Chapter 12: Statics

For a system in static equilibrium:

\[ F_{\text{net}} = 0 \quad (\text{sum of all the forces must be zero.}) \]

\[ \tau_{\text{net}} = 0 \quad (\text{sum of all the torques must be zero.}) \]

Chapter 15: Oscillations

Simple Harmonic Motion

\[ x(t) = x_m \cos(\omega t + \phi) \quad (\text{displacement}) \]

\[ x_m \] is the amplitude

\[ \omega = \frac{2\pi}{T} = 2\pi f \quad (\text{angular frequency}) \]

\[ v(t) = -\omega x_m \sin(\omega t + \phi) \quad (\text{velocity}) \]

\[ v_m = \omega x_m \quad (\text{velocity amplitude}) \]

\[ a(t) = -\omega^2 x_m \cos(\omega t + \phi) \quad (\text{acceleration}) \]

\[ a_m = \omega^2 x_m \quad (\text{acceleration amplitude}) \]

\[ a(t) = -\omega^2 x(t) \]

For linear simple harmonic oscillator (S.H.O.)

\[ \omega = \sqrt{\frac{k}{m}} \quad (\text{angular frequency}) \]

\[ T = 2\pi \sqrt{\frac{m}{k}} \quad (\text{period}) \]

\[ T = 2\pi \sqrt{\frac{L}{g}} \quad (\text{simple pendulum}) \]

Energy

\[ U(t) = \frac{1}{2} k x^2 = \frac{1}{2} k x_m^2 \cos^2(\omega t + \phi) \quad (\text{potential energy}) \]

\[ K(t) = \frac{1}{2} m v^2 = \frac{1}{2} k x_m^2 \sin^2(\omega t + \phi) \quad (\text{kinetic energy}) \]

\[ E = U + K = \frac{1}{2} k x_m^2 \quad (\text{total energy}) \]
Chapter 16: Waves

Types of waves:
- Mechanical (must have a medium through which to propagate)
- Electromagnetic (does not need a medium through which to propagate)

Transverse waves: Displacement of every oscillating element is perpendicular to direction of travel.
Examples: waves in water, waves on a string

Longitudinal waves: Displacement of every oscillating element is parallel to direction of travel.
Examples: sound waves

\[ y(t) = y_m \sin (kx - \omega t) \]  (general expression for a wave)

- \( y_m \) is the amplitude
- \( k \) is angular wave number
- \( x \) is position
- \( \omega \) is angular frequency
- \( t \) is time

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

\[ f = \frac{1}{T} = \frac{\omega}{2\pi} \]

Speed of traveling wave (assume \( kx - \omega t \) is constant)

\[ v = \frac{\omega}{k} = \frac{\lambda}{T} = \lambda f \]

\[ y(x,t) = \sin (kx \pm \omega t) \]  (- means wave travels in +x direction)
(+) means wave travels in – x direction)

\[ v = \sqrt{\frac{\tau}{\mu}} \]  (for a stretched string)

Constructive & destructive interference

Chapter 17: Sound

sound is longitudinal, mechanical wave

\[ f = f \frac{v \pm v_D}{v \pm v_s} \]  Doppler effect