Physics 200 (Stapleton) Name: _____
Trajectory Contest
Handout #1

Project Overview: Modify, calibrate, and fine-tune a projectile launcher to shoot targets while avoiding obstacles. Use your physics knowledge to create a spreadsheet that will help you determine the best trajectory for each shot, as well as the proper setting for your launcher.

Project Requirements:

- Participate in all of the contest shots.
- On the contest day, submit of a printed "launcher calibration graph" and corresponding contest solutions. These solutions must be successful, given the calibration graph.
- Create and turn-in a working trajectory spreadsheet with at least three sheets…
    - Sheet 1: This sheet is named "Trajectory," and it accomplishes the following:
        - Calculates initial X and Y velocities, based on the following inputs:
            - launch angle
            - launch speed
        - Provides a graph of position vs time meeting the following requirements:
            - The graph is generated based on the following inputs:
                - initial angle
                - initial speed
                - Initial y position
            - The Y axis shows only positive (above the floor) values.
            - The graph also includes the following, each in a color different from the projectile's path:
                - A point designating the position of the target.
                - At least three points designating the ceiling height
                - At least two points showing the top and bottom of a first vertical obstacle
                - The ability to include two more points showing the top and bottom of a second vertical obstacle.
            - The projectile's trajectory is shown as a 2^{nd} degree polynomial trendline, with the "point size" set to zero.
            - The calculation time increments are adjustable.
    - Sheet 2: This sheet is named "Launcher Calibration," and it provides the following:
        - At least two of these initial speed calculators (in working order):
            - Horizontal Launch v_0 Calculator
                - Determines the initial speed of a projectile launched horizontally from a height above the target level.
                - Inputs: launch height, horizontal distance traveled (x distance)
            - Symmetric Launch v_0 calculator
                - Determines the initial speed of a projectile launched upward at an angle, traveling horizontally, and landing at the same height at which it was launched.
                - Inputs: launch angle, range (horizontal distance traveled – x distance)
            - **Bonus (worth 5% added to project grade):** Asymmetrical Launch v_0 Calculator
                - Determines the initial speed of a projectile launched at an angle, traveling horizontally, and landing at a height that is different from the launch height.
                - Inputs: launch angle, range, y displacement
        - Calibration Graph: A graph of "Initial speed (v_0) vs. Launcher Setting" for your launcher. On this graph, fit a trendline to your data points, but don't get rid of the dots.

- Sheet 3: This sheet is named "Launcher Calibration Graph." Create this sheet by copying and pasting your graph on sheet two, so that you have two identical copies. Then move this one to its own sheet. Adjust the gridlines so that you can read the graph more precisely. You may also find it useful to adjust the axes' minima and maxima.

Trajectory Practice Problems:

These are actual contest problems from a past year. Use your spreadsheet to determine a successful combination of launch angle and initial speed. Then use the example calibration graph to determine the correct launch setting for the hypothetical launcher. Obstacle positions are described in terms of their horizontal distance from the launch point and their vertical distance above the floor.

1. Release height = 01.63m Horizontal Distance To Target = 5m Target Height = 0.025m
   Obstacle 1 Position: 2m from the launch point, 1.18m-2m from the floor
   Ceiling Height = 2.57m

   Θ = _____ V_0 = _____ Launcher Setting = _____

2. Release height = 0.55m Horizontal Distance To Target = 1m Target Height = 0.025m
   Obstacle 1 Position: 0.4m from the launch point, 1.5-1.8m from the floor
   Obstacle 2 Position: 0.65m from the launch point, 0-0.86m from the floor
   Ceiling Height = 2.57m

   Θ = _____ V_0 = _____ Launcher Setting = _____

3. Release height = 0.55m Horizontal Distance To Target = 8m Target Height = 0.025m
   Obstacle 1 Position: 2m from the launch point, 0-0.86m from the floor
   Obstacle 2 Position: 4m from the launch point, 1.38m-2.2m from the floor
   Ceiling Height = 2.57m

   Θ = _____ V_0 = _____ Launcher Setting = _____