Harmonic Motion

Harmonic Motion

- Vibratory periodic motion

Simple Harmonic Motion (SHM)

Terms

Cycle

- Single sequence of moves that characterize a repeated unit.

Period (T)

- Time for system to complete one cycle.
- measured in seconds (s)

Frequency (f)

- Number of cycles per unit time
- measured in Hertz (Hz)

Angular frequency (ω)

↑ omega, lower case

$$\omega = 2\pi f$$

- Also called angular speed.

SHM —

- Sinusoidal motion with a single frequency

SHM Displacement

$$x = A \cos \omega t$$

A - amplitude (m)

ω - angular frequency (radians)

t - time (s)

x - displacement (m)

SHM Velocity

$$V_x = -A\omega \sin(\omega t) = \pm V_{max} \sqrt{1 - \left(\frac{x}{A}\right)^2}$$

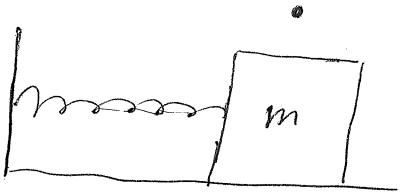
SHM Acceleration

$$a_x = -A\omega^2 \cos(\omega t)$$

* SHM

Acceleration is proportional to its displacement.

Elastic Restoring Force



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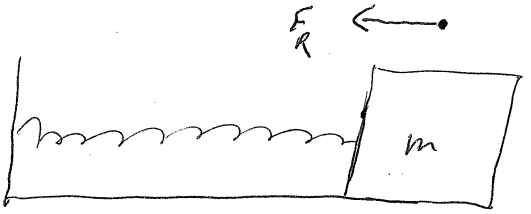

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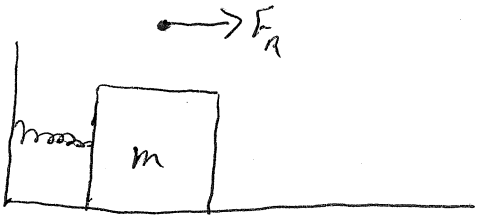

compressed

$$F_R = F_s = kx$$

$$F_R = kx = ma$$

$$\frac{kx}{m} = a$$

Note: Acceleration is proportional to displacement (x).

$\Rightarrow$ SHM.

Frequency and Period

Natural Angular Frequency

- specific frequency at which the system oscillates by itself once set in motion.

$$\omega_0 = \sqrt{\frac{k}{m}}$$

$$\omega = 2\pi f$$

$$\Rightarrow$$

$$\omega_0 = 2\pi f_0 = \sqrt{\frac{k}{m}}$$

$$\Rightarrow$$

$$f_0 = \frac{\sqrt{\frac{k}{m}}}{2\pi}$$

$$T = \frac{1}{f}$$

$$\Rightarrow$$

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

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