Physics 113 - October 17, 2006

Springs, gravitation, Potential energy

Heads up → Exam II

October 26 (Thursday)

0800-0920

Hubbell Auditorium

... yes, we will have lecture that day

Last Time —

Energy is Conserved

$$\sum E_{initial} = \sum E_{final}$$

KE + PE for initial STATE

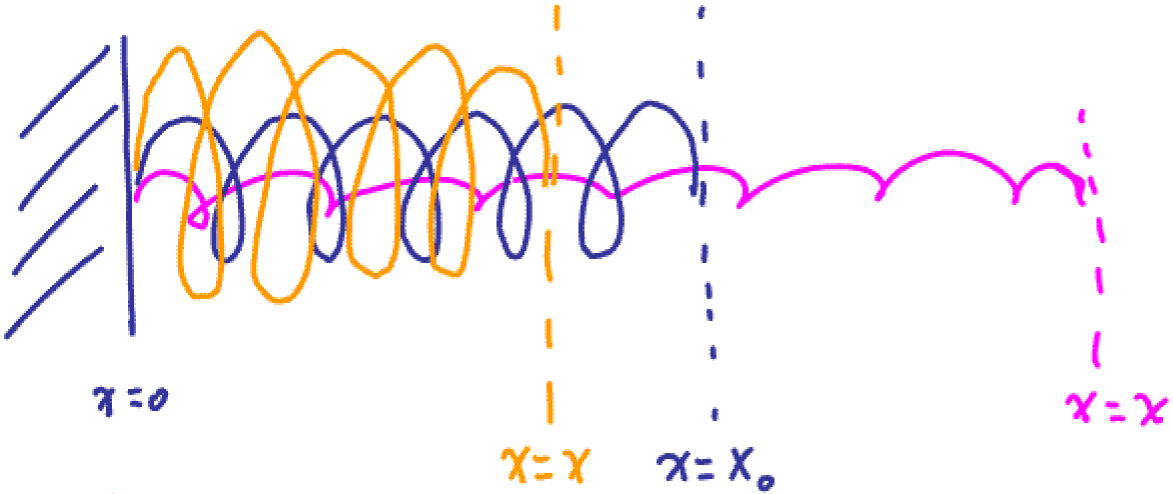
$$W_{Non\,conservative} = \Delta KE + \Delta PE$$

(i.e. due to friction)

$$= \Delta K + \Delta U$$

$K \equiv KE \equiv$ Kinetic Energy $= \frac{1}{2}mv^2$

$U \equiv PE \equiv$ Potential Energy due to gravity
Spring
etc.

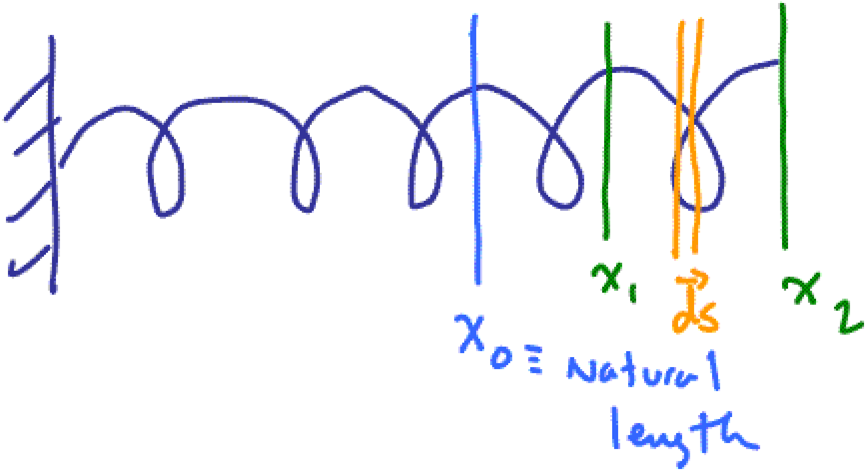


Important

$\vec{F} = -k(\vec{x} - \vec{x}_0)$ Hooke's Law (vector form)

$F = k(x - x_0)$ Magnitude form
use common sense to put direction into problem

$F = kx$ Magnitude form w/ $X_0 \equiv 0$



Stretch Spring From $x_1 \rightarrow x_2$

Work done by me in stretching spring

$$W = \int_{x_1}^{x_2} \vec{F} \cdot \vec{ds} = \int_{x_1}^{x_2} kx\,dx = k \int_{x_1}^{x_2} x\,dx = k \left. \frac{x^2}{2} \right|_{x_1}^{x_2}$$

$|\vec{F}||ds|$

$F dx$

$ds = dx$

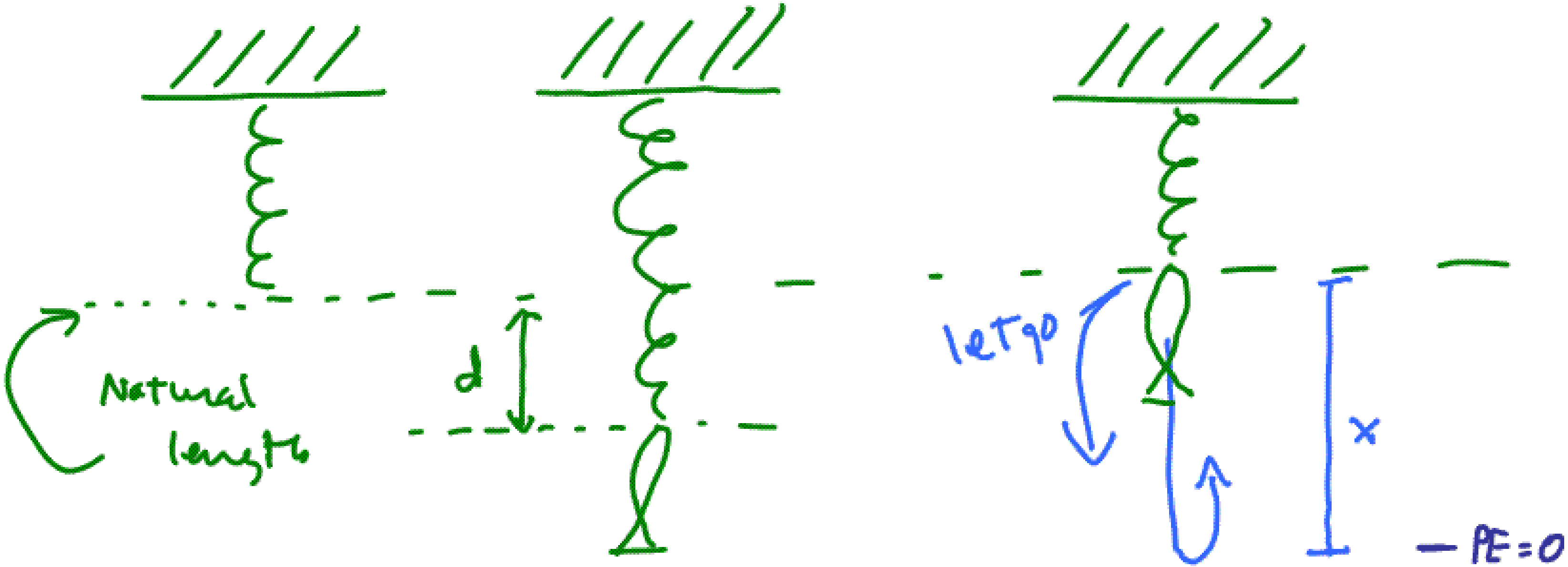
$$W = \tfrac{1}{2}kx_2^2 - \tfrac{1}{2}kx_1^2$$

$$W = PE_{end} - PE_{start}$$

Important

$$PE_{spring} = \tfrac{1}{2}kx^2$$

$x \equiv$ Stretch or compression of spring (rel. to x_0)



fish attached + slowly lowered

Thru what max. distance will spring stretch (how low does fish go)

$\Sigma F_y = 0$

$F_s = kd = mg$ — $k = \frac{mg}{d}$

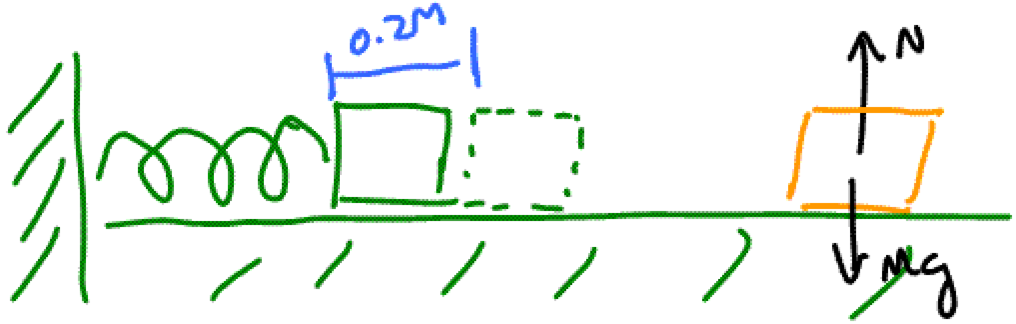
grav. PE converted into PE_s

work done by grav = PE increase of spring

$$mgx = \frac{1}{2}kx^2$$

$$mgx = \frac{1}{2}\frac{mg}{d}x^2$$

$$\boxed{2d = x}$$



Block has Mass of 0.5 kg

Spring constant = 100 N/M

Spring compressed 0.2 M

Block released → Moves 1.0 M before coming to rest

What is μ_k bet. block and table?

$$PE_{spring} = W_{Friction}$$

$$\mu_k N = \mu_k mg$$

$$\frac{1}{2} k x^2 = F_{fr} d$$

x = 0.2 M

1.0 M

$$\frac{1}{2}kx^2 = \mu_k mgd$$

$$\mu_k = \frac{kx^2}{2Mgd}$$

$\mu_k = 0.41$

$$\text{Power} \equiv \frac{\Delta W}{\Delta t}$$

work ≡ Energy ≡ Joules

$$P = \frac{dW}{dt} \quad \frac{\text{Joules}}{\text{sec}}$$

Important

≡ Watt

A 100 watt light bulb converts 100 Joules of energy into heat/light per second.

Potential energy and Force

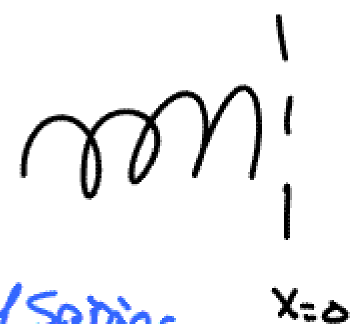
$$W = Fd$$

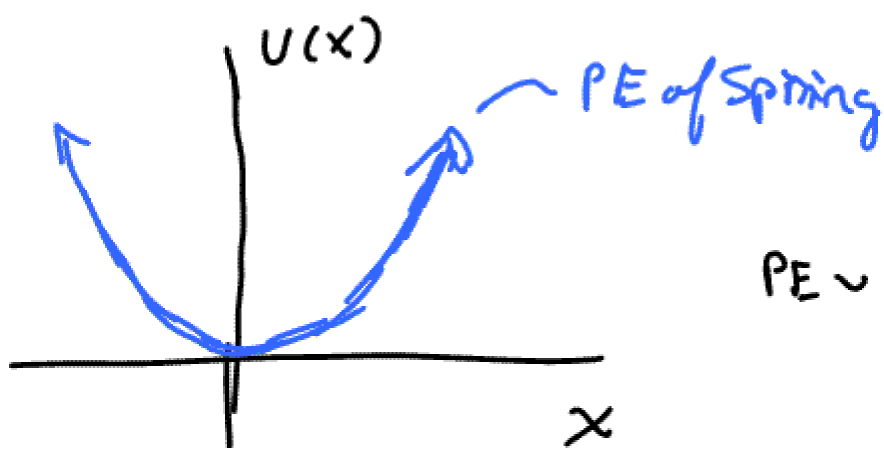
$$dW = F\,dx$$

//

dU — Δ in PE of Spring

$$\frac{dU}{dx} \sim F_x$$



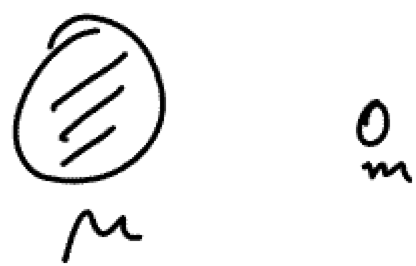


$$PE \sim \frac{1}{2}kx^2$$

$$F_x = -\frac{dU(x)}{dx}$$

$$-\frac{d\left(\frac{1}{2}kx^2\right)}{dx} = -kx = F_x$$

$$PE_{grav} = -\frac{GMm}{r}$$



$$-\frac{d}{dr}\left(-\frac{GMm}{r}\right) = -\frac{GMm}{r^2} = F_g$$

$$F_s = -\frac{dU(s)}{ds}$$

Important