Penny Drop Lab Report

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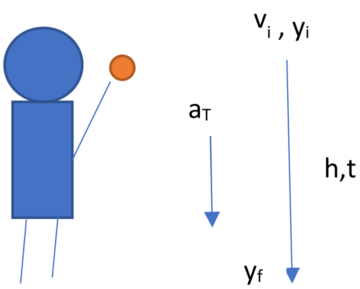
Introduction

The purpose of this lab was to design an experiment using a penny and a stopwatch to determine the acceleration if gravity based on the curve of best fit from the graphed data. The researchable question was how does increasing the height aboveground the penny is dropped from affect the length of time it takes the penny to hit the ground? If the height the penny is dropped from increases, then the time it takes for the penny to hit the ground will increase where free fall time is proportional to the initial height.

Procedure and Materials

The heights of 0.500, 1.000, 1.250, 1.750 and 2.000 meters were measured with a meterstick held parallel against a wall and marked with piece of tape. Svabhu held a 1984 US penny with a mass of 2.53 grams with the edge perpendicular to the wall on top of his fingernail. Asya counted off “3, 2, 1, go” and on “go”, Svabhu moved his finger away from the surface allowing the penny to drop with minimal friction against the wall. Asya also recorded time with the stopwatch and began the timer on go and stopped the timer when she saw the penny hit the ground. Isaiah recorded the values after each trial. If there was an abnormal drop such as the penny not leaving the fingernail the trial was repeated.



Constants and Equations

M_p = 2.53 g a_T = -9.8 m/s

v_i = 0 m/s

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

y_i = h

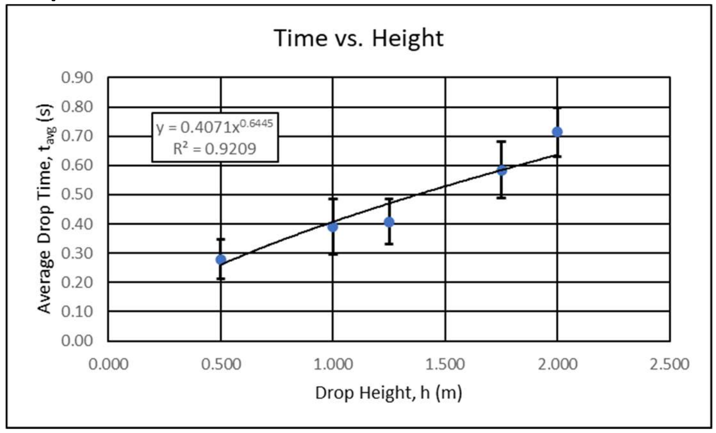
y_f = 0 m

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

Data Summary

h (m)	t_{AVG} (s)	SD (s)	%RSD of t_{avg}	t_T of t	|%err| (s^2)	t_{AVG}^2 (s^2)
0.500	0.28	0.07	24.45	0.32	12.66	0.08
1.000	0.39	0.09	24.25	0.45	13.45	0.15
1.250	0.41	0.08	18.89	0.51	19.42	0.17
1.750	0.58	0.10	16.49	0.60	2.28	0.34
2.000	0.71	0.08	11.68	0.64	11.76	0.51
		Avg	**19.15**	Avg	**11.91**	

Graph



Analysis

The data has low precision with the average |%RSD| being 19.15%. The average % error was 11.91%, making the accuracy low as well. The R^2 was 0.9209 showing that the strength of the mathematical model was moderate. The curve of best fit was $t_{avg} = 0.4071*h^{0.6445}$. The slope of the line represents the change in velocity. The y intercept of 0 means that at 0 meters the penny would take 0 seconds to fall. The calculated acceleration due to gravity, g, from this model was 8.065 m/s^2. The point furthest away from the trendline was at 1.25 meters making its actual time furthest from the theoretical time. The point closet to the trendline was at 1.75 meters meaning this was the actual time closest to the theoretical time. The power of h, 0.6445, is not close to 0.5, meaning time changes almost proportionally to the square root of height but not as close as it should indicating human error.

Conclusions

The experiment supported the initial hypothesis because the penny took more time to reach the ground when starting at higher heights and less time when starting at lower heights. A potential source of error came from the friction from the penny’s contact with the fingernail which would have in turn increased measured time. Another source of error may have come from air resistance acting on the penny and when the penny was seen to hit the floor it took some reaction time for the person recording the time to hit stop on the stopwatch. One future extension to this lab could be to determine the effect of the mass of different objects on drop time,