Change in “Ballistic Pendulum and Projectile Motion” procedure for Part 2

Replace the projectile motion procedure on page 140 with:

0. Record the mean and standard error (α_{N-1}) you determined for \( \bar{v}_{x0} \) in calculation table 1:

\[ \bar{v}_{x0} = ( \underline{\text{__________________}} \pm \underline{\text{__________________}} ) \text{ m/s} \]

1. *(unchanged from what is in the lab manual.)*

2. Place the apparatus close to the sink end of the table. (For some spring settings, the ball may hit the table if the gun is pushed all the way against the sink. However, you must be close to the sink so that the ball hits the floor before it hits the wall.) Put it near one side of the table to make height and distance measurements easier.

3. Place the ball on the rod of the spring gun but do not cock the gun. Measure the vertical distance \( Y \) that the ball will fall as described in step 4 of the lab manual. (Is this the distance from the bottom of the ball to the floor, or from the bottom of the ball to the bottom of the box?) Enter \( Y \) in Data Table 2 and record it here as well:

\[ Y = ( \underline{\text{__________________}} \pm \underline{\text{__________________}} ) \text{ m} \]

4. Solving Eq. (6) for \( X \) gives \( X = \bar{v}_{x0} \sqrt{2Y / g} \). Use this to **predict** \( X \) from the average value of the projectile speed (\( \bar{v}_{x0} \)) and \( Y \):

\[ X = \underline{\text{__________________}} \text{ m} \]

Calculate the uncertainty in \( X \) by propagating the uncertainties in \( \bar{v}_{x0} \) and \( Y \). This uncertainty is found from \( \alpha_X = X \left[ \left. \alpha_{\bar{v}_{x0}} \right/ v + \frac{1}{2} \alpha_Y \right] \), where the \( \frac{1}{2} \) is due to the square root. Record your result:

\[ \alpha_X = \underline{\text{__________________}} \text{ m} \]

5. **Put the catch box against the wall.** Put white paper in the box and draw a target line near the middle, bracketed by \( \pm \alpha_X \). This “target” will also serve as a reference point for your measurements of the landing positions (which you will record in Data Table 2). Carefully measure the distance \( X \) back from the target line, positioning the launcher so the ball is \( X \) from the target line. Also mark where the launcher is, since it will move when you fire the ball.

6. Cover the white paper with carbon paper and make the five firings and measurements in the original step 5 as described in the lab manual. Since you already know \( X \) for the target line, you only have to add or subtract the distance from the line. Finally, do the remaining calculations described in the manual to get a second estimate of \( v_{x0} \).