Penny Drop Lab

Ryan Dillon, Section L — September 26, 2019 — Lab Partners: S. Poruri, S. Chittibabu

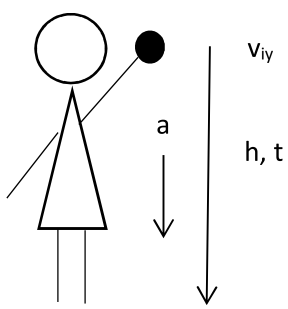
Introduction

The purpose of this lab was to design an experiment using a penny and stopwatch to determine the acceleration of gravity based on the curve of best fit from the graphed data. How does increasing the height from which a penny is dropped affect the time elapsed until the penny hits the floor? If the height from which the penny is dropped increases, then the time elapsed until the penny hits the ground will increase, where time is proportional to the square root of the height.

Procedure and Materials

Ryan held a meter stick vertically against the wall next to a doorframe. Sri aligned the bottom edge of a piece of masking tape with the 0.50, 1.0, 1.37, 1.5, and 2.0 meter markings and stuck the tape to the wall. Ryan held a 1996 penny with a mass of 2.51 grams horizontally, with one finger on either side of the penny, and aligned it with the bottom edge of the 0.50 meter tape marking. Ryan counted aloud to three. When she reached three, the penny was dropped, and Sri started the stopwatch. Sri stopped the stopwatch when she saw the penny hit the ground. Sri reported the time on the stopwatch to Shriyaa, who then recorded the times in an Excel file. This process was repeated 10 times for each predetermined height.

Diagram



Constants and Equations

m_p = 2.50 g
v_{iy} = 0 m/s
y_i = h
y_f = 0 m
a_T = -4.00 m/s²

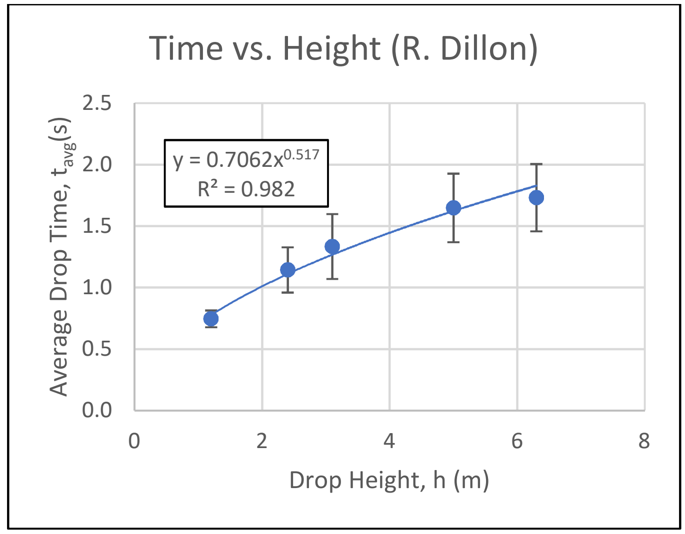
$$y_f = \frac{1}{2}at^2 + v_{iy}t + y_i$$

$$t_T[h] = \sqrt{\frac{-2h}{a_T}}$$

Data Summary

h (m)	t_{avg} (s)	SD (s)	%RSD of t_{avg}	t_T (s)	|%err| of t
0.50	0.34	0.04	12.92	0.32	5.81
1.00	0.53	0.04	8.51	0.45	16.44
1.37	0.61	0.03	5.06	0.53	14.42
1.50	0.65	0.04	5.46	0.55	17.30
2.00	0.91	0.08	8.50	0.64	42.44
		Avg	**8.09**	Avg	**19.28**

Graph



Analysis

The acceleration due to gravity that was derived from the non-linearized data and the linearized data were 5.263 m/s² downward and 4.447 m/s² downward respectively. These values were calculated using the power curve of best fit for the non-linearized graph, and the linear fit of the linearized graph. Both values were lower than the theoretical value of gravity, which was 9.8 m/s² downwards. The data displayed moderate precision with an average % RSD value of 8.09%, low accuracy with an average % error value of 19.28%, and a strong mathematical model with an average R^2 value of 0.9688. Limits for the data and the graph included that both time and height had to be greater than zero. There was no known maximum height or time, as the penny could theoretically be dropped from a height that was infinitely tall.

Conclusions

The data that was collected supports the hypothesis that was made, as it shows that as the height increased, the time that elapsed before the penny hit the ground also increased. The data that was collected was inaccurate and imprecise when compared to the theoretical acceleration, and this is largely due to human error. The values of the downward acceleration that were calculated were lower than expected. Possible sources of this error include stopping the timer after the penny hit the ground due to an inability to start and stop the timer in such a small period of time, and well as possibly dropping the penny from slightly different heights. A possible extension of this project includes using a video camera to capture the exact time at which the penny hits the ground rather than relying on just the visual of the impact. This would allow for more accurate and precise collection of data. Another possible extension is