Phys 2110 - 5 10/8/12

Note Title 10/8/2012

Energy, Work

Chap 6

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

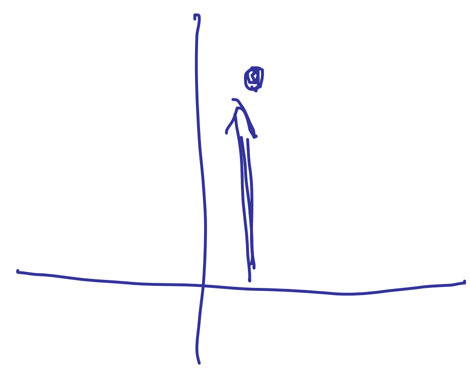
Pot'l energy

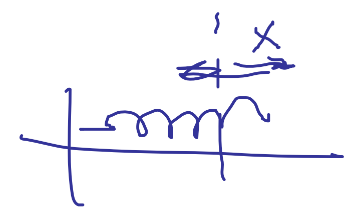
$$\Delta U = -W = -\int_a^b F_x \, dx$$

Stored energy

$$U_{grav} = mgy$$

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





$$U_{grav} = mgy$$

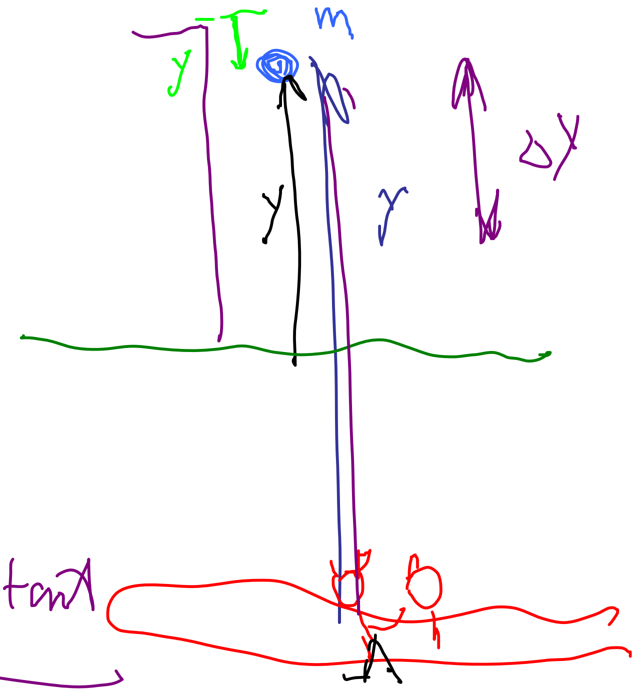
$$= mgy + mgh$$

Irregardless of how ht meas'd

ΔU is same

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

Be consistent



$$\underbrace{W_{grav} + W_{fric} + W_{-} + \cdots}_{-\Delta U_{Total}} W_{non\ cons} = \Delta K$$

$$\boxed{\underbrace{\Delta K}_{\text{change in energy of motion}} + \underbrace{\Delta U}_{\text{change in stored energy}} = W_{\text{non cons}}}$$

(friction)

Often we have problem where $W_{\text{non cons}} = 0$ (or ignore it)

$$\Delta K + \Delta U = 0$$

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

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

or $E_i = E_f$

E stays same energy is conserved

$\Longrightarrow$ Principle of $\boxed{\text{cons of energy}}$

(Assuming $W_{\substack{non\\cons}} = 0$)

$\Delta E = 0$ $\quad E_1 = E_2$ $\quad \Delta K + \Delta U = 0$

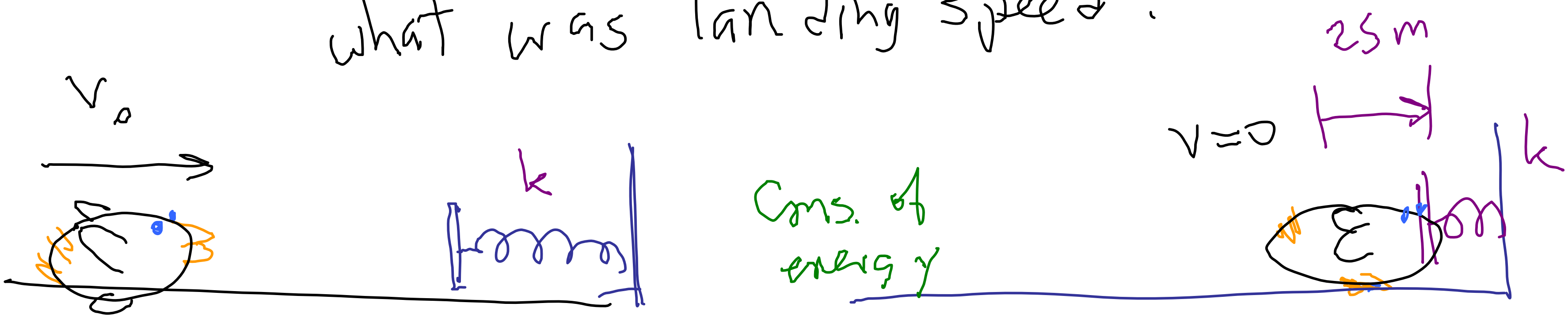
$K_1 + U_1 = K_2 + U_2$ ...

In general, $W_{\substack{non\\cons}} \neq 0$ (friction)

or F_{ext} does work. Then calc $W_{\substack{non\\cons.}}$

Do lotsa problems!

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



$$E_1 = E_2 \qquad E = K + U$$

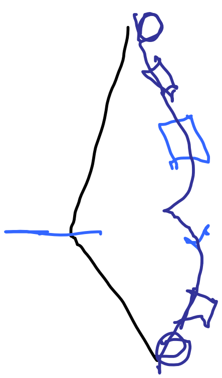
$$\cancel{\tfrac{1}{2}} m v_0^2 + 0 = 0 + \cancel{\tfrac{1}{2}} k x^2$$

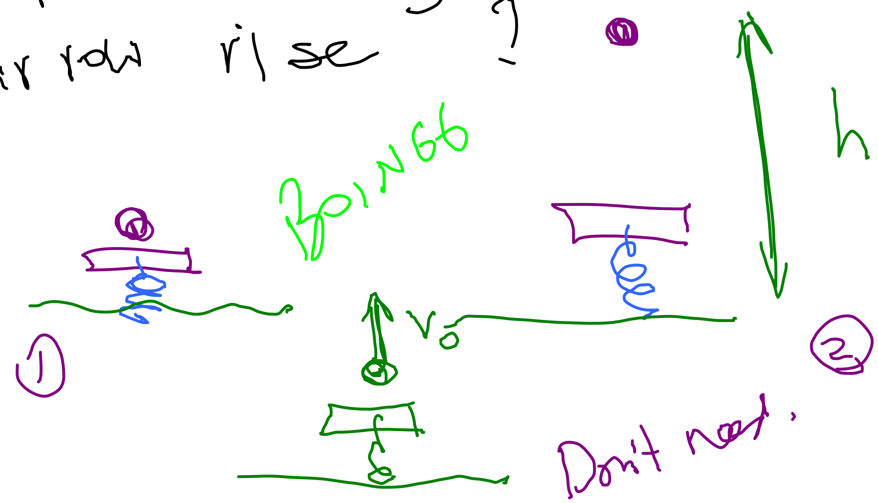
Do math

$$v_0^2 = \frac{k}{m} x^2 = \frac{\left(40 \times 10^3 \frac{N}{m}\right)}{(10,000 \text{ kg})} (25 \text{ m})^2$$

$$\boxed{v_0 = 50 \frac{m}{s}}$$

7.21 A 120 g arrow is shot vertically from bow whose effective spring constant is 430 $\frac{N}{m}$. If bow is drawn 71 cm before shooting to what height does arrow rise?





~~No non-cons forces~~

E is const

$$E_1 = E_2 \qquad E = K + U$$

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

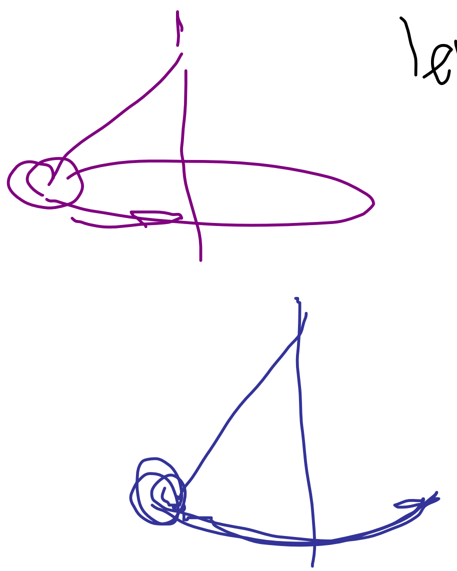
$$h = \frac{kx^2}{2mg} = \frac{(430\ \frac{N}{m})(0.71\ m)^2}{2(0.120\ kg)(9.8\ \frac{m}{s^2})}$$

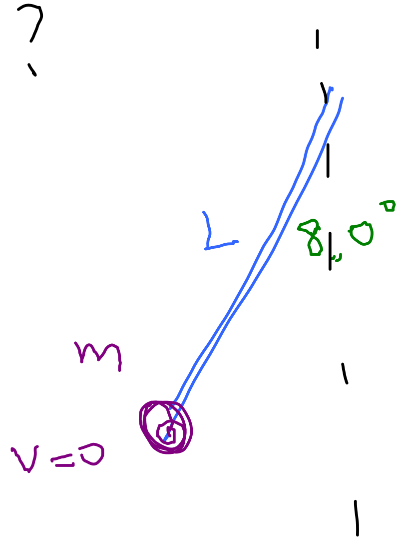
$$= 92.2\ m$$

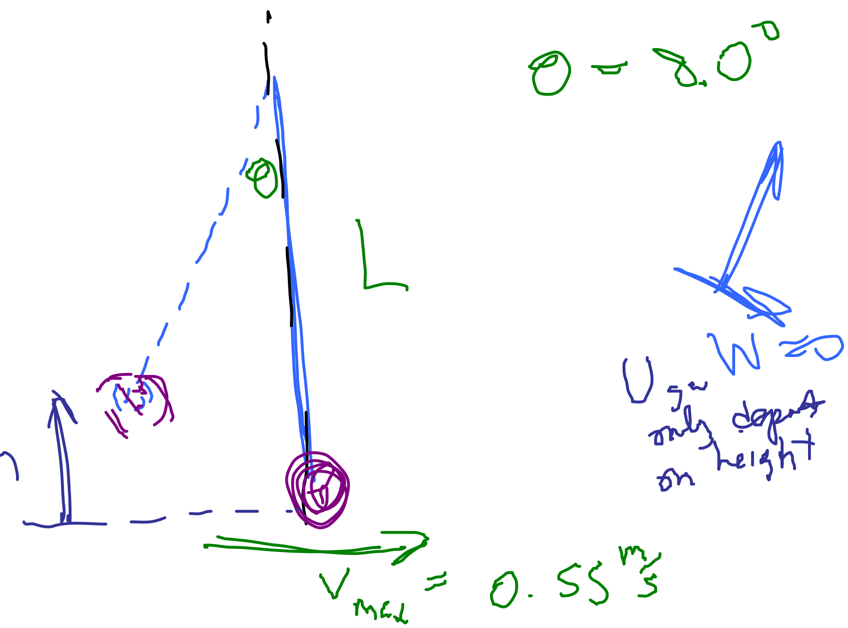
$$N = \frac{kg\ m}{s^2}$$

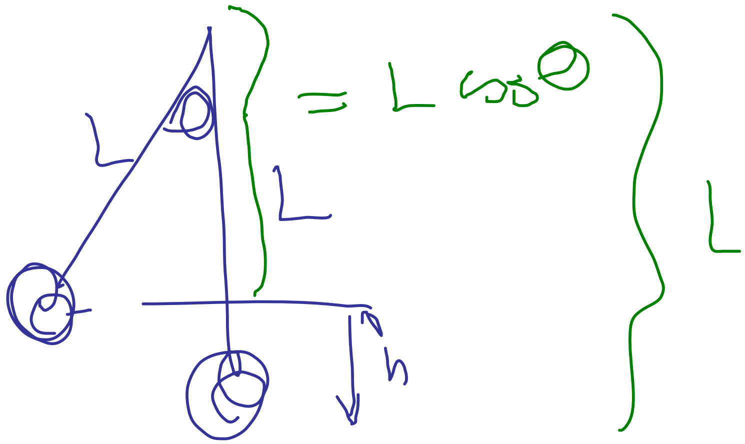
7.46 The maximum speed of the pendulum bob in clock is 0.55 m/s

If pendulum makes max angle 8.0° with vertical, what pendulum's length?









$$h = L - L\cos\theta$$
$$= L(1-\cos\theta)$$

Cons.

$$E_1 = \underset{\text{top}}{mgh} = mgL(1-\cos\theta)$$

$$E_2 = 0 + \frac{1}{2}mv^2$$

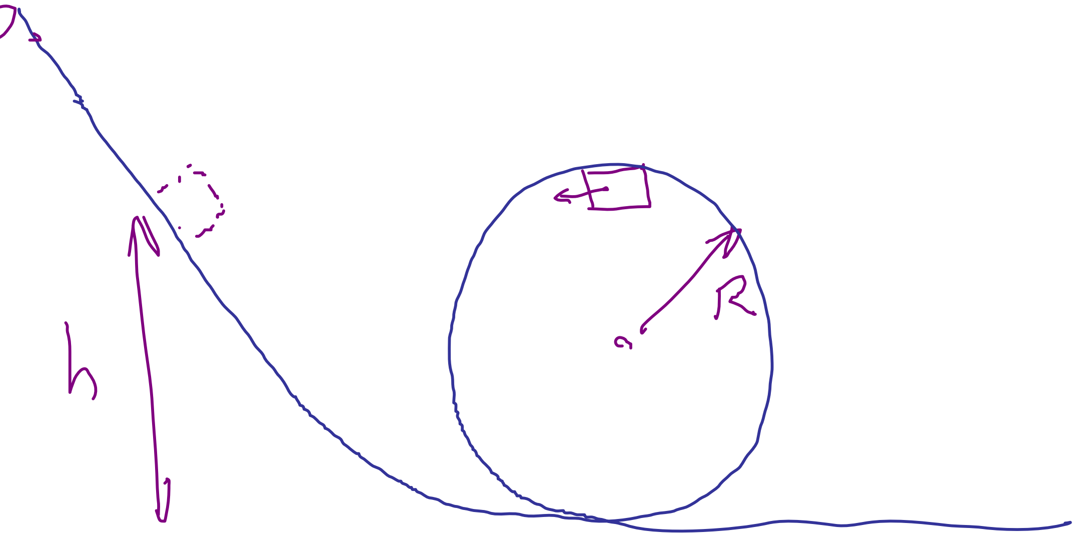
Cons of E

$$\cancel{m}gL(1-\cos\theta) = \frac{1}{2}\cancel{m}v^2$$

Solve for L

$$\boxed{L = 1.59\,m}$$

7.45 A block slides on frictionless loop-the-loop track, see fig. Find the minimum height h at which it can start from rest & still make it around loop.

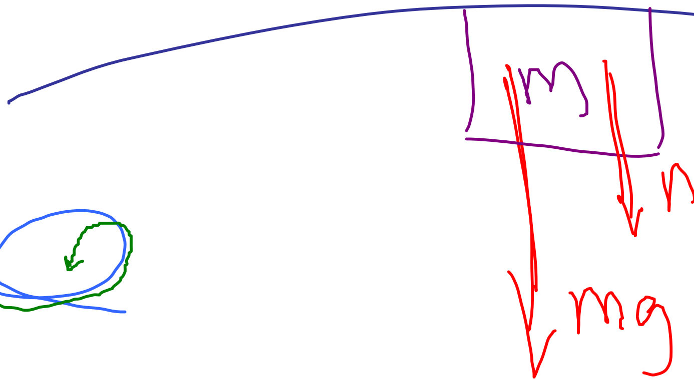


$h = 2R$

can't be right

Block must have

K at top position.



$$n + mg = \frac{mv^2}{R}$$

Minimum v, $n = 0$

$$\cancel{m}g = \frac{\cancel{m}v^2}{R}$$

$$v^2 = gR$$

canc

Cons. of energy

$$mgh = \frac{1}{2}mv^2 + mg(2R)$$

$$= \frac{1}{2}mgR + mg(2R)$$

$$h = \frac{1}{2}R + 2R$$

$$\boxed{h = \frac{5}{2}R}$$