Simple Harmonic Motion (SHM)

All SHM can be ***characterized*** by:

— Amplitude, A (m or rad)
maximum displacement from equilibrium

— Temporal Period, T (s)
time to complete one cycle of oscillation

— Temporal Frequency, f (cycles/s or Hz)
number of cycles in one second

— Temporal Angular Frequency, ω (rad/s)

$$\omega \equiv 2\pi f = \frac{2\pi}{T}$$

$$y(t) = A\cos(\omega t + \phi_0) = A\cos(2\pi f t + \phi_0) = A\cos\left(\frac{2\pi}{T}t + \phi_0\right)$$

Simple Harmonic Motion (SHM)

Each of these characteristics ***depends*** on the physical system:

— Amplitude, A (m or rad)

determined by initial displacement and initial velocity

— Temporal Angular Frequency, ω (rad/s)

$$\omega \propto \frac{restoring\ force\ (or\ torque)}{inertia}$$

$$\omega = \sqrt{\frac{k}{m}}$$ for a mass/spring system

$$\omega = \sqrt{\frac{mgL}{mL^2}} = \sqrt{\frac{g}{L}}$$ for a pendulum

Mechanical Waves

All waves can be ***characterized*** by:

— Amplitude, A (m)
  maximum displacement from equilibrium

— Temporal Period, T (s)
  time to complete one cycle of oscillation

— Spatial Period, λ (m) (wavelength)
  distance between repetitions of the wave form

— Temporal Frequency, f (cycles/s or Hz)
number of cycles in one second

— Spatial Frequency, κ (cycles/m)
number of wave forms in one meter

— Temporal Angular Frequency, ω (rad/s)

$$\omega \equiv 2\pi f = \frac{2\pi}{T}$$

— Spatial Angular Frequency, k (rad/m) (wave number)

$$k \equiv 2\pi\kappa = \frac{2\pi}{\lambda}$$

— Wave Speed, v (m/s)

$$y(x,t) = A\cos\left[k(x \pm vt)\right]$$

Mechanical Waves

Each of these characteristics ***depends*** on the physical system:

— Amplitude, A (m or rad)

determined by amplitude of the oscillator creating the wave

— Temporal Frequency, f (cycles/s or Hz)

determined by frequency of the oscillator creating the wave

— Wave Speed, v (m/s)

$$v \propto \frac{restoring\ force\ (or\ torque)}{inertia}$$

— Spatial Period, λ (m) (wavelength)

$$\lambda = \frac{v}{f}$$