Sample Problems

1. A block of mass 1.5 kg is attached to the end of a vertical spring of force constant \( k = 3.00 \times 10^2 \) N/m.
   a) What is the frequency of the block's motion? \( 2.3 \text{ Hz} \)
   b) What is the maximum amount of stretch of the spring during oscillations of the block? \( 0.049 \text{ m} \)

2. When a family of four people with a mass of \( 2.00 \times 10^2 \) kg step into their car, the car's spring compress 3.00 cm.
   a) What is the spring constant of the car's spring's (assuming they act like a single spring)? \( 6.53 \times 10^4 \text{ N/m} \)
   b) What are the period and frequency of the car after hitting a bump? \( 0.348 \text{ s} \), \( 2.87 \text{ Hz} \)

3. A small insect of mass 0.30 g is caught in a spider-web. The web vibrates with a frequency of 15 Hz.
   a) What is the value of the spring constant for the web? \( 2.7 \frac{\text{N}}{\text{m}} \)
   b) At what frequency would you expect the web to vibrate if an insect of mass 0.10 g were trapped? \( 26 \text{ Hz} \)
4. a) Find the period of a pendulum with a 2.45 kg bob and having a length of 1.36 m.

b) By what amount would you have to increase the length in order to double the period?

5. Estimate the length of the pendulum in a grandfather clock that ticks once a second.

**Answer Key**

1. a) 2.3 Hz
   b) 0.049 m

2. a) $6.53 \times 10^4$ N/m
   b) 0.348 s, 2.87 Hz

3. a) 2.7 N/m
   b) 26 Hz

4. a) 2.34 s
   b) --------

5. 0.25 m
1. a) \( T = \frac{2\pi \sqrt{m}}{k} \)

b) \( f = \frac{k}{T} \)

\[ x = \frac{m}{k} \]

\[ T = 2\pi \sqrt{\frac{m}{k}} \]

\[ T = \frac{2\pi}{0.005} \]

\[ T = 0.4 \text{ s} \]

\[ x = \frac{1}{3}R(9.8) \]

\[ 3.1 \]

\[ f = \frac{1}{T} = \frac{1}{0.44} \]

\[ f = 2.3 \text{ Hz} \]

\[ x = 0.049 \text{ m} \]

2. a) \( k = \frac{F}{x} \)

\[ k = \frac{mg}{x} = \frac{300 \times 9.8}{3.0 \times 10^{-2}} \]

\[ k = 3.53 \times 10^4 \text{ N/m} \]

b) \( T = \frac{2\pi \sqrt{m}}{k} \)

\[ f = \frac{1}{T} \]

\[ T = \frac{2\pi}{\sqrt{\frac{200}{4.53 \times 10^4}}} \]

\[ T = 0.3485 \text{ s} \]

\[ T = 2\pi \text{ (0.0002063)} \]

\[ T = 0.03485 \text{ s} \]

2. a) \( T = \frac{1}{f} \)

\[ T = \frac{4\pi \sqrt{m}}{k} \]

\[ T = \frac{1}{\sqrt{\frac{m}{k}}} \]

\[ \frac{5}{16} \]

\[ T = 0.006675 \text{ s} \]

\[ k = \frac{m \times 2\pi^2}{T^2} \]

\[ k = 0.3 \times 10^{-5} \text{ N/m} \]
3 b) \[ k = 2.7 \text{ N/m} \]

\[ m = 0.16 \times 10^{-3} \text{ kg} \]

\[ T = \frac{2\pi}{\sqrt{\frac{k}{m}}} \]

\[ T = 2\pi \sqrt{\frac{9.81}{8.7 \times 10^{-5}}} \]

\[ T = 2\pi \left( 0.0010856 \right) \]

\[ T = 0.0311 \text{ s} \]

\[ F = \frac{1}{T} \]

\[ F = \frac{1}{0.0311} \approx 32 \text{ N} \]

\[ f = 26 \text{ Hz} \]
Sample Problem

1. a) Find the period of a pendulum with a 2.45 kg bob and having a length of 1.36 m.
   b) By what amount would you have to increase the length in order to double the period?

\[ T = 2\pi \sqrt{\frac{L}{g}} \]

\[ T = 2\pi \sqrt{\frac{1.36}{9.8}} \]

\[ T = 2\pi \times (0.3725) \]

\[ T \approx 2.34 \text{ s} \]

2. Estimate the length of the pendulum in a grandfather clock that ticks once a second.

\[ L = ? \]

\[ T = 1.0 \text{ s} \]

\[ \frac{T^2}{4\pi^2} = \frac{L}{g} \]

\[ T^2 \cdot g = 4\pi^2 \cdot L \]

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

\[ L = \frac{(1.0)^2 \cdot (9.8)}{4\pi^2} \]

\[ L = 0.25 \text{ m} \]