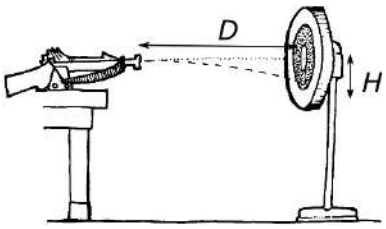
NAME _____ DATE _____

Scenario

An engineer is testing the design of a new crossbow to try to find the speed of a dart the instant it is launched from the crossbow. The crossbow is fixed to a table so that the dart is launched horizontally. A target is placed in front of the crossbow so that the crossbow is pointing directly at the center of the target. The distance D from the crossbow to the target is varied, and each time the crossbow is fired, the distance H from the center that the dart strikes the target is measured.



Quantitative Analysis

The data taken by the engineer are shown in the table.

Horizontal Distance to Target D(m)	*Vertical Distance Dart Falls H(m)*	*Time the Dart Is a Projectile T(s)*
5.00	0.084	
10.00	0.169	
15.00	0.408	
20.00	0.677	
25.00	0.975	

PART A: Using the assumption that the crossbow darts were projected horizontally, derive an expression for T in terms of H and g. (Remember that derivations should start with a fundamental equation of physics, i.e., an equation given on the AP Physics 1 equation sheet.)

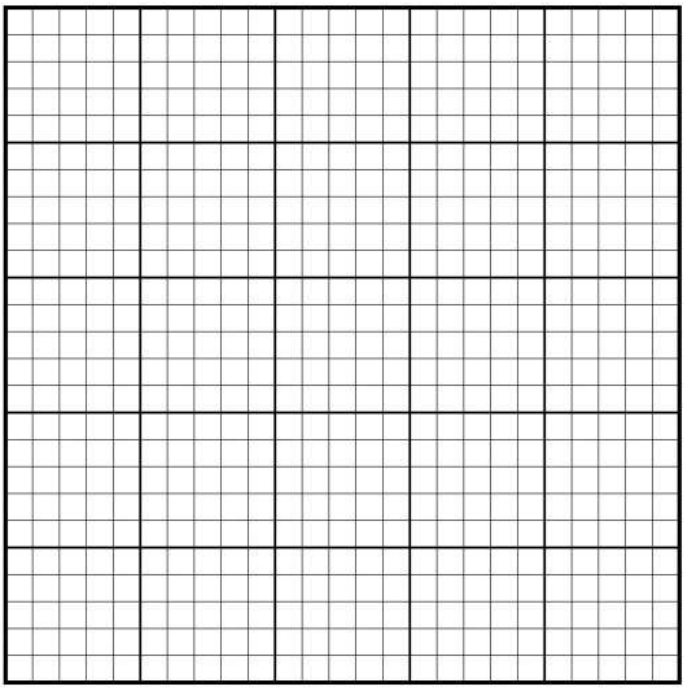
Step 1:
Step 2:
Step 3:
Step 4:

PART B: Fill in the data table with five values of T calculated using your expression in Part A. Use $g = 9.8\ \text{m/s}^2$ and a reasonable number of significant figures.

Using Representations

PART C: What quantities should be plotted on a graph if the graph is to have a linear trend and the slope of the best-fit line is to be the launch speed of the dart?

PART D: Plot the quantities stated in Part C on the graph below. Label the axis with quantities, a scale, and appropriate units. Draw a best-fit line.



Quantitative Analysis

PART E: Using the best-fit line, determine the speed of the crossbow darts the second they have launched. (Hint: Carefully calculate the slope and determine the relationship between the quantities you plotted on the graph above and how they relate to the speed of the crossbow darts. Use the slope to determine the speed.)