you can do to improve your performance and your launcher's performance. I could suggest some things, but I would rather give those of you who are motivated and clever the chance to distinguish yourselves. You will be sharing launchers, but you can modify them as long as you do not hinder the success of a group in the other class. Among other problems, you will need to devise a way to launch at a specific height and angle.

To do (feel free to go in an order that suits you, but this one makes sense to me):

1. Choose a launcher and write down your number.
2. Set up your launcher, and get a projectile. You may want to measure your projectile (in case you lose it). It is also a good idea to label your projectile.
3. You might want to think about strategy at this point, but it's not required.
4. Adjust your launcher so that you can launch projectiles with a v_0 up to at least 10m/s. There is no benefit to being able to launch faster.
5. Create or adopt a launcher scale. You can draw on the launcher if you wish.
6. Choose a method for finding your launcher's initial velocity (symmetric flight, horizontal launch, or asymmetric flight).
7. Get a cardboard backstop.
8. Find a good place to work (probably a hallway). Then shoot your launcher at a variety of settings on your scale and collect the necessary data to determine your launcher's v_0 with the calculator that you have chosen. Be organized; create and use a data table to record your data. Repeat measurements as many times as you deem efficient and necessary. You want good data, but you don't want to spend to long on data collection.
9. Enter your data into sheet 2 of your spreadsheet. Make your graph of v_0 vs launcher setting. Add a trendline. You may have to use a high order polynomial trendline. If you have switched groups, you can make a copy of your previous group's spreadsheet.
10. Copy and paste this calibration graph. Then move the copy to its own sheet (sheet 3). This graph will be bigger, so you can read it with more precision.
11. Practice. Set up some practice scenarios and see how close you can come to hitting targets that you set for yourself.
12. On day 2, perform a test to see if your calibration graph still accurately predicts initial velocity.

Some Contest Details:

- You will be given the contest problems at the end of class on the day before the contest. This will allow you to strategize before class, so that you can take your best shots and so that the contest will run smoothly.
- Instead of a specified launch height, you will be offered a 15" (38cm) vertical (y axis) launch "window" above some horizontal surface. The reason for this is that you may choose from a variety of launch angles, and your choice of launch angle will constrain the starting height of your projectile. For example, if you launch straight upward from a horizontal surface, your launch height must be at least 14" above that surface, since the launcher is 14" long. On the other hand, someone who wants to launch horizontally can have a launch height of about 1" from that surface, since the launcher is not as tall as it is long.

<u>Project Grading:</u> 28 Points Total

- Spreadsheet completion and submission
  - Sheet 1: (**8pts**) Produces an interactive trajectory graph with "programmable" obstacles and ceiling.
  - Sheet 2: (**6pts**)
    - Provides at least two correctly-functioning calculators for determining a launcher's initial velocity (for a horizontal launch above the target and a symmetric launch
    - Provides a graph of v_o vs launcher setting, based on data you collect by shooting your launcher at different settings.
  - Sheet 3: (**1pt**) Provides a larger, more precise version of the graph on sheet 2.
- Contest Problem Solutions: (**3pts**)
  - Before trying your competition shots, you will turn in the solutions to three trajectory problems. You will receive these problems on the day before the contest. For each problem, you will provide an initial height, an initial velocity, and an initial angle.
  - I will check your solutions with my spreadsheet (simulation). For full credit, your solutions must not predict a collision with an obstacle, and their X axis error must be less than or equal to 5%. For error over 5%, a deduction equal to approximately twice the error will be applied to the problem in question (e.g. 20% error means you lose 40% of the points).
- Practical Application (Contest Shot #1): (**10pts**)
  - The first contest shot will have one simple obstacle, requiring an angle of more than 20 degrees. Grading of this first shot will be the same as the grading of the contest solutions, described above.
  - If your shot is blocked by the obstacle, the obstacle will be considered your impact point, and your % error will be the distance between the obstacle and the target divided by the overall distance to the target.
  - You will have two chances for this shot (and the others), and your best shot is the one that will be scored. [If you don't like your score, you can try again some time during Flex. The distance will change each time you try this.]

<u>Prizes</u>: Donuts (or the equivalent) and glory for the top two groups. Possibly something more for the first place group.