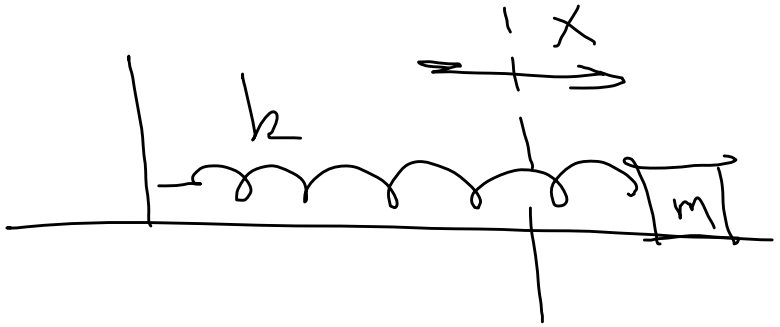
Phys 2110-4 11/16/11

Note Title 11/16/2011

Chap 13 Oscillations

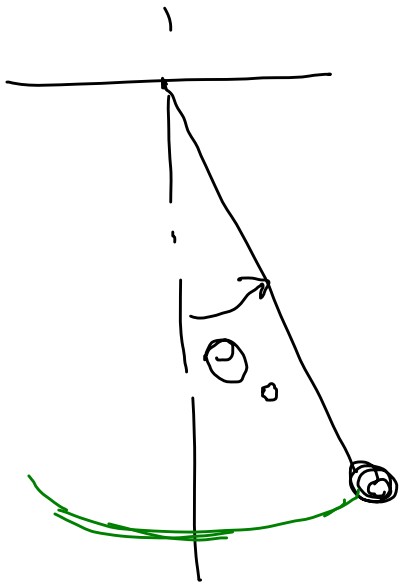


$f, T, \omega = 2\pi f$

$$\omega = \sqrt{\frac{k}{m}} \qquad f = \frac{\omega}{2\pi} = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

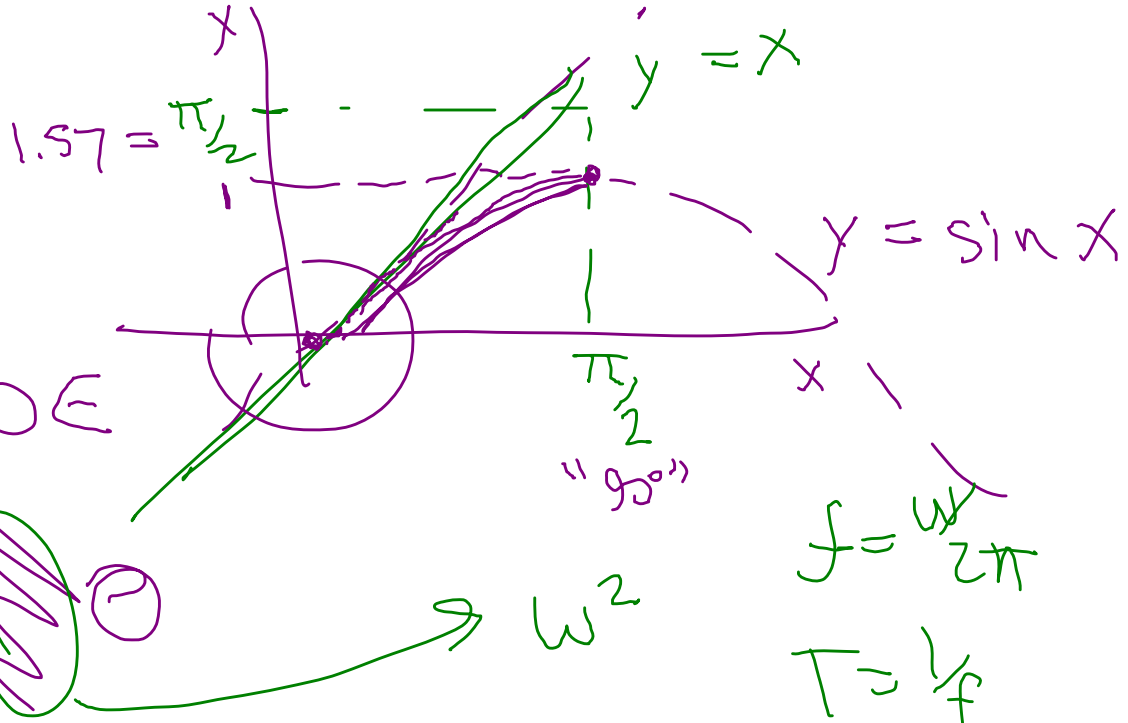
etc.

Simple Pendulum



Cheat: θ is "small"

$\sin\theta \approx \theta$



With this, solve DE

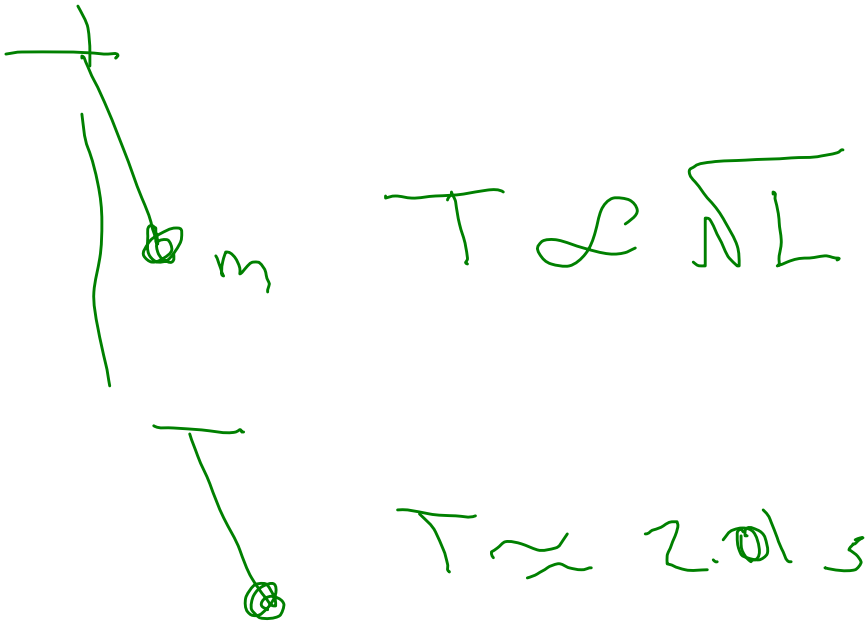
$$\frac{d^2\theta}{dt^2} = -\theta \rightarrow \omega^2$$

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

$$T = 1/f$$

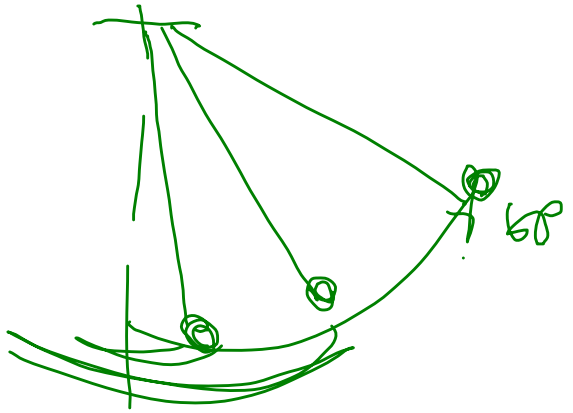
Pendulum

$$\omega = \sqrt{\frac{g}{L}} \qquad f = \frac{1}{2\pi}\sqrt{\frac{g}{L}} \qquad T = 2\pi\sqrt{\frac{L}{g}}$$



$T \propto \sqrt{L}$

$T \approx 2.01\ s$

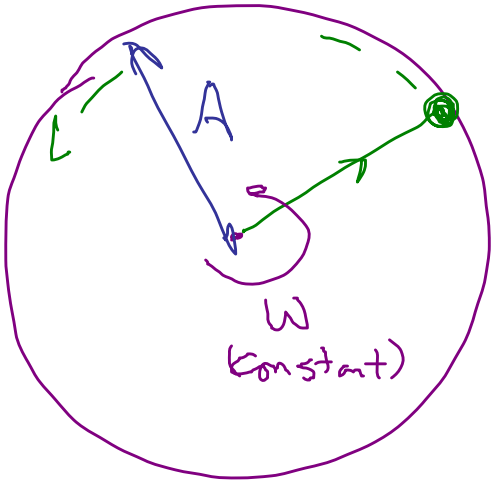


$$\theta(t) = \theta_0 \cos(\omega t)$$

$$\theta(t) = \theta_0 \cos(\omega t + \phi)$$

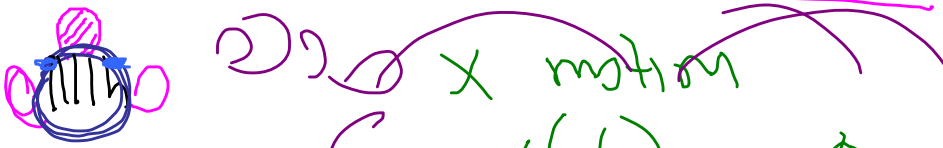
Relation between Osc motion & Circ. Motion "Reference Circle"

$\omega t = 0$



coords $x = A\cos(\omega t)$

$y = A\sin(\omega t)$

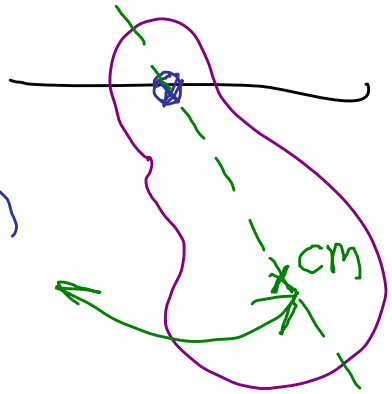


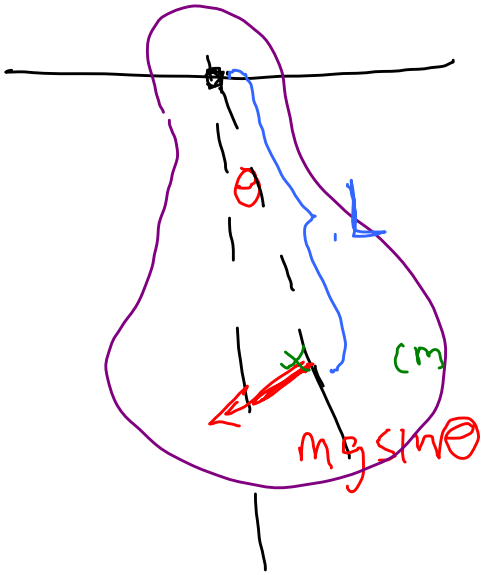
x motion

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

Pendulae:

"Physical" Pendulum





$$\tau = -MgL\sin\theta$$

$$= I\alpha = I\frac{d^2\theta}{dt^2}$$

$$\frac{d^2\theta}{dt^2} = -\frac{MgL}{I}\sin\theta$$

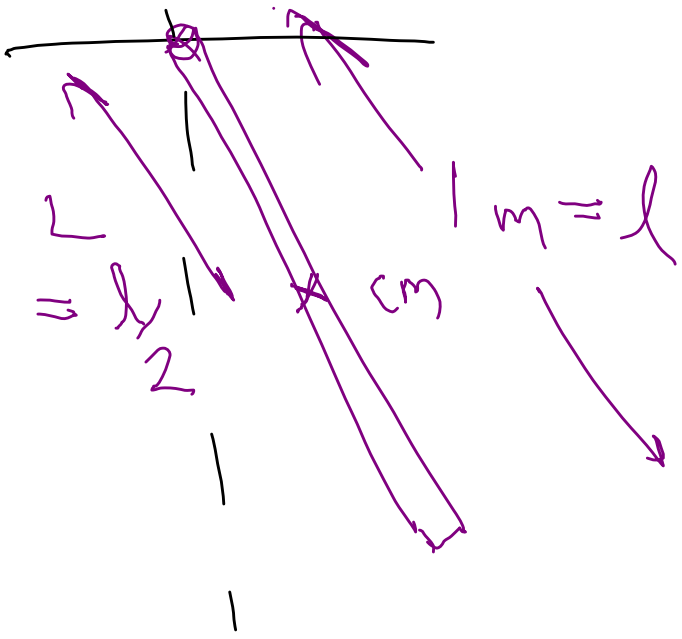
cheat!

$$\frac{d^2\theta}{dt^2} = -\left(\frac{MgL}{I}\right)\theta$$

I is moment of inertia around given axis

$$\omega = \sqrt{\frac{MgL}{I}}$$ etc.

(13.13)



Find period of meter stick swinging about end!

$$I = \frac{1}{3} M l^2$$

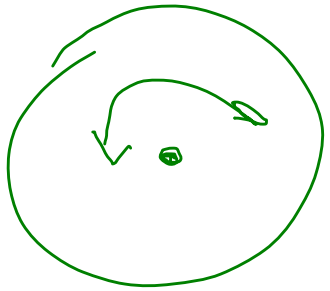
$$\omega = \sqrt{\frac{MgL}{I}}$$

$$= \sqrt{\frac{Mg\left(\frac{l}{2}\right)}{\frac{1}{3}Ml^2}}$$

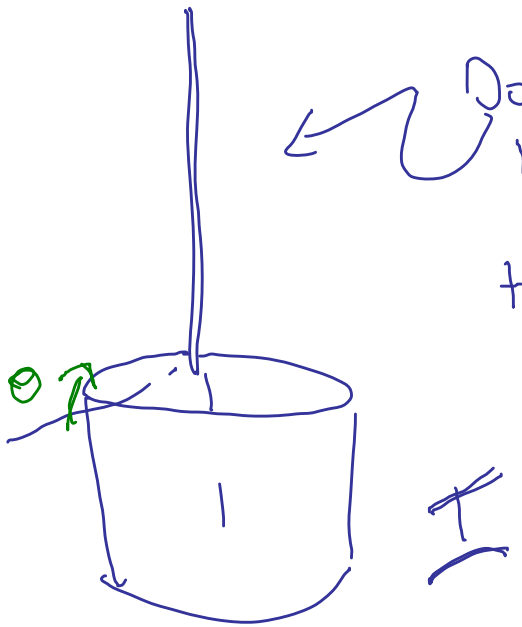
$$= \sqrt{\frac{3}{2} g/l} = \sqrt{\frac{3}{2}}\sqrt{\frac{g}{L}}$$

etc. f, T

Torsional Pendulum



Top view



Fibre gives opposing torque:

$$\tau = -K\theta$$

K torsional constant

Units $\frac{N.m}{rad} = N.m$

$$\tau = -K\theta = I\alpha = I\frac{d^2\theta}{dt^2}$$

$$\frac{d^2\theta}{dt^2} = -\frac{K}{I}\theta$$

Don't need to check $\rightarrow \omega$

$$\omega = \sqrt{\frac{K}{I}}$$

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