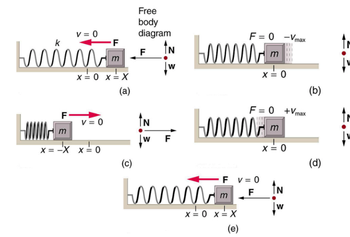
Introduction to Physical Science

Simple Harmonic Motion

Presented by Robert Wagner

Simple Harmonic Motion

- Net force can be described by Hooke's Law
    -
    - No damping - so no friction or other non-conservative forces
- Period of a simple harmonic oscillator
    -
    - Neither T nor f depends on the amplitude



Example

- Calculate the period and frequency of oscillation for a car if the total mass is 900. kg and the force constant of the suspension system is $6.53x10^4$ N/m.
    - Draw a sketch (if applicable)
    - Identify known values
    - Identify equation
    - Enter values in the equation and solve

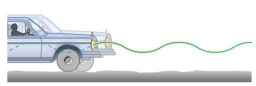


Figure 16.10 The bouncing car makes a wavelike motion. If the restoring force in the suspension system can be described only by Hooke's law, then the wave is a sine function. (The wave is the trace produced by the headlight as the car moves to the right.)

Example

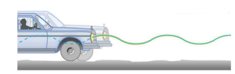


Figure 16.10 The bouncing car makes a wavelike motion. If the restoring force in the suspension system can be described only by Hooke's law, then the wave is a sine function. (The wave is the trace produced by the headlight as the car moves to the right.)

- Calculate the period and frequency of oscillation for a car if the total mass is 900. kg and the force constant of the suspension system is $6.53x10^4$ N/m.
    - Draw a sketch (if applicable)
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    - Identify equation
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$$m = 900.kg\ ;\ k = 6.53x10^4\ N/m$$

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = \frac{1}{2\pi}\sqrt{\frac{6.53x10^4\ N/m}{900.\ kg}}$$

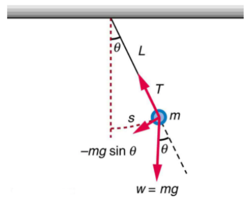
$$f = 1.36s^{-1} = 1.36\ Hz$$

$$T = \frac{1}{f} = \frac{1}{1.356\ Hz} = 0.738\ s$$

Image Credit: OpenStax College Physics - Figure 16.10 CC BY 4.0

A Simple Pendulum

- Common pendulums
  - Clocks, swings, etc.
- Simple pendulum
  - Small mass suspended from a light wire or string
  - For small angles (<15°) - exhibits simple harmonic motion
- Restoring force:
  - ;



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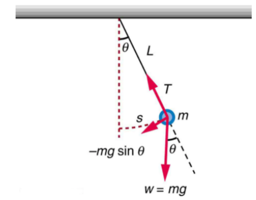
A Simple Pendulum (2)

- Period of a pendulum
  -
- Depends only on the pendulum length, NOT the mass!



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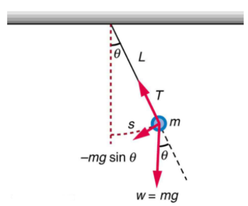
Example

- What is the acceleration due to gravity in a region where a simple pendulum having a length of 75.000 cm has a period of 1.7357 s?
  - Draw a sketch (if applicable)
  - Identify known values
  - Identify equation
  - Enter values in the equation and solve



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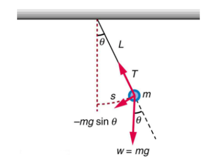
Example



- What is the acceleration due to gravity in a region where a simple pendulum having a length of 75.000 cm has a period of 1.7357 s?
  - Draw a sketch (if applicable)
  - Identify known values
  - Identify equation
  - Enter values in the equation and solve

$L = 75.000\ cm = 0.75000\ m\ ;\ T = 1.7357\ s$

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

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

$$g = 4\pi^2\frac{0.75000\ m}{(1.7357\ s)^2}$$

$$g = 9.8281\ m/s^2$$

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Summary

- Simple harmonic motion occurs when the net restoring force can be described by Hooke's Law.

- The period of a simple harmonic oscillator has no dependence on amplitude

- A pendulum behaves as a simple harmonic oscillator for small displacements. The period is independent of the mass.