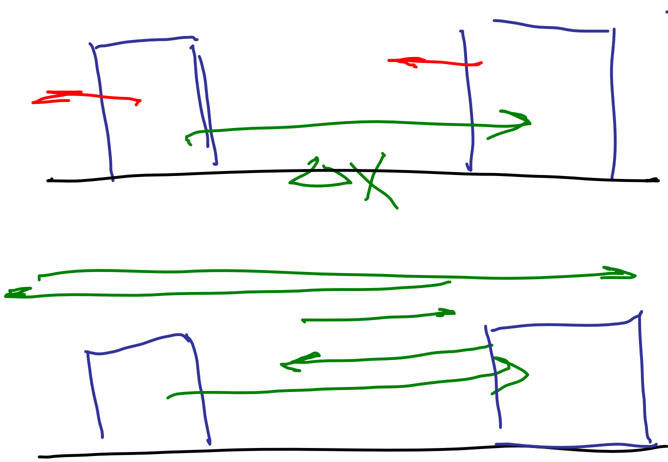
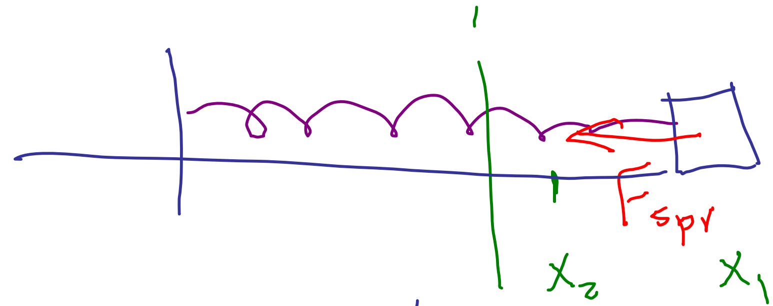
Phys 2110-4 3/1/13

Note Title 3/1/2013

Ch 7 Comparing work done by various forces



W_{fric}



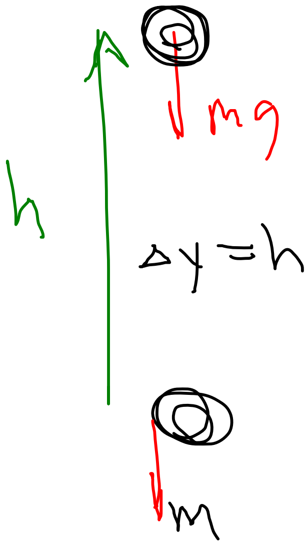
$$W_{spr} = -k\int_{x_1}^{x_2} x\,dx \qquad F_{spr} = -kx$$

$$= -k\frac{x^2}{2}\Big|_{x_1}^{x_2} =$$

Work done by spring

$$= -\frac{k}{2}\left(x_2^2 - x_1^2\right) = \frac{k}{2}\left(x_1^2 - x_2^2\right)$$

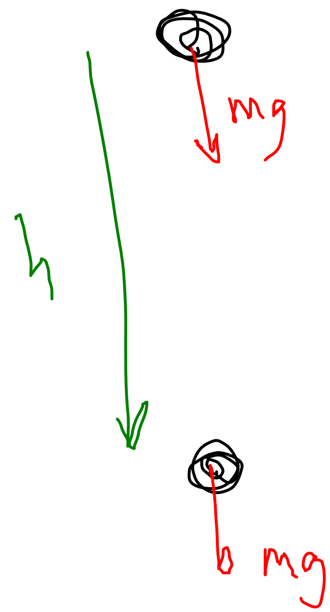
Change in $\frac{1}{2}kx^2$



$\Delta y = h$

$$W_{grav} = -mgh$$

Change in height $= \Delta y$



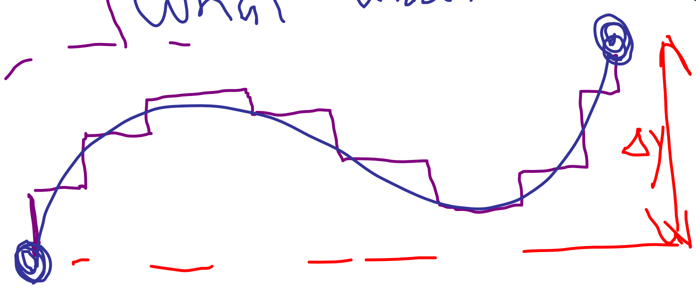
$$W_{grav} = mgh$$

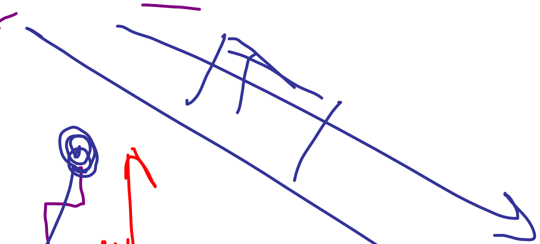
$$\Delta y = -h$$

Both formulae can written:

$$W_{grav} = -mg\Delta y$$

What about





Approx path by str. segments

On sideways parts $W_{grav} = 0$

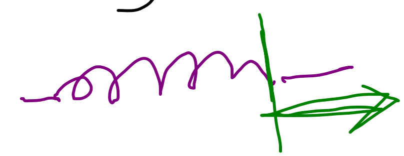
Vert changes in height add up to give Δy $\quad W_{grav} = -mg\Delta y$

Once again W only depends on final & initial position

$$W_{grav} = -mg\,\Delta y$$

7.17 How far would you have to stretch spring w/ $k = 1.4\ \frac{kN}{m}$ for it to store 210 J energy

(In stretching spring, spring does -210 J of work)



$$W = -\tfrac{1}{2}k(x^2 - 0^2) = -210\text{ J}$$

$$= -\tfrac{1}{2}\left(1.4\times10^{3}\ \tfrac{N}{m}\right)x^2$$

$$\boxed{x = 0.55\,m}$$

Energy stored $= -$ (Work done)

Can write work done spring $\Delta\left(\frac{1}{2}kx^2\right)$

grav $\Delta(mgy)$

Define stored energy U potential energy

work done related to ΔU

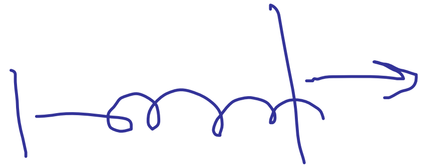
Spring $W_{spr} = -\Delta\left(\frac{k}{2}x^2\right)$ $W_{grav} = -\Delta(mgy)$

$U_{spring} = \frac{1}{2}kx^2$ $U_{grav} = mgy$ (stored)

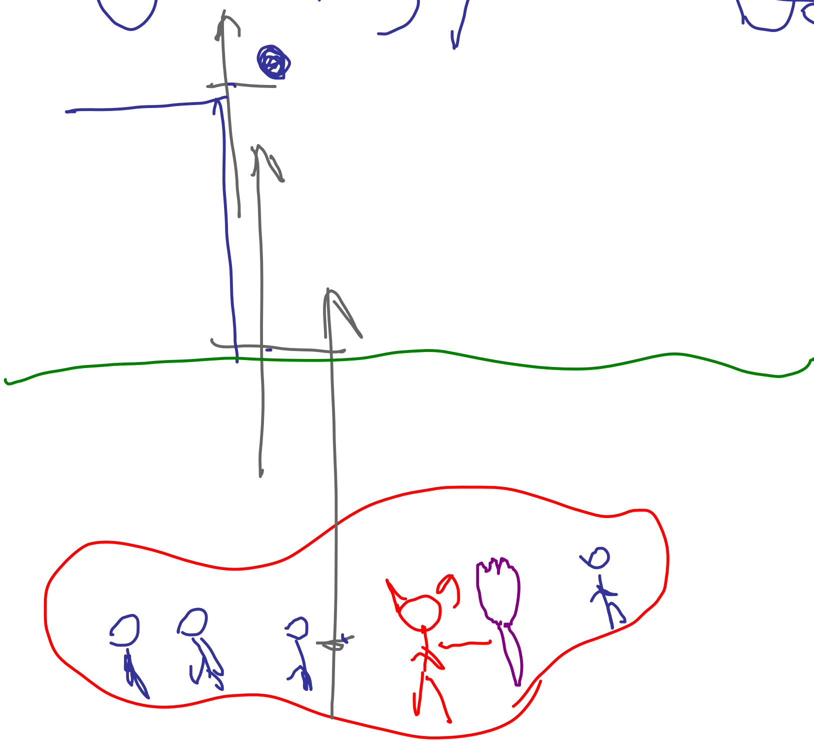
Compare to fric: No way to write W_{fric} = change

Stored energy, U

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



$U = mgy$



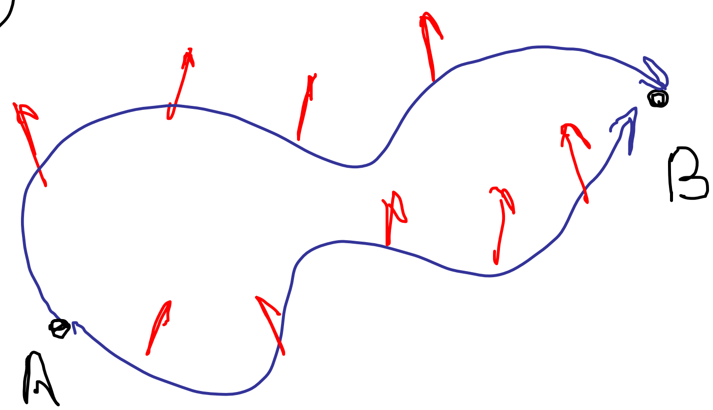
Does not make difference

$\Delta U = -W_{grav} = -mg\Delta y$

Δy is small

Grav. & Spring Conservative

Particular force $\vec{F}$,



$\Rightarrow$ If $\vec{F}$ is conservative then

$W_{A \to B}$ does not depend path.

If I go $A \to B$ on one path $B \to A$ on other path, total work done is zero.

$$W_{\substack{grav \\ spr}} = -\Delta U$$

Work-energy Thm

$$W_{net} = \Delta K$$

Some forces

$$W = -\Delta U$$

$$\underbrace{W_1 + W_2 + W_3 + \cdot + }_{\text{cons forces}} W_{\text{non-cons}} = \Delta K$$

$$\underbrace{-\Delta U_1 - \Delta U_2 - \Delta U_3}+ \cdots W_{\text{non cons}} = \Delta K$$

$$\Delta K + \Delta U_1 + \Delta U_2 + \cdots = W_{\text{non cons}}$$

$$U_{Tot} = U = U_1 + U_2 + U_3$$

The potential

$$\boxed{\Delta K + \Delta U = W_{\text{non cons.}}}$$

If we can ignore non-cons forces. $W_{\text{non cons}} = 0$

$$\boxed{\Delta K + \Delta U = 0}$$

$K + U = E$ Total mechanical energy of system.

all potent.

$$\boxed{\Delta E = 0}$$

Doesn't count thermal internal energy.

Lesson of Chapter.

$\Delta E = 0$

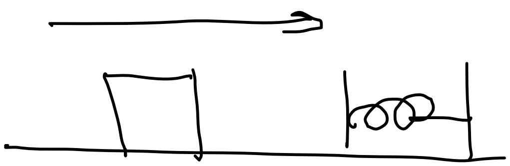
$E_1 = E_2$

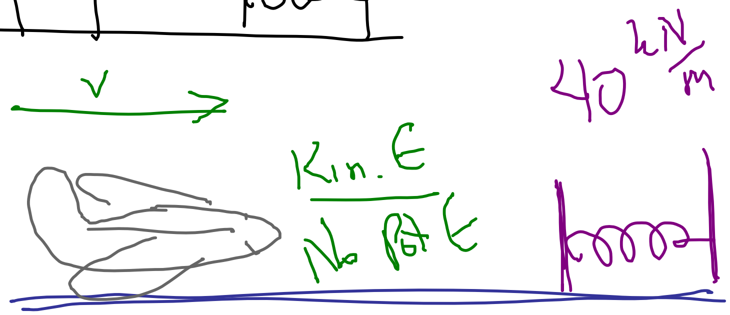
$\Delta K + \Delta U = 0$

Conservation of energy.

$K_1 + U_1 = K_2 + U_2$

7.20 A 10,000 kg Navy jet lands a-c carrier snags a cable to slow it down. Cable is attached to spring with $k = 40\ \frac{kN}{m}$. If spring stretches by 25 m to stop plane what was its landing speed?





$E_1 = E_2$

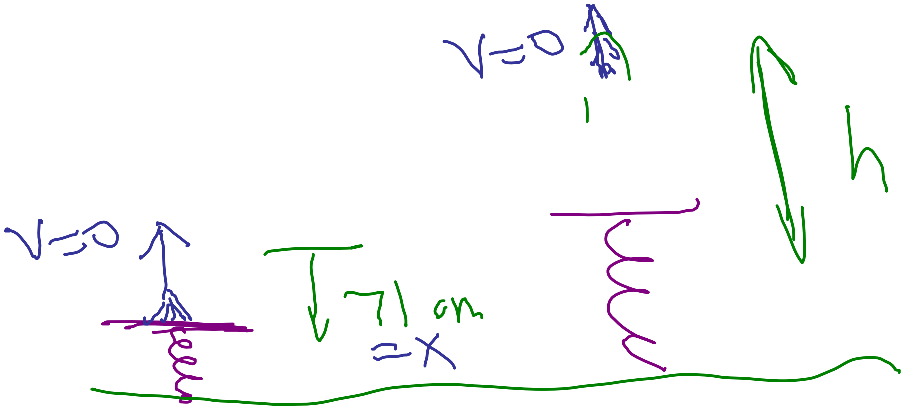
$\frac{1}{2}mv^2 + 0 = 0 + \frac{1}{2}kx^2$

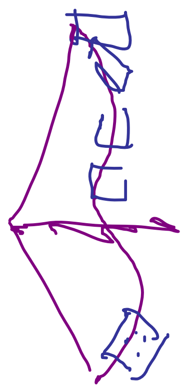
Plug in! Solve for v $x = 25x$

$\Longrightarrow \boxed{v = 50\,\frac{m}{s}}$

7.21 A 120 g - arrow is shot vertically from a bow with effective spr. const 430 N/m

If bow is drawn 71 cm before shooting how high does arrow go?





$$E_1 = E_2$$

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

spr pot   grav pot

Solve for h

$$h = \frac{1}{2}\frac{kx^2}{mg} = \boxed{92.2\text{ m}}$$

plug in