

Title: Simple Harmonic Motion

Object: To measure the spring constant, k , for a spring; and to measure the period of oscillation for a mass on a spring and for a simple pendulum, and compare the results with theory.

Theory: Simple harmonic motion is a subject of great interest and importance in all fields of physical science. This phenomenon occurs in countless mechanical, electrical, and atomic systems of interest. We will consider two simple examples of systems where simple harmonic motion can be easily studied: that of an object with mass m oscillating at the end of a spring, and of a bob swinging back and forth at the end of a cord to form a simple pendulum. In both of these examples the motion is a steady oscillation with the period T given by standard formulas:

$$\text{for the mass and spring : } T = 2\pi\sqrt{m/k} \quad (1)$$

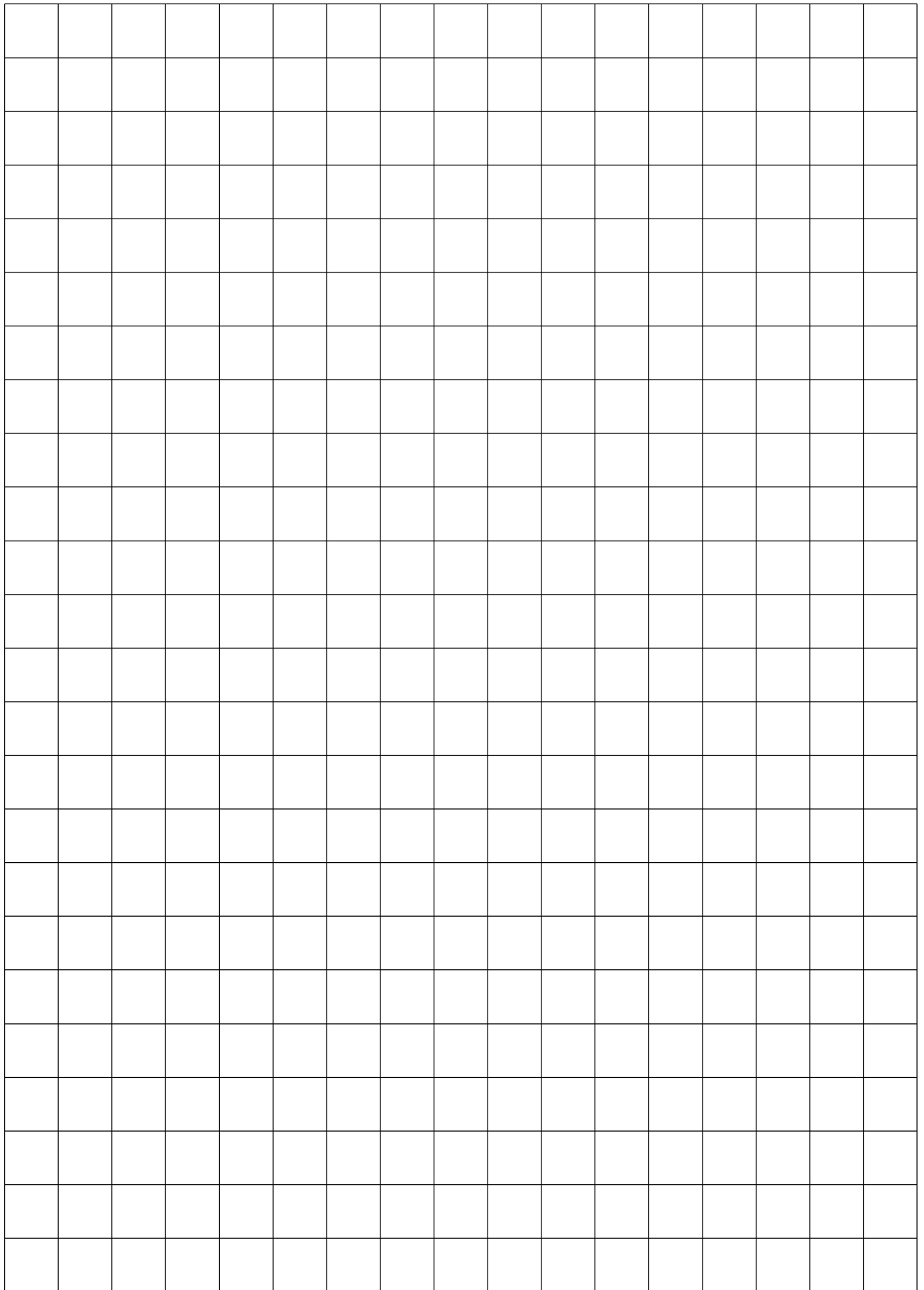
$$\text{for the simple pendulum : } T = 2\pi\sqrt{L/g} \quad (2)$$

Procedure and Results: Show all work in each step below. Measure periods by letting the system oscillate for several periods and dividing the total time by the number of oscillations.

- Hooke's Law for springs is $F = -kx$. (The negative sign merely indicates that it is a restoring force.) The spring constant k is the applied force per distance stretched (units of N/m). Determine the spring constant of your spring by hanging different amounts of weight on the spring and note the resting stretch in each case. Make a graph of force vs. stretch on the next page. The slope of the best-fit straight line through $(0, 0)$ is k . You will use this value of k in procedure 3.

Stretch (m)	Force (N)
0	0

$$k = \underline{\hspace{2cm}}$$



4. Using a bob and string, form a simple pendulum. Measure the period (for small oscillations, $\theta < 20^\circ$) for different lengths L (measured to the middle of the bob) of the pendulum. Start with a length of 15 cm and increase by 15 cm each trial until maximum length is reached. Use your calculator to square the period for the third column.

Length (m)	Period (s)	Period ² (s ²)

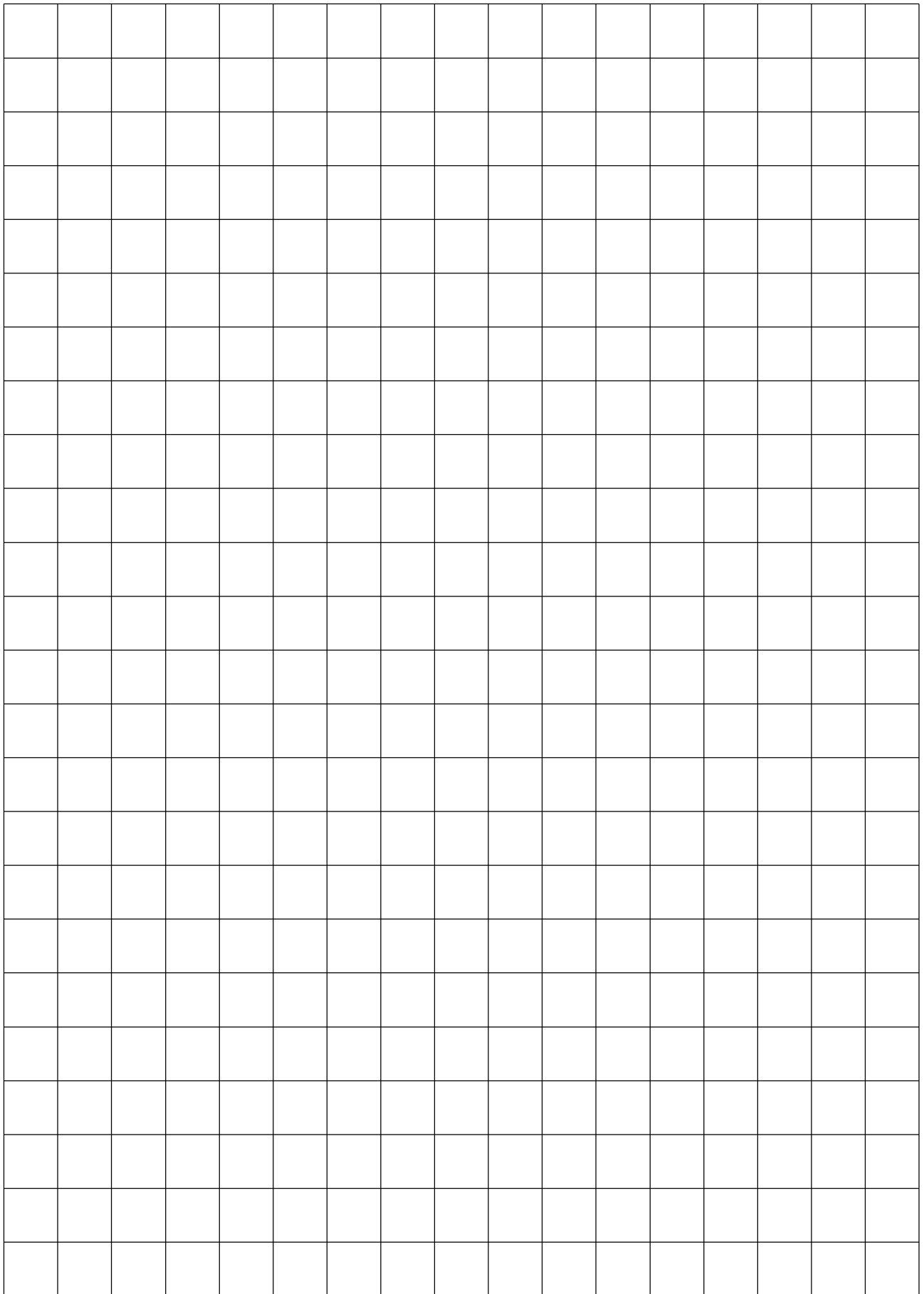
5. Using graph paper (next page), plot period squared vs. length and compute the slope of the best-fit straight line. Compare with the theoretical value obtained by squaring both sides of equation 2, and give the percent difference.

Slope = _____ Theoretical Value = _____ % diff = _____

6. Experimentally determine if the mass of the bob affects the period of a simple pendulum. Experimentally determine if the angle of swing (amplitude of oscillation) affects the period of a simple pendulum, first just for small angles, but then for angles clear up to 90° .
Observations:

Questions:

- When a 5.0 kg mass is hung from a certain spring it stretches down 35 cm to reach equilibrium. If the mass is then set into oscillatory motion, what will be the period of these oscillations?
- Suppose you have a clock with a pendulum that has a period of oscillation of 2 s. How much should you add to its length in order to increase its period to 2.5 s?



Conclusions: