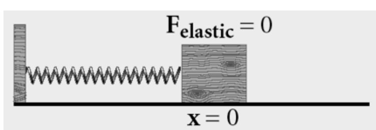
Chapter 10

Simple Harmonic Motion

Simple Harmonic Motion

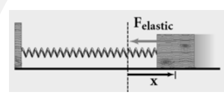
- Vibration about an equilibrium position in which a restoring force is proportional to the displacement from equilibrium

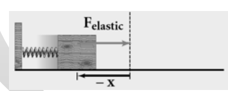
Equilibrium Position



- Position where net force is equal to zero
- Natural resting place
- Velocity is at maximum
- Acceleration is zero

Restoring Force

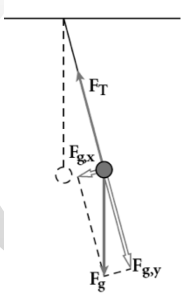




- Force that causes simple harmonic motion
- Proportional to the displacement
- Maximum displacement
  - Acceleration is maximum
  - Velocity is zero

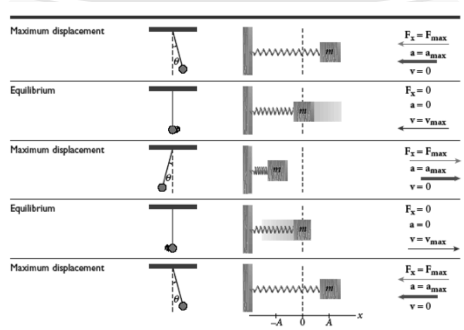
$$F_{elastic} = -kx$$

Simple Pendulum



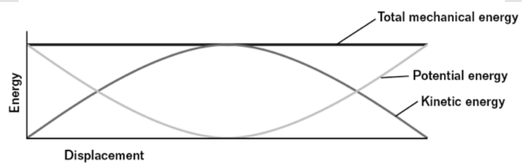
- Restoring force is the bob's weight
- Weight is broken into perpendicular components
- The net force is the gravitational force in the x-direction

Simple Harmonic Motion



Energy Changes in SHM

- Potential energy is proportional to displacement
- Kinetic energy is inversely proportional to displacement



Amplitude, Period, and Frequency

- Amplitude - Maximum disdplacement from equilibrium
  - Radians or meters
- Period - Time it takes to execute a complete motion
  - Seconds
- Frequency - Number of cycles or vibrations per unit of time
  - Hertz

Period of Pendulum

- Depends on
  - Length
  - Acceleration of gravity

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

Period of Mass-Spring System

- Depends on
  - Mass
  - Spring constant

$$T = 2\pi\sqrt{\frac{m}{k}}$$

Elastic Deformation

- Stretching and Compression

$$F = Y(\frac{\Delta L}{L_0})A$$

- Y=Young's Modulus
  - Different for each solid
  - N/m^2
  - p. 291

Elastic Deformation

- Shear deformation

$$F = S(\frac{\Delta X}{L_0})A$$

- S=Shear Modulus
  - Different for each solid
  - N/m^2
  - p. 291

Elastic Deformation

- Volume deformation

$$\Delta P = -B(\frac{\Delta V}{V_0})$$

- B=Bulk Modulus
  - Different for each solid and liquid
  - N/m^2
  - p. 293

Stress and Strain

- **Stress** is proportional to **Strain**

$$\frac{F}{A} = Y \quad (\frac{\Delta L}{L_0})$$

$$\frac{F}{A} = S \quad (\frac{\Delta X}{L_0})$$

$$\Delta P = B \quad -(\frac{\Delta V}{V_0})$$