

To determine the local gravitational acceleration g by measuring the period of a simple pendulum at various lengths and comparing the result with the accepted value of $g = 9.81 \text{ m/s}^2$.

For a simple pendulum with small angular displacement ($\theta < 15^\circ$), the period T is:

$$T = 2\pi\sqrt{\frac{L}{g}} \quad (1)$$

where L is the length of the pendulum and g is the gravitational acceleration. Squaring both sides:

$$T^2 = \frac{4\pi^2}{g}L \quad (2)$$

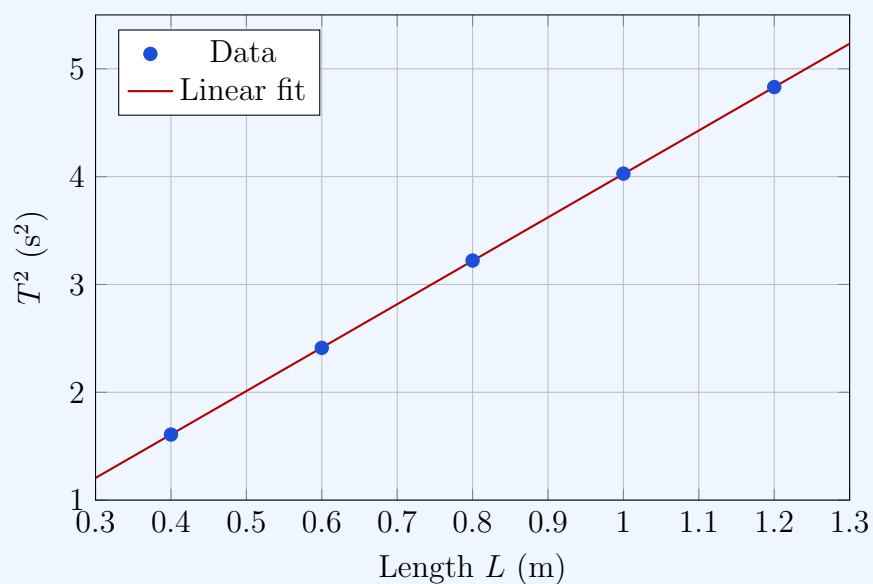
This is linear in L . The slope $m = 4\pi^2/g$, so $g = 4\pi^2/m$.

- Steel bob ($m = (50.0 \pm 0.1) \text{ g}$)
- Nylon string (L varied from 0.40 m to 1.20 m)
- Digital stopwatch (resolution: 0.01 s)
- Meter stick (resolution: 1 mm)

For each length, 10 full oscillations were timed and repeated 3 times. The period was computed as $T = t_{10}/10$, with uncertainty from the standard deviation of trials.

Table 1: Pendulum period measurements at various lengths.

L (m)	T (s)	δT (s)	T^2 (s ²)
0.40	1.268	0.008	1.608
0.60	1.553	0.010	2.412
0.80	1.795	0.012	3.222
1.00	2.007	0.009	4.028
1.20	2.198	0.011	4.831


 Figure 1: T^2 vs. L with linear regression. Slope $m = (4.028 \pm 0.045) \text{ s}^2/\text{m}$.

From the slope of the linear fit:

$$g = \frac{4\pi^2}{m} = \frac{4\pi^2}{4.028} = 9.80 \text{ m/s}^2$$

Using standard error propagation on $g = 4\pi^2/m$:

$$\delta g = g \cdot \frac{\delta m}{m} = 9.80 \times \frac{0.045}{4.028} = 0.11 \text{ m/s}^2$$

Final result: $g = (9.80 \pm 0.11) \text{ m/s}^2$

Our measured value of $g = (9.80 \pm 0.11) \text{ m/s}^2$ agrees with the accepted value of 9.81 m/s^2 within experimental uncertainty. The percent error is:

$$\% \text{error} = \frac{|9.81 - 9.80|}{9.81} \times 100\% = 0.10\%$$

Sources of systematic error include air resistance (which would increase the measured period and decrease the computed g) and the finite size of the bob. The small angle approximation is valid since all swings were initiated at $\theta \approx 10^\circ$.

The gravitational acceleration was determined to be $g = (9.80 \pm 0.11) \text{ m/s}^2$, consistent with the accepted value. The linear relationship between T^2 and L confirms the simple pendulum model for small oscillations.