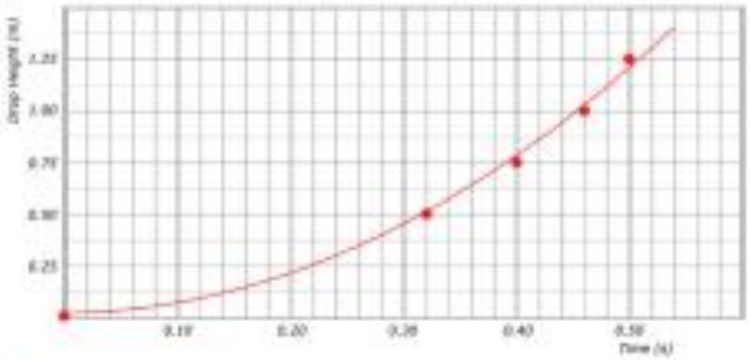
NAME _____ DATE _____

## Scenario

*Angela, Blake, and Carlos have been given a stopwatch, several large spheres, and a meterstick and have been asked to determine the acceleration due to gravity. They decide that they need to collect drop height and time to fall for the ball at several different heights to create a position vs. time graph. The averages of the collected data are shown in the data table below.*




| *H (m)* | *T (s)* | $T^2 (s^2)$ |
|---|---|---|
| 0 | 0 | 0 |
| 0.50 | 0.32 | 0.10 |
| 0.75 | 0.40 | 0.16 |
| 1.0 | 0.46 | 0.21 |
| 1.25 | 0.50 | 0.25 |

## Quantitative Analysis

PART A: Graph the drop height as a function of fall time on the axis above.

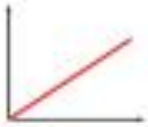
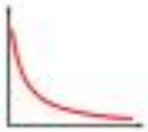
PART B: Based on your graph and the table at the right, identify the correct relationship between the drop height and the time to fall to the ground.

**Claim:** The displacement (physical quantity) is proportional (proportional / inversely proportional) to the square (square / square root) of time (physical quantity).

PART C: The relationship between drop height and time to fall can be compared to the equation for a line, so that the students can create what is called a linearized graph. Fill in the third column in the data table with appropriate values and graph to create a linearized graph.

$H$ vs $T^2$

$y = mx + b$

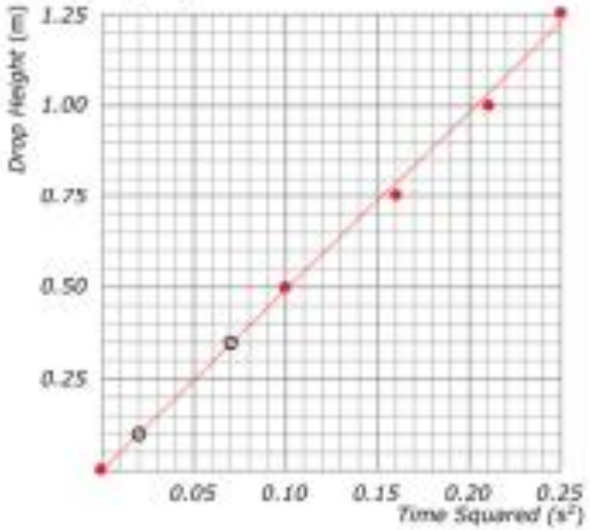
| *Graph* | *Relationship* |
|---|---|
|  | As *x* increases, *y* increases proportionally. *y* is directly proportional to *x*. |
|  | As *x* increases, *y* decreases. *y* is inversely proportional to *x*. |
|  | *y* is proportional to the square of *x*. |
|  | The square of *y* is proportional to *x*. |

PART D: 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 used to determine the acceleration due to gravity?

Drop height vs. time squared. (Also acceptable are square root of drop height vs. time, among others) If students graph drop height vs. time squared, the slope will be equal to one half the acceleration due to gravity. If students graph the square root of drop height vs. time, the slope will be equal to the square root of ($\frac{1}{2}$ g)

## Using Representations

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




## Quantitative Analysis

PART F: Using the best-fit line, determine the acceleration due to gravity. (Hint: Carefully calculate the slope of the best-fit line and determine the relationship between the quantities you plotted and the acceleration due to gravity.)

$$slope = \frac{y_2 - y_1}{x_2 - x_1} = \frac{0.35\text{ m} - 0.10\text{ m}}{0.07\text{ s}^2 - 0.02\text{ s}^2} = \frac{0.25\text{ m}}{0.05\text{ s}^2} = 5\ \frac{\text{m}}{\text{s}^2}$$

$$slope = \frac{1}{2}g$$

$$5\frac{\text{m}}{\text{s}^2} = \frac{1}{2}g$$

$$g = 10\frac{\text{m}}{\text{s}^2}$$