Projectile Motion Procedure

Full Name, Period, AP/Honors: **due: 2/14**

1 Problem Statement

You are attempting to determine the speed that a projectile leaves a launcher. The environment that you are in has negligible air resistance. You have access to the following materials:

- Angle vice (allows an object to be set at a precise angle from the ground and displays the angle it is set at). The vice is bolted to the ground and is too heavy to move.
- Protractor
- Projectile launcher and projectile
- Tape measure(s)
- Ruler(s)
- Meter-stick(s)
- String

2 Answer

2.1 Materials

I will use the following materials

1. Projectile launcher and projectile
2. Tape measure
3. Angle vice

You did not need to explain your materials choices, and generally shouldn't on the AP unless explicitly asked. If asked, here are the explanations I would provide. (optional explanation): The tape measure is a better choice to measure distances because it limits the potential for miscounting the number of rulers or meter-sticks used and also removes the possibility of placing the rulers at an angle to each other and thus measuring a larger distance than the object traveled.

(optional explanation): The angle vice is a better choice than the protractor because a protractor needs to be manually oriented with the surface, which introduces a lack of accuracy. They are also generally less precise than well made angle vices.

2.2 Procedure

1. Set up angle vice at an angle θ. Ensure that $20^\circ < \theta < 70^\circ$.
2. Put the projectile launcher in the angle vice carefully and ensure it is firmly seated.
3. Record the angle from the angle vice.
4. Launch a projectile and measure the displacement (Δx) using the tape measure. Record Δx
5. Repeat steps 1-4 with different angles.
6. Linearize the resulting data
   (a) Start with the equations $\Delta x = v\cos(\theta)t$ for the x displacement and $0 = v\sin(\theta) - gt_{1/2}$ for the y displacement, where $t_{1/2}$ is the time to reach the maximum height, or half the flight time. This means
   $$t = \frac{2v\sin(\theta)}{g}$$
   Plugging into the x equation gives
   $$\Delta x = \frac{2v^2\cos(\theta)\sin(\theta)}{g}$$
   (b) We can then linearize this to get
      - Vertical axis: $\sqrt{\Delta x}$
      - Horizontal axis: $\sqrt{\frac{2\cos(\theta)\sin(\theta)}{g}}$

   (c) Plot these variables, and the slope will be v

3 important notes

- Do NOT use x and y to refer to the axes on the graph. x and y are already used to represent the horizontal and vertical directions, we cannot re-use them without confusion.
- You must have multiple trials. Most years this is an automatic deduction on the AP.
- There was no way to measure time in this experiment. Even if there was, measuring it would be a bad idea, since time measurements involve large errors.
- A bulleted or numbered list is far easier to read than a wall of text.
- You generally don't need really detailed derivations
- You should never be solving for v in your procedure in any way except by finding the slope of the trend line.