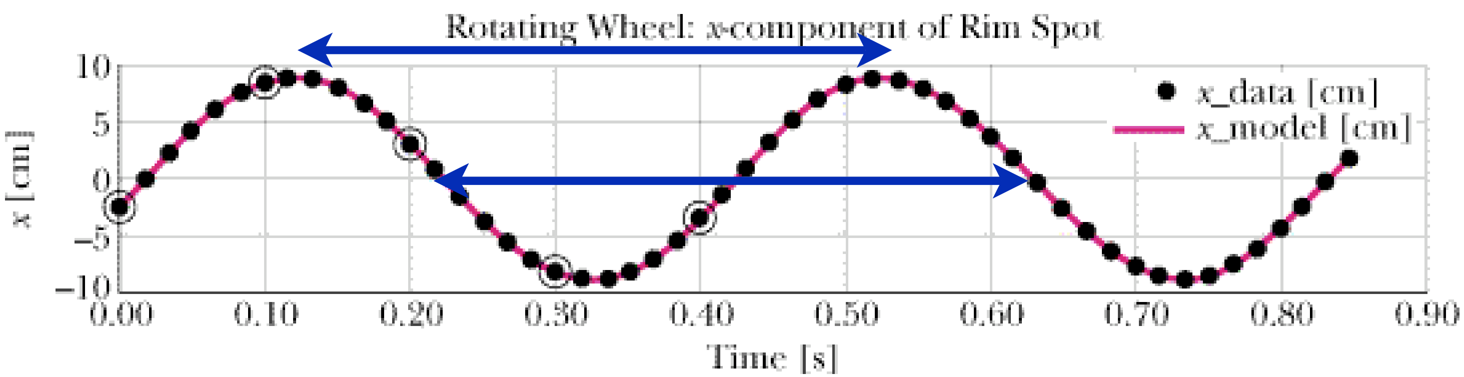
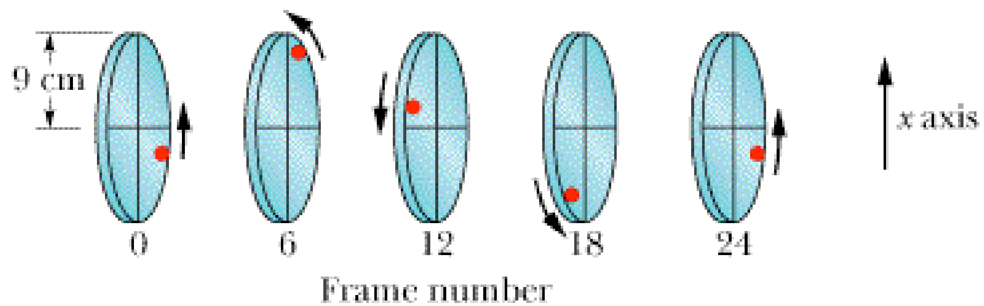
Oscillations

Periodic Parameters

Period

T =0.4 s



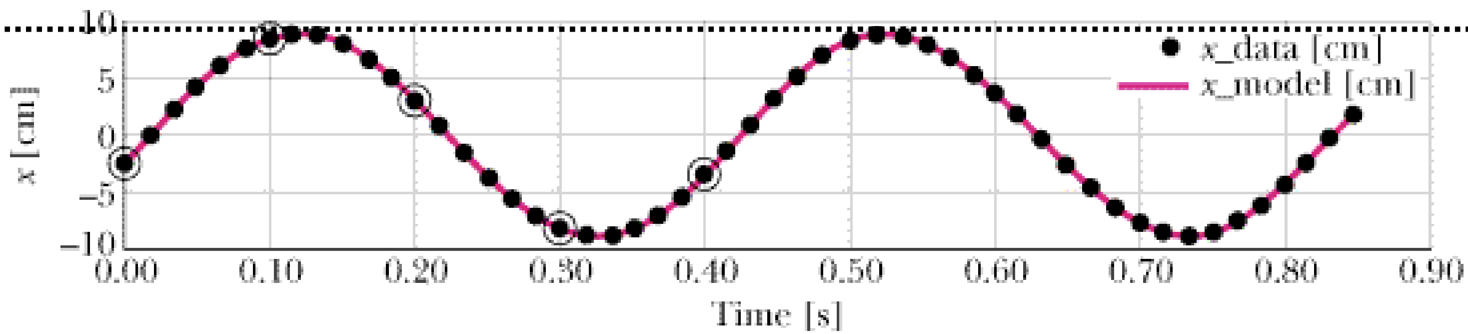


Frequency

$f = 1/T$ =2.5 Hz

$\omega = 2\pi f = 2\pi/T$ =15.7 s^{-1}

Mathematical Model



$$x(t) = A\cos(\omega t + \phi)$$

Amplitude

frequency

phase shift

9.5 cm

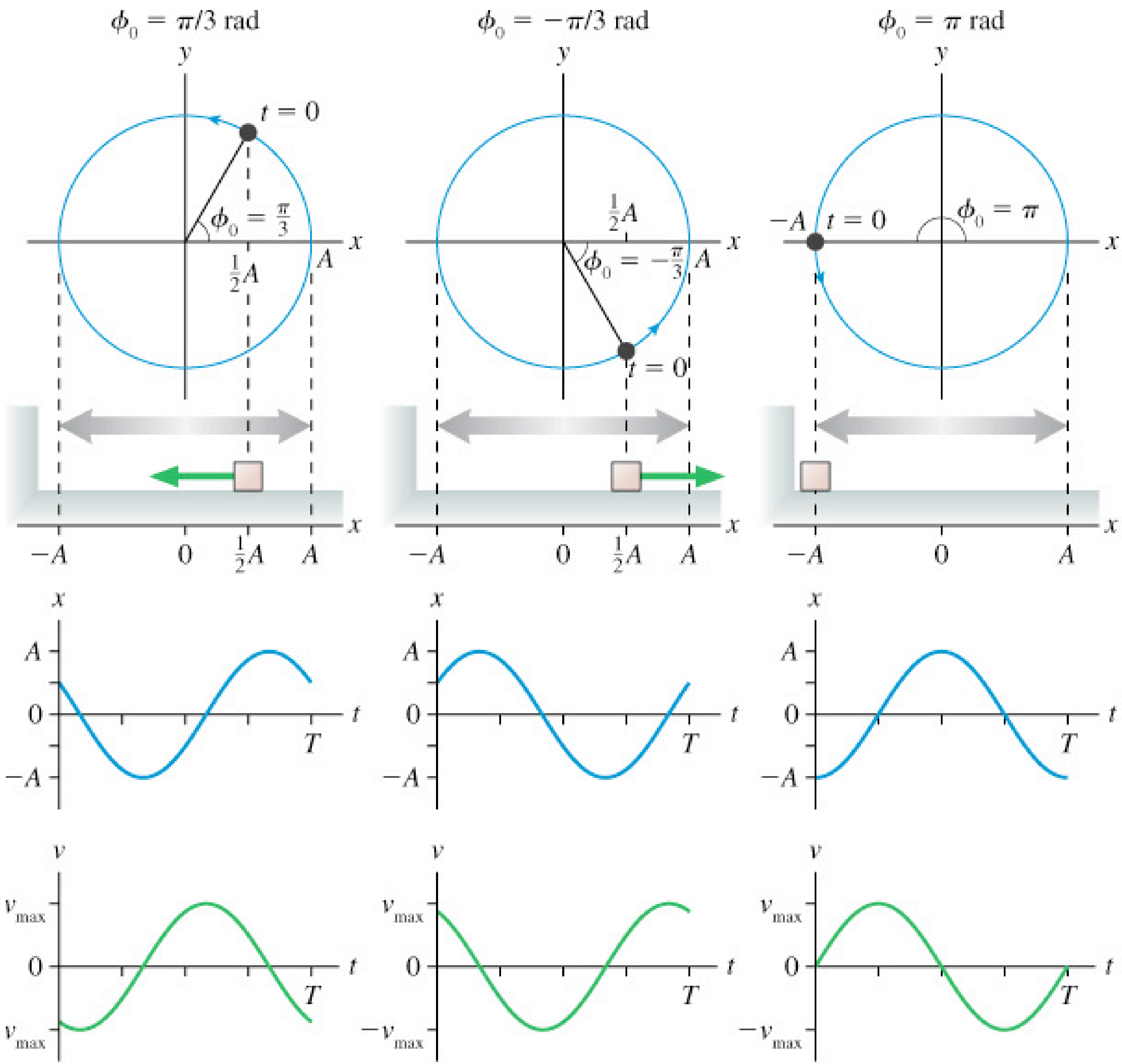
15.7 s^{-1}

At t=0

$x(0) = 9.5\cos(\phi) = -2.5$ cm

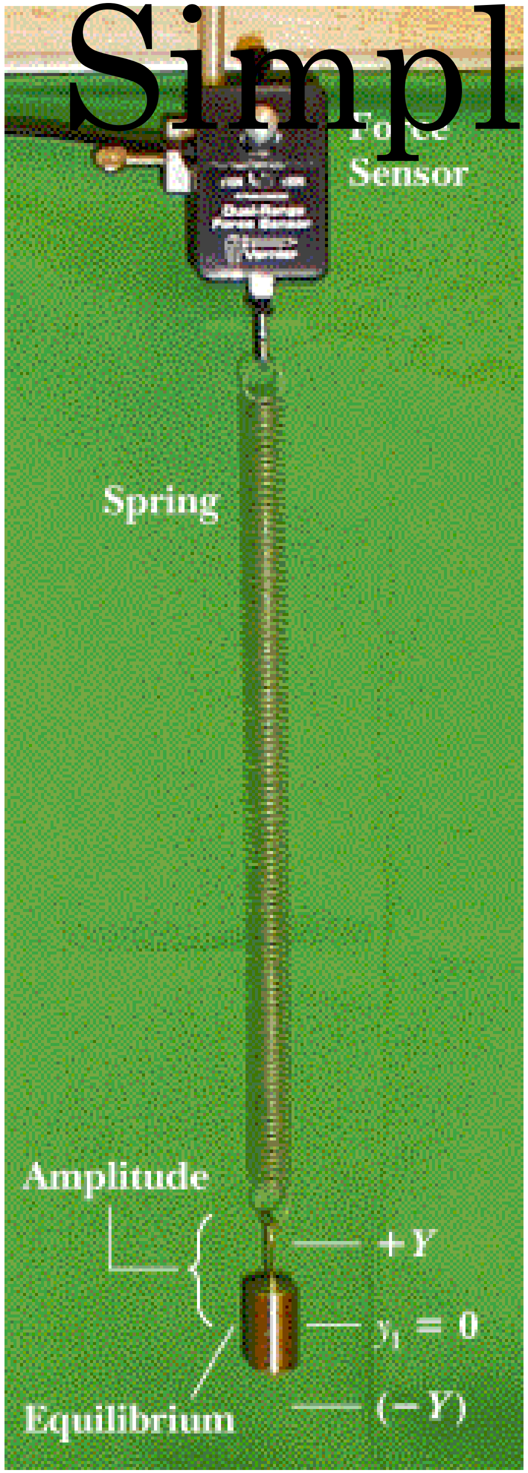
$\phi = \cos^{-1}(-2.5/9.5)$

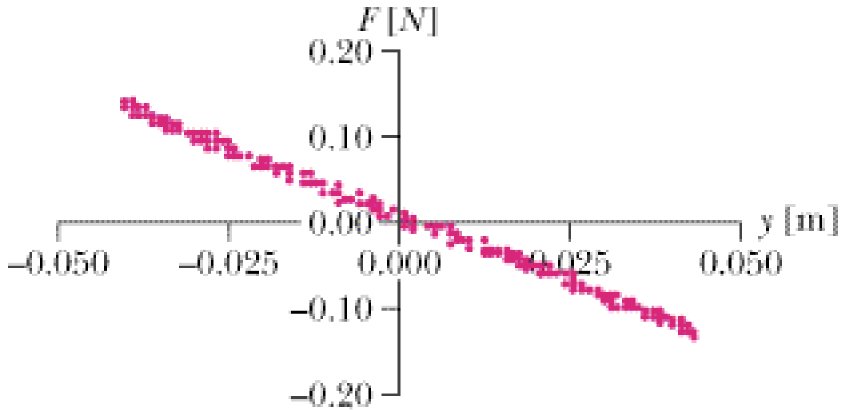
$= -1.8$ rad



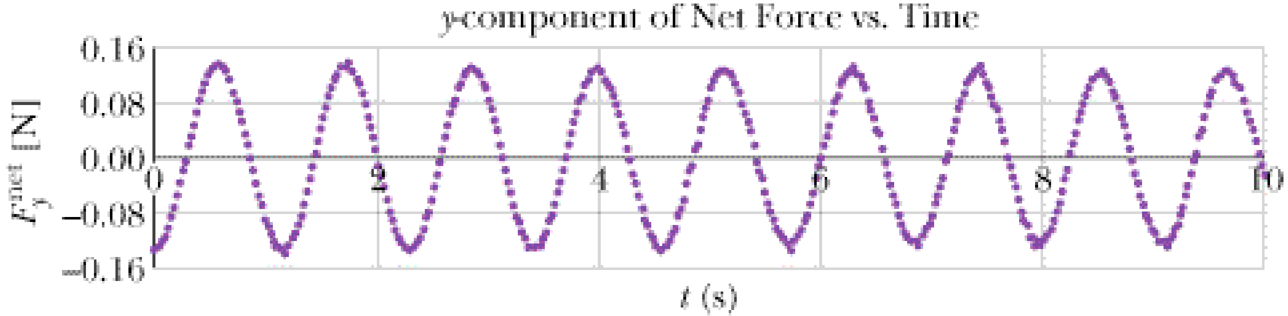
$\phi_0 = \pi/3$ rad
$\phi_0 = -\pi/3$ rad
$\phi_0 = \pi$ rad
$t = 0$
$\phi_0 = \frac{\pi}{3}$
$\frac{1}{2}A$
$\phi_0 = -\frac{\pi}{3}$
$\phi_0 = \pi$
$-A$
A
0
T
v_{max}
$-v_{max}$

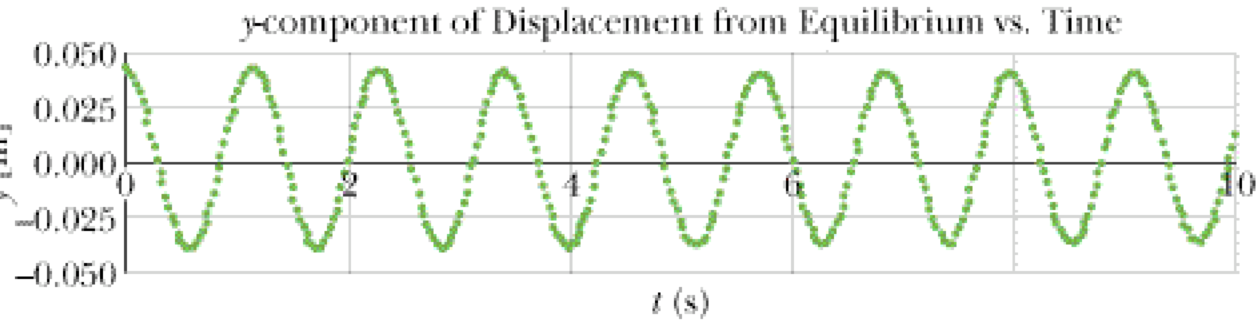
Simple Harmonic Motion





Push the mass up a little.





$$x(t) = X\cos[\omega t + \phi_0] = (0.040\,\mathrm{m})\cos[(5.5\,\mathrm{rad/s})t + 0.0\,\mathrm{rad}].$$

Simple Harmonic Motion

$$F^{\text{net}} = ma_x = m\frac{d^2x}{dt^2} = -kx, \quad \text{so that} \quad \frac{d^2x}{dt^2} = -\frac{k}{m}x\ .$$

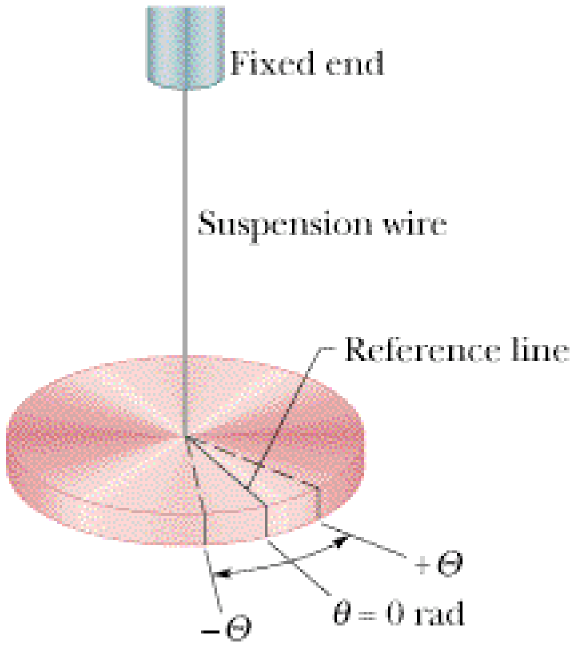
$$x(t) = X\cos[\omega t + \phi_0]$$

$$\frac{dx}{dt} = \frac{d\left[X\cos(\omega t + \phi_0)\right]}{dt} = -\omega X\sin(\omega t + \phi_0),$$

$$\frac{d^2x}{dt^2} = \frac{d\left[-\omega X\sin(\omega t + \phi_0)\right]}{dt} = -\omega^2 X\cos(\omega t + \phi_0) = -\omega^2 x\ .$$

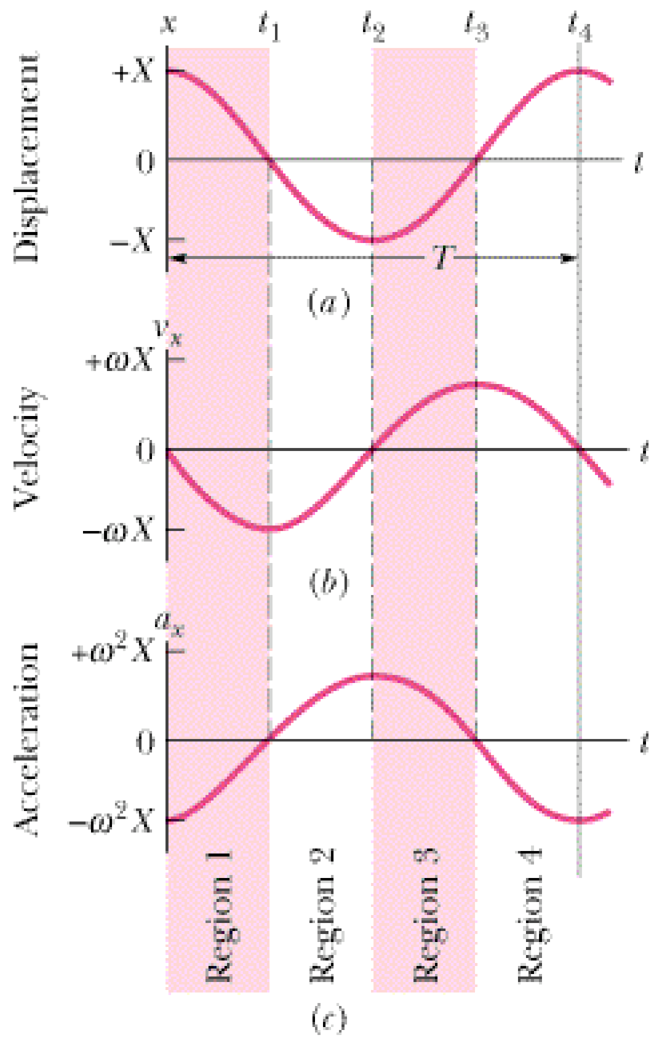
$$\omega = \sqrt{\frac{k}{m}}$$

Torsional Oscillator

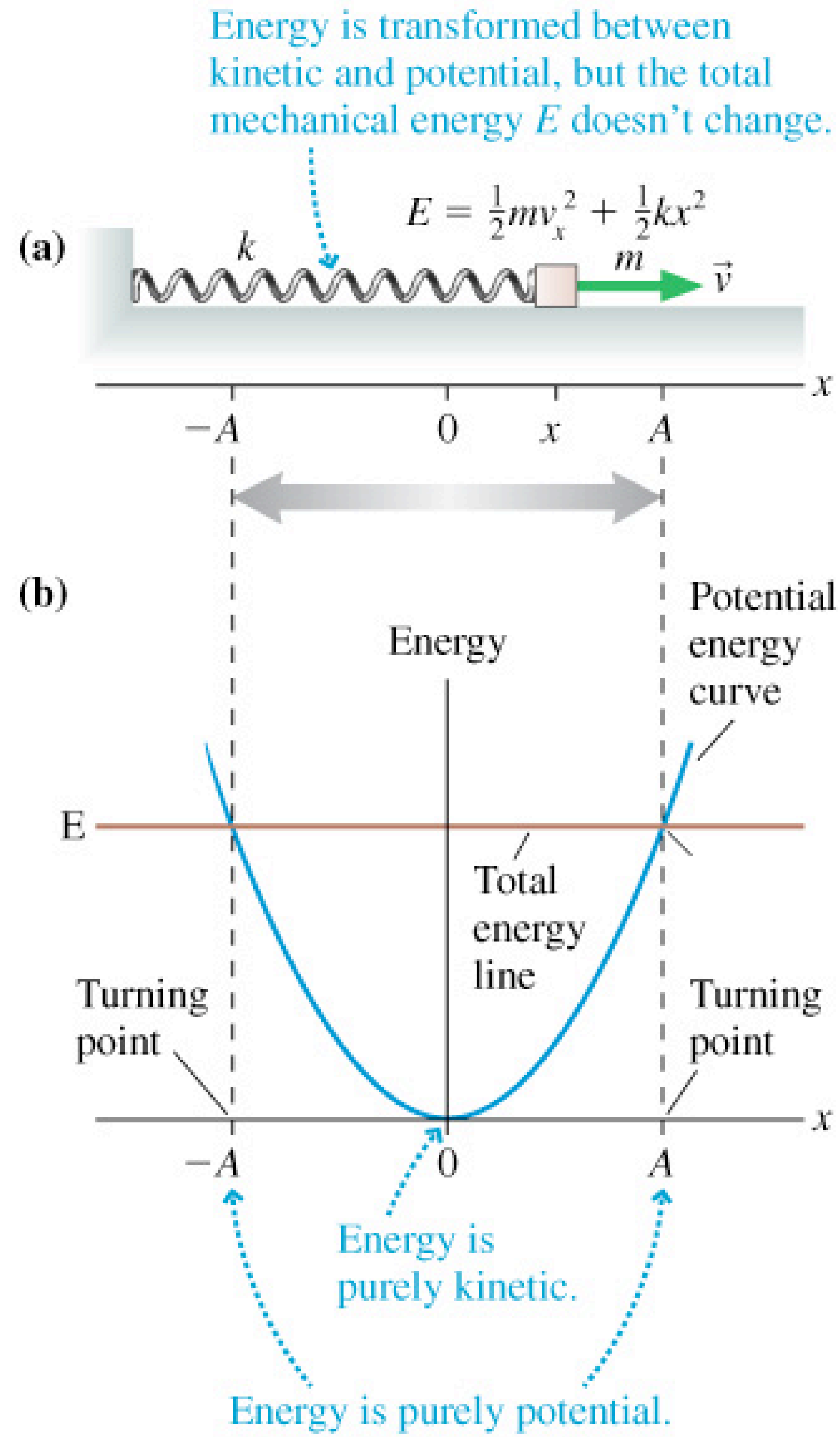


$$T = 2\pi\sqrt{\frac{I}{k}}$$

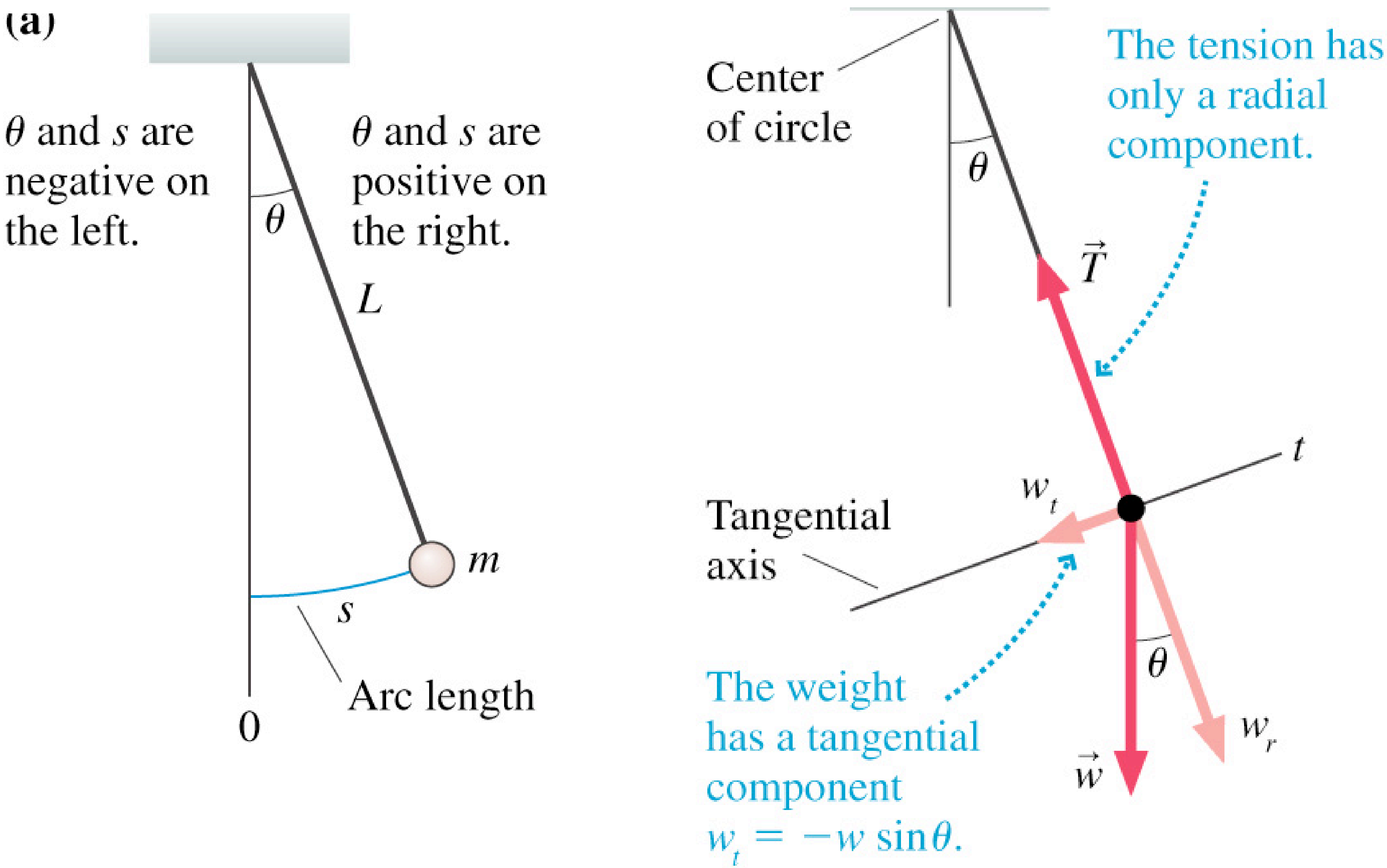
x, v and a in S.H.M.



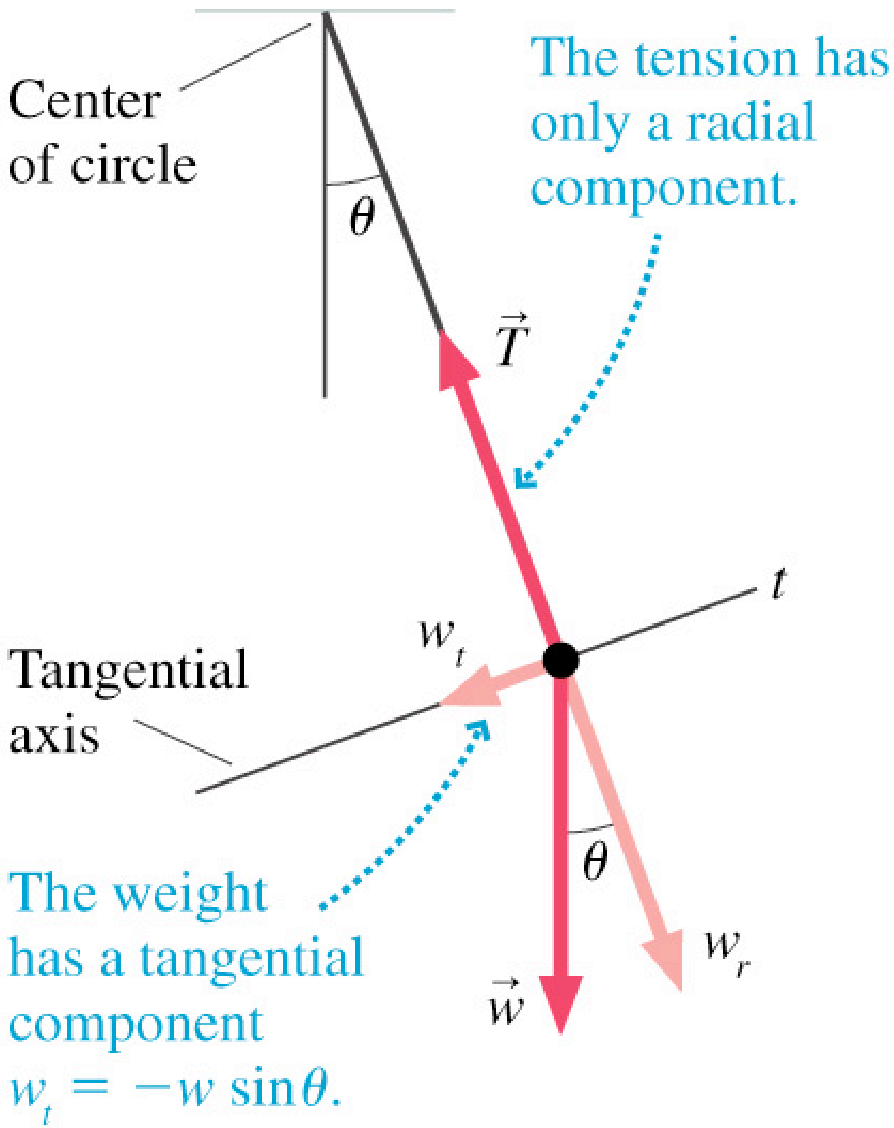
Energy in S.H.M



Simple Pendulum



Simple Pendulum



$$m \frac{d^2 s}{dt^2} = -mg \sin(\theta)$$

$$\sin(\theta) \approx \theta = \frac{s}{L}$$

$$\frac{d^2 s}{dt^2} = - s \frac{g}{L}$$

$$\omega = \sqrt{\frac{g}{L}}$$