

LAB DAY 2: PENDULUM & LINEARIZATION

PURPOSE

Measure the period of a simple pendulum at different lengths, plot T^2 vs L , and use the linear relationship to calculate gravitational acceleration g . Compare with Day 1 spring results.

THEORY

The period of a simple pendulum is:

$$T = 2\pi\sqrt{\frac{L}{g}}$$

Squaring both sides gives a linear relationship:

$$T^2 = \frac{4\pi^2}{g} \cdot L$$

Plotting T^2 vs L yields a line with slope $m = \frac{4\pi^2}{g}$. Therefore:

$$g = \frac{4\pi^2}{\text{slope}}$$

PROCEDURE

1. Set up a simple pendulum with a small bob suspended by string.
2. Measure string length L from pivot to center of mass of bob (6+ lengths, 0.20 m to 1.20 m).
3. Pull bob to small angle ($<10^\circ$). Release and **time 10 complete oscillations** three times.
4. Record all trials and calculate average period $T = \frac{(10T)_{\text{avg}}}{10}$.
5. Repeat for all lengths. Calculate T^2 for each.

⚠ **Critical:** Measure L to the center of mass of the bob, not the bottom. Small angle oscillations only ($<10^\circ$).

DATA COLLECTION & CALCULATIONS

MEASUREMENTS

Record the time for 10 oscillations (10T) for each length and trial:

<i>L</i> (m)	Trial 1 (10T, s)	Trial 2 (10T, s)	Trial 3 (10T, s)	<i>T</i> _{avg} (s)	<i>T</i> ² (s ²)
0.20					
0.40					
0.60					
0.80					
1.00					
1.20					

SAMPLE CALCULATION

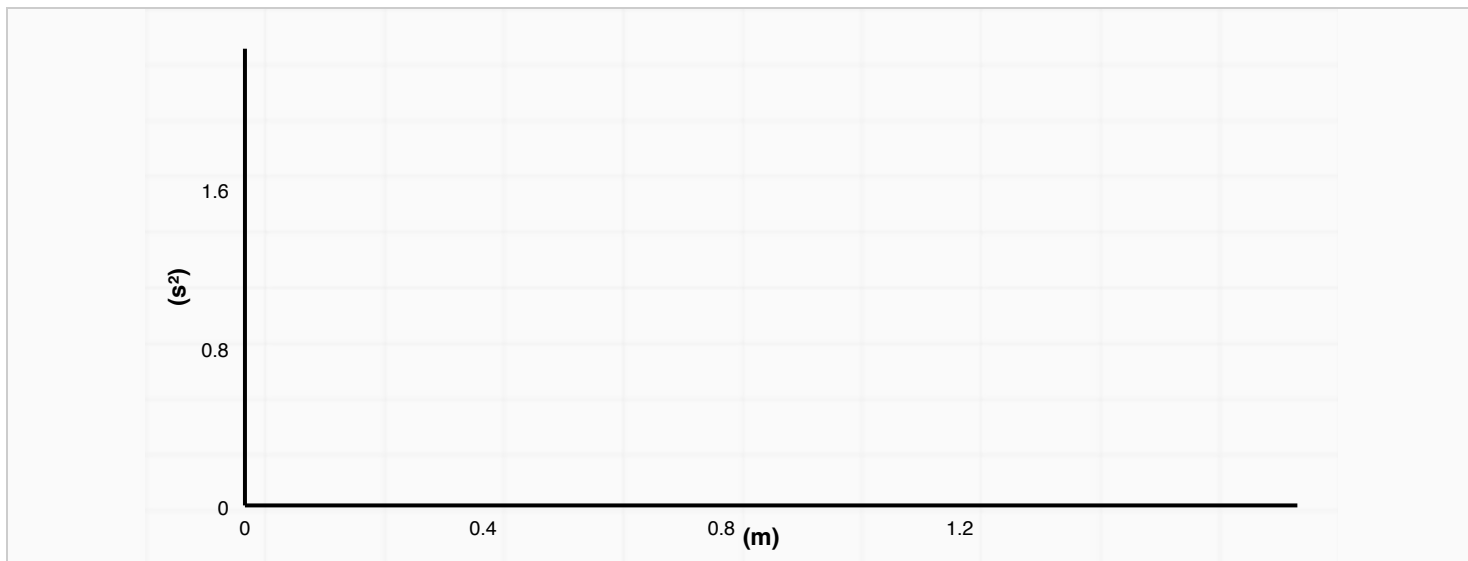
EXAMPLE For *L* = 0.40 m, if your trials were 1.26, 1.27, 1.25 s:

- Average: $T_{\text{avg}} = \frac{(1.26+1.27+1.25)/3}{10} = 0.126 \text{ s}$
- Squared: $T^2 = (0.126)^2 = 0.0159 \text{ s}^2$

LINEAR GRAPH & EXTRACTION OF G

PLOT T^2 VS L

Instructions: Plot your (L , T^2) data points on the grid below. Draw a best-fit line through the points.



SLOPE & GRAVITY CALCULATION

1. Calculate slope from your best-fit line:

$$\text{slope} = \frac{\Delta T^2}{\Delta L} = \text{_____ } \text{s}^2/\text{m}$$

2. Calculate g from slope:

$$g = \frac{4\pi^2}{\text{slope}} = \text{_____ } \text{m/s}^2$$

3. Percent error:

Accepted $g = 9.81 \text{ m/s}^2$ | Your $g = \text{_____ } \text{m/s}^2$ | Error = _____ %

COMPARISON & ANALYSIS

SPRING VS PENDULUM LINEARIZATION

Property	Spring (Day 1)	Pendulum (Day 2)
Linear relationship	$T^2 \propto m$	$T^2 \propto L$
How slope yields g	$k = 4\pi^2 m / \text{slope}$	$g = 4\pi^2 / \text{slope}$
Your percent error	_____ %	_____ %
Easier to measure?	_____	_____

POST-LAB QUESTIONS

Q1 Which experiment gave better accuracy? Why?

Q2 What would your measured g be on the Moon ($g = 1.62 \text{ m/s}^2$)? How would your slope change?

Q3 Did the mass of the bob affect the period? (Test with two different masses at same L.)

LAB CONCLUSION

Write 2–3 sentences summarizing what you confirmed and your experimental value of g :

Next: Review lab coming up! Bring both Day 1 and Day 2 data.