Phys 2110-4 2/24/12

Note Title 2/24/2012

Chap 6.

$$W = \int_{x_1}^{x_2} F_x \, dx$$

$$K = \frac{1}{2} m v^2$$

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

Units $N \cdot m = J$

$1 \text{ Btu} = 1.054 \text{ kJ}$

$1 \text{ cal} = 4.184 \text{ J}$

g, cm, s

p. 93

$$\frac{g \cdot cm^2}{s^2} = \text{erg} = 10^{-7} J$$

Later

electron-Volt $= 1 eV = 1.6 \times 10^{-19} J$

$1 \text{ ft-lb} = \ldots ?$

P units $J/s = W$

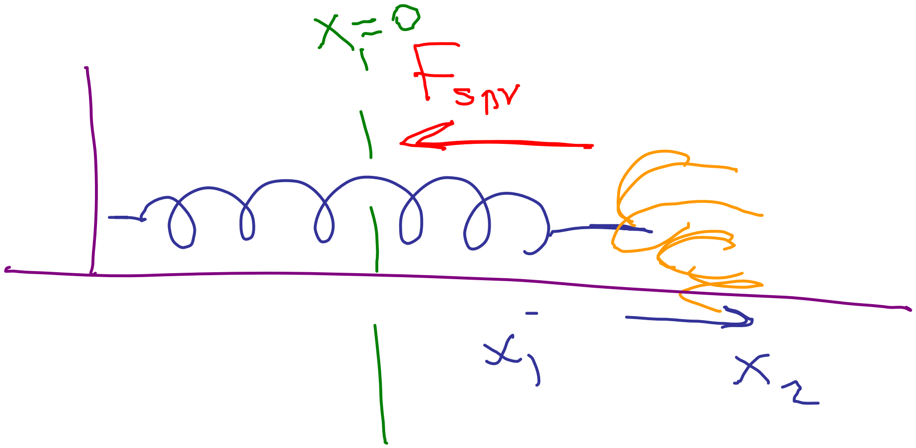
One horsepower $= 1\text{ hp} = 746\ J/s$

Chap 7 $W_{net} = \Delta K$

Calculating work

Work done by forces we've seen:

F_{spr}, F_{grav}



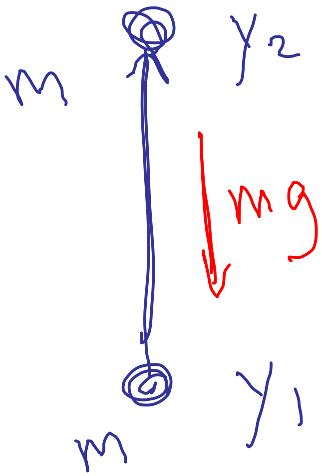
$$F_{sp} = -kx$$

$$W_{spr} = \int_{x_1}^{x_2} F_{spr}\, dx = \int_{x_1}^{x_2} (-kx)\, dx$$

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

Work depends only on beginning & ending pts (Diff. in squares)

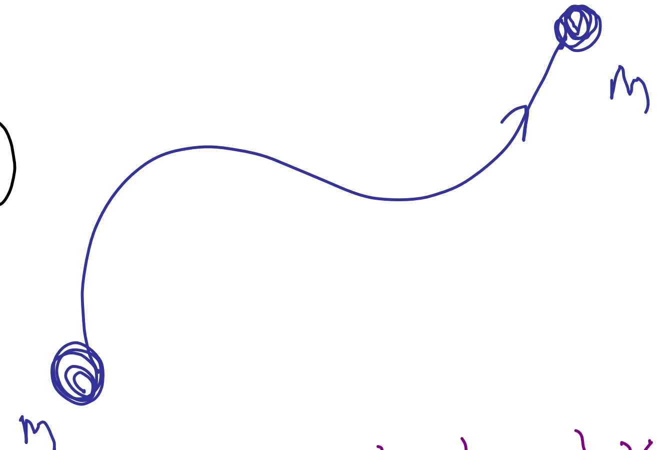
Gravity



$$W_{grav} = -mg(y_2 - y_1)$$

$$= -mg\Delta y$$

$$\Delta y = y_2 - y_1$$



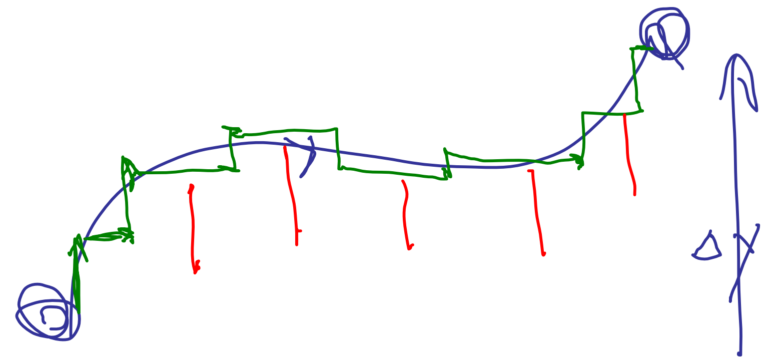
Work done by grav also depends on beginning & end pts.

$$W_{grav} = mg(y_2 - y_1)$$

$$= -mg\Delta y$$

$$\Delta y = y_1 - y_2$$

What work done by grav if path also goes sideways



On sideways parts, grav. does no work

Same expression

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

$$W_{spr} = -\frac{1}{2}k\left(x_2^2 - x_1^2\right)$$

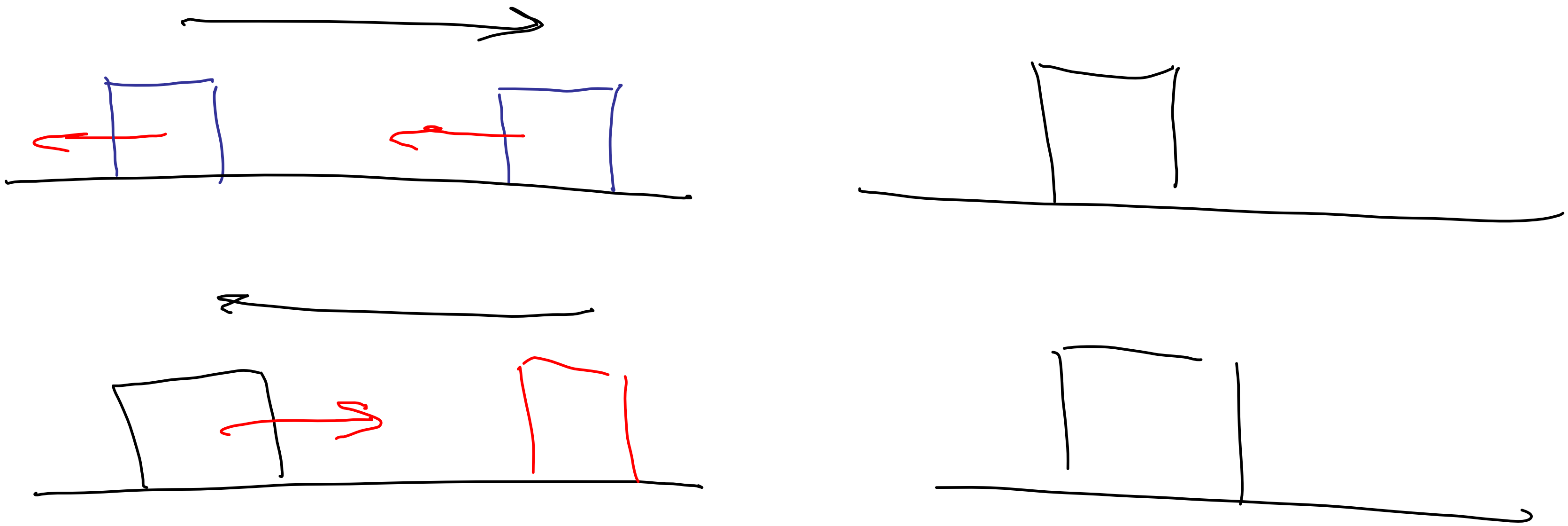
Some kinds of work have simple expressions, only involves a difference of some function of coordinates

$$\underbrace{W}_{\text{nice cases}} = \underbrace{-}\, \Delta U \qquad \Delta U = -W$$

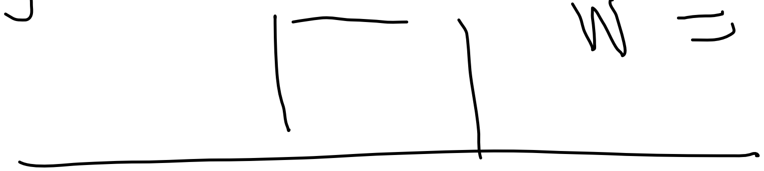
Higher math

U = potential energy "stored energy"

$$U_{spr} = \frac{1}{2} k x^2 \qquad U_{grav} = mgy$$



$W_{fric} = -14\ J$



$W = 0$

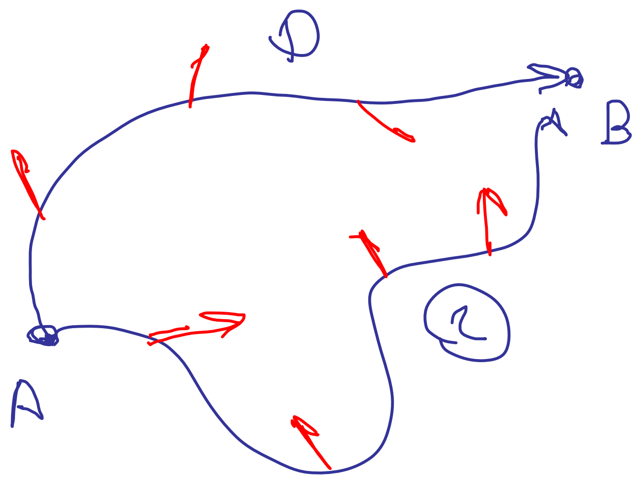
W_{fric} depends on path

Bad force

Force which lend themselves to ΔU thing

Conservative forces

If force depends on path, Non-cons. force.

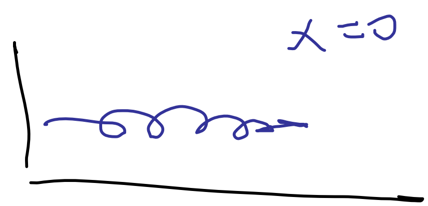


$$W_{①} = \int_{①} \vec{F} \cdot d\vec{r}$$

$$= W_{②} = \int_{②} \vec{F} \cdot d\vec{r}$$

Conservative.

7.17 How far you stretch spring with $k = 1.4\ \text{kN/m}$ for it to store 210 J of energy.



$$U = \frac{1}{2} k x^2$$

$$U = \frac{1}{2}kx^2 = 210\ \mathrm{J}$$

$$x^2 = \frac{2(210\ \mathrm{J})}{1.4\times10^3\ \mathrm{N/m}} = 0.30\ \mathrm{m}^2$$

$$x = 0.54\ \mathrm{m}$$

Check this..

$$W_{nice} = -\Delta U$$

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

$$U = mgy$$

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

$$W_{fric} + W_{grav} + W_{spring} + \dots = \Delta K$$

$$W_{fric} - \Delta U_{grav} - \Delta U_{spr} + \dots = \Delta K$$

$$\Delta K + \Delta U_{grav} + \Delta U_{spr} + \dots = W_{fric}$$

$$U = U_{spr} + U_{grav} + \ldots$$

$$\Delta K + \Delta U = W_{fric}$$
(non-cons)

$$E = K + U$$ Total mechanical energy

motion $\frac{1}{2}mv^2$

stored energy

$$\boxed{\Delta E = W_{non\text{-}cons.}}$$ (7.5)

p.106

Cons of energy theorem

Special case: No friction

$W_{nc} = 0$

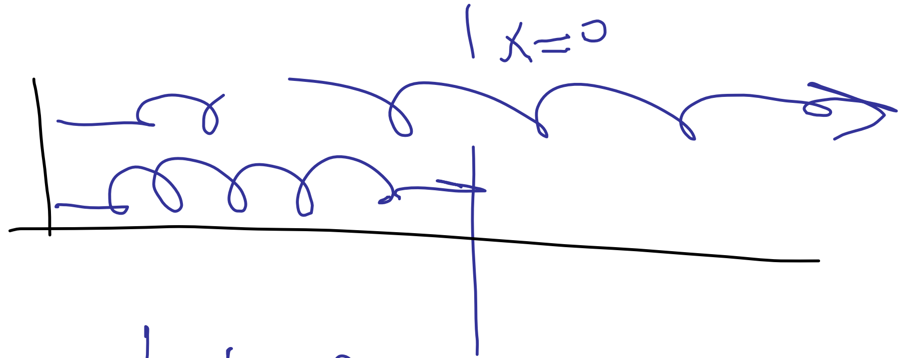
non-cons

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

$E_2 - E_1 = 0$ $\quad$ $E_1 = E_2$

$K_1 + U_1 = K_2 + U_2$ $\quad$ $\Delta K + \Delta U = 0$

No friction: All energy stays there.

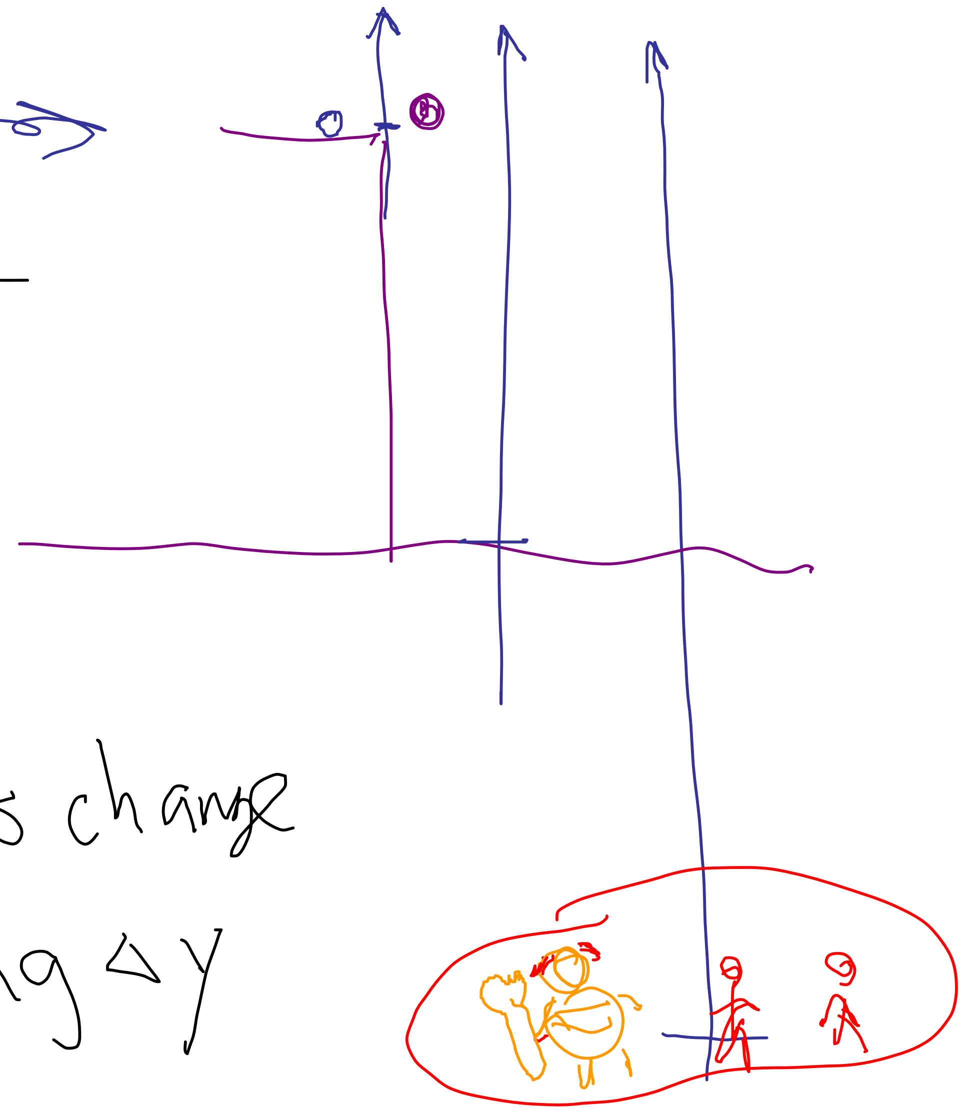


$$U_{sp} = \frac{1}{2} k x^2$$

$$U_{grn} = mgy$$

All that matters is change in y

$$\Delta U = mg\Delta y$$



$$\boxed{\Delta K + \Delta U = W_{fm}}$$

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

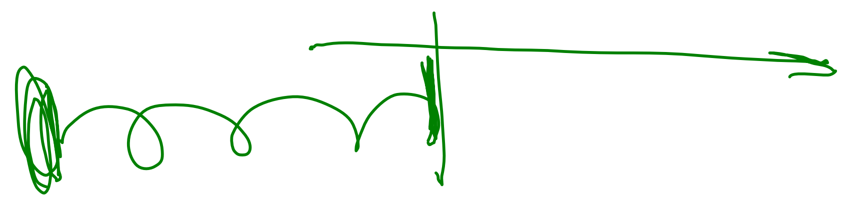
(1)

(2)

$$E_1 = E_2$$

$$K_1 + 0 = 0 + U_2$$

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



$$\frac{1}{2} m v^2 = \frac{1}{2} k x^2$$

$$v^2 = \frac{k x^2}{m} = \frac{\left(40 \times 10^3 \ \frac{N}{m}\right)(25\,m)^2}{(10{,}000\ kg)}$$

$$= 50\ \frac{m}{s} \qquad (?)$$