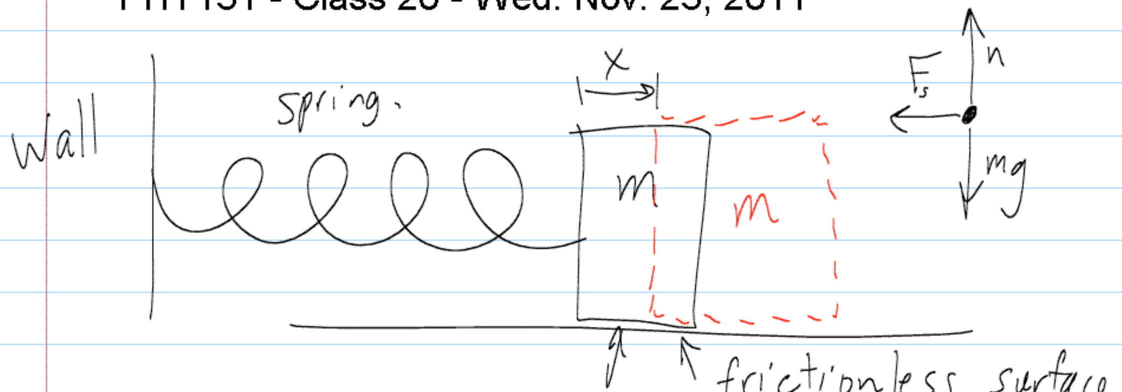
PHY131 - Class 20 - Wed. Nov. 23, 2011

$n = mg$



X = position of mass.

Must set $x = 0$ to correspond to spring Equilibrium.

$$F_s = F_{net} = -kx = ma$$

$$a = -\frac{k}{m}x$$

$$a_x = \frac{dv_x}{dt} = \frac{d}{dt}\left(\frac{dx}{dt}\right) = \frac{d^2x}{dt^2}$$

$$\frac{d^2x}{dt^2} = -Cx \qquad \text{where } C = \text{constant.}$$

"Trial Solution"

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

A, ω are constants.

Let's take derivatives:

$$\frac{dx}{dt} = A[-\sin(\omega t)]\omega$$

$$v = -A\omega\sin(\omega t)$$

$$a = \frac{dv}{dt} = -A\omega[\cos(\omega t)]\omega$$

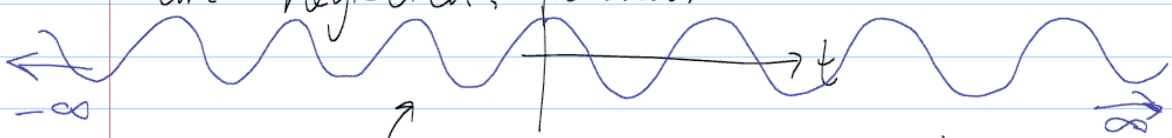
$$a = -A\omega^2\cos(\omega t) \qquad x = A\cos\omega t!$$

So $a = -\omega^2 x$

Trial Solution is good if $\omega^2 = C$

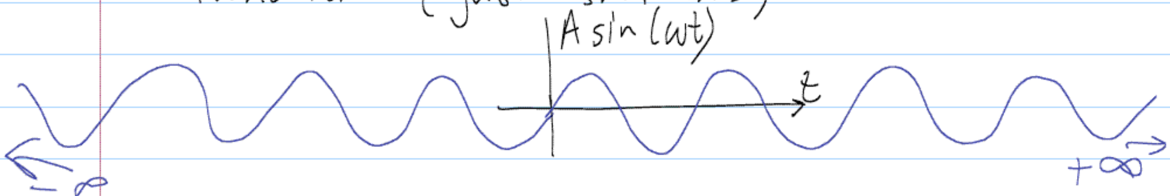
Notes about S.H.M.

→ Friction and other dissipative forces are neglected.



A is constant forever!

Note: sine and cosine are the same function (just shifted.)

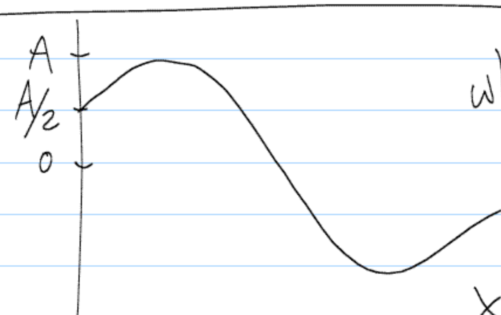


→ Either $A\cos(\omega t)$ or $A\sin(\omega t)$ would work as a solution to S.H.M.

→ Knight always uses cosine

General solution includes phase constant:

$$x = A\cos(\omega t + \phi_0)$$ ← "phi"



when $t = 0$, $x = +A$

$x = A\cos(\omega t + \phi_0)$

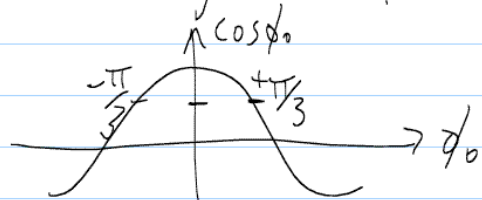
set $t = 0$

$x_0 = A\cos\phi_0$

$x_0 = A/2 \Rightarrow \frac{x_0}{A} = \frac{1}{2}$

$\phi_0 = \cos^{-1}\left(\frac{x_0}{A}\right) = \cos^{-1}(1/2)$

Calculator gives: $\phi_0 = +\pi/3$



← answer is $\pm\pi/3$

A look at x vs t shows that if t is slightly positive, then x is increasing. $\Rightarrow$ $\phi_0 = -\pi/3$ is answer.