Phys 2110-4 3/4/13

Note Title 3/4/2013

Conservation of Energy

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

$U_{spr} = \frac{1}{2}kx^2$

$U_{grav} = mgy$

$\Delta K + \Delta U = \Delta E = W_{non-cons}$

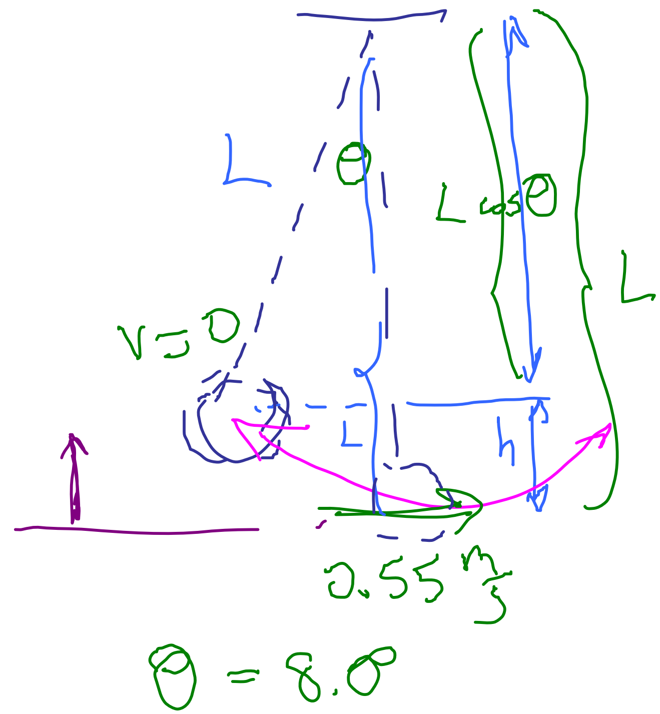
$E = K + U$

[fric, applied forces]

If $W_{non-cons} = 0$

$\Delta E = 0$

7.46 The maximum speed of the pendulum bob in a grandfather clock in $0.55\,\frac{m}{s}$. If the pendulum makes max angle of 8.0° w/ vertical what is pendulum's length?



Find h:

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

$$E_1 = mgh = mgL(1-\cos\theta) = \frac{1}{2}mv^2$$
$$= E_2$$

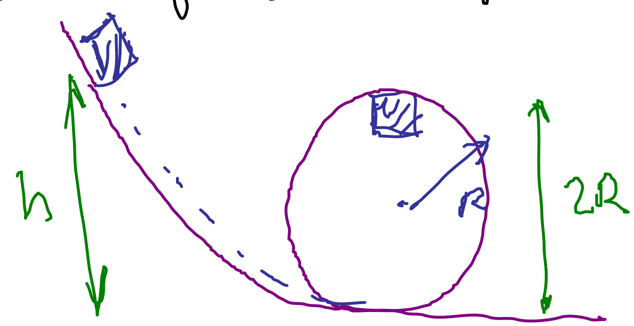
$$\cancel{m}gL(1-\cos\theta) = \frac{1}{2}\cancel{m}v^2$$

$$v = 2.55\ \frac{m}{s}$$

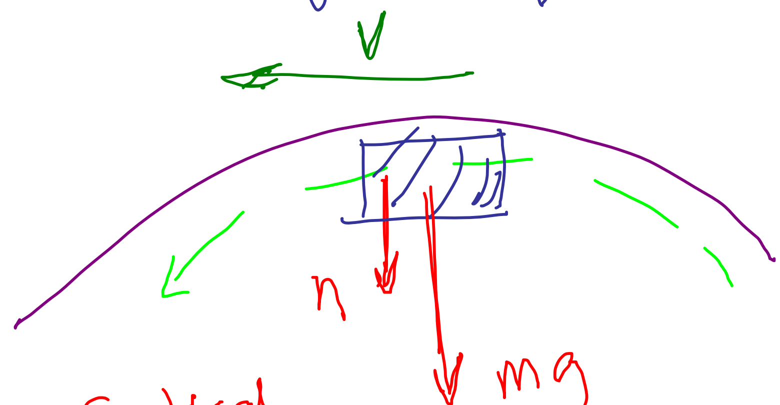
$$\theta = 8.0 \qquad \text{Do it}$$

$$L = 1.59\ m.$$

7.45 Block slides on frictionless loop-the-loop shown here. Find minimum h at which it can start from rest and stay on track



Cons of energy.



Critical point $n = 0$

Cons. of energy

$$\cancel{m}gh = \cancel{m}g(2R) + \frac{1}{2}\cancel{m}v^2$$

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

$$v^2 = gR$$

$$\cancel{g}h = 2\cancel{g}R + \frac{1}{2}(\cancel{g}R)$$

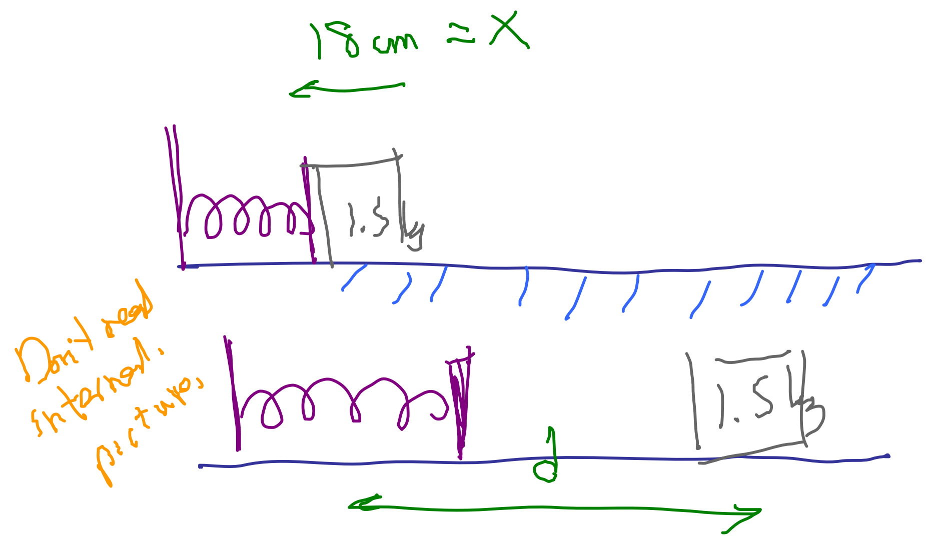
$$h = 2R + \frac{1}{2}R = \frac{5}{2}R$$

7.53 A spring of constant $k = 340\ \frac{N}{m}$ is used to launch a 1.5 kg block along a horiz. surface whose coeff sliding friction is 0.27. Spring is compressed 18 cm. How far block slide?

$$E_1 = \frac{1}{2}kx^2$$

$$E_2 = 0$$

$$W_{fric} = f_k \cdot d\ (-1)$$



$f_k = \mu_k m g$

$$\Delta E = W_{fric}$$

$$E_2 - E_1 = W_{fric}$$

$$0 - \left(\tfrac{1}{2} k x^2\right) = -\mu_k m g d$$

$$\tfrac{1}{2} k x^2 = \mu_k m g d$$

$$d = \frac{1}{2}\frac{k x}{\mu_k m g}$$

$$= \frac{1}{2}\frac{340\,\frac{N}{m}\,(0.18\,m)^2}{(0.27)(1.5\,kg)(9.8\,\frac{m}{s^2})} = \boxed{1.4\,m}$$

7.62 A 17-m vine hangs vertically from a tree on one side 10-m gorge. Tarzan wants to drop to land on other side. How fast must he run?

$\Rightarrow$ $\theta = 36°$ No friction

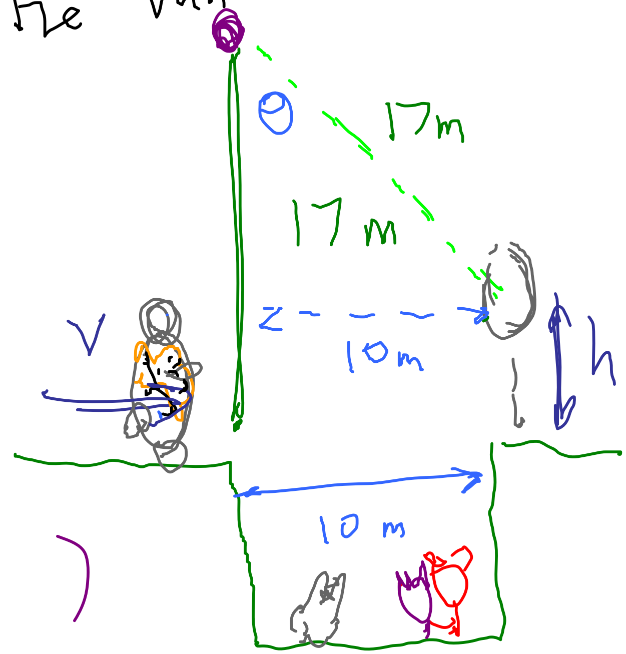
Energy cons:

$$\frac{1}{2}\cancel{m}v^2 = \cancel{m}gh$$

$$v^2 = 2gh$$

$$\boxed{v = 7.98\,\frac{m}{s}}$$

$$h = L(1-\cos\theta)$$
$$= (17m)(\quad)$$
$$= 3.25\,m$$



7.59 A child sleds down a fric'less hill whose vertical drop is 7.2m. At bottom is a level stretch (rough) where $\mu_k = 0.51$. How far she slide on level stretch?

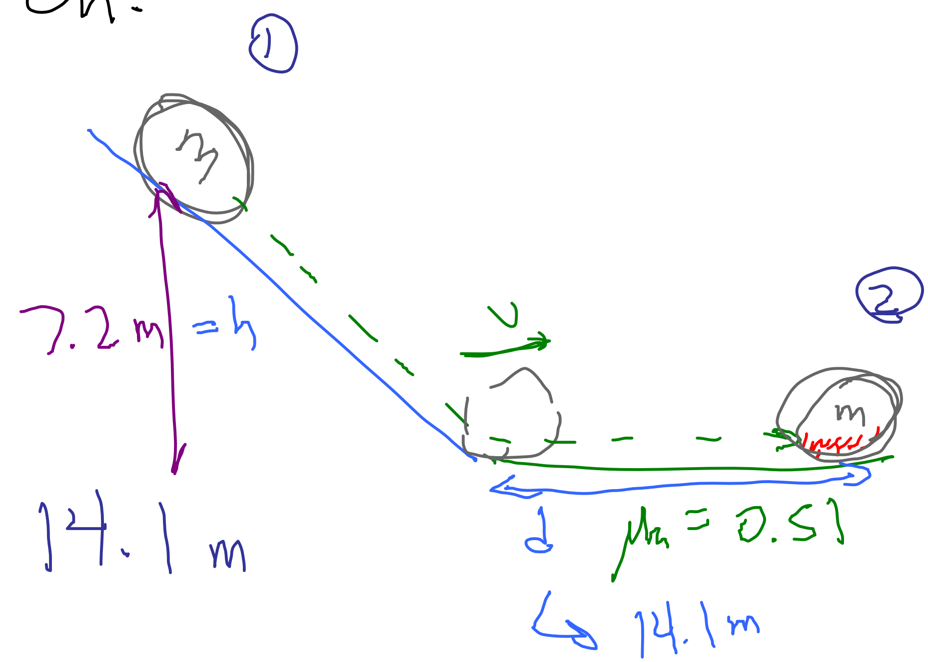
$$\Delta E = W_{fric}$$

$$0 - \cancel{m}\cancel{g}h = -\mu_k \cancel{m}\cancel{g}\, d$$

f_k

Do math

$$d = \frac{h}{\mu_k} = \frac{7.2\,m}{0.51} = 14.1\,m$$



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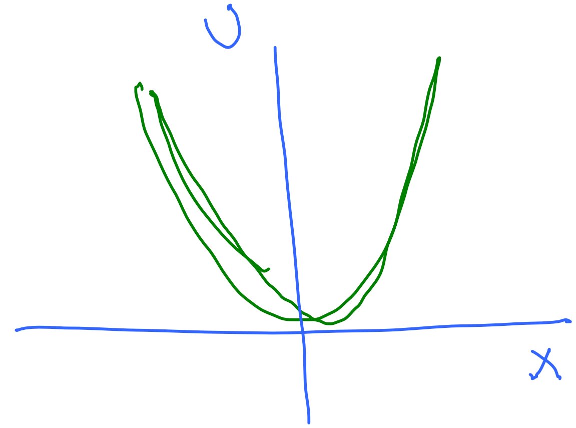
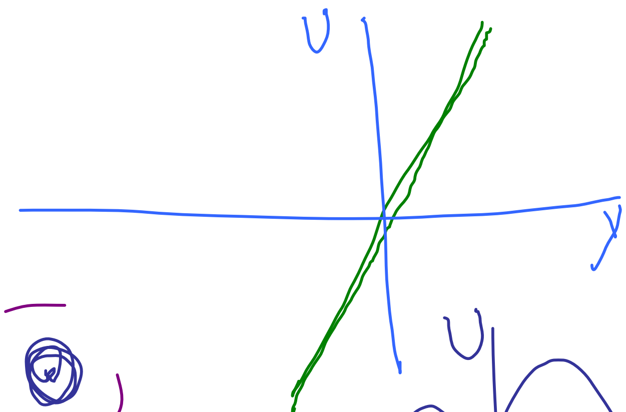
Potential Energy Curves

$U(x)$

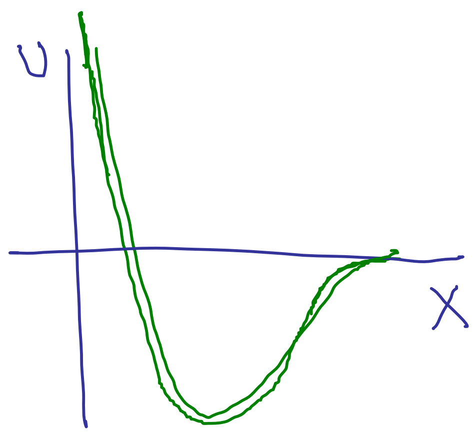
$U_{spring} = \frac{1}{2}kx^2$



$U_{grav} = mgy$



One could have:



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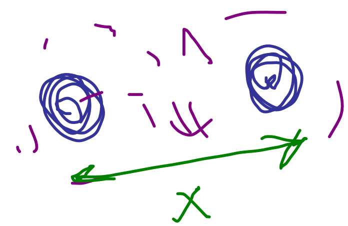
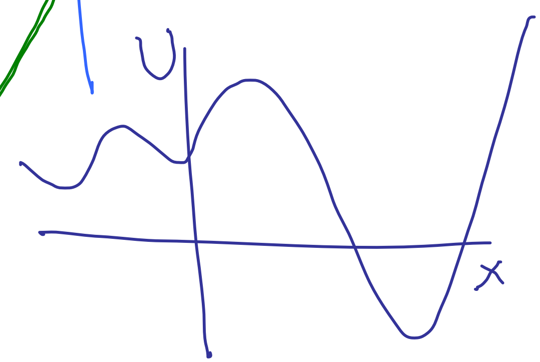




$$W = -\Delta U \quad \Rightarrow \quad \Delta U = -W$$

$$W = \int_a^b F_x \, dx$$

Choose a place where we say $U = 0$

$\Rightarrow$ Reference point Point $\equiv 0$

$$W = \int_0^x F_x(x') \, dx' = -U$$

U is minus of indefinite integral of $F(x)$

$$U = -\int_0^x F(x') \, dx'$$

$$F(x) = -kx \qquad -\int F(x) \, dx = -\left(\tfrac{1}{2} kx^2\right) = \tfrac{1}{2} kx^2$$

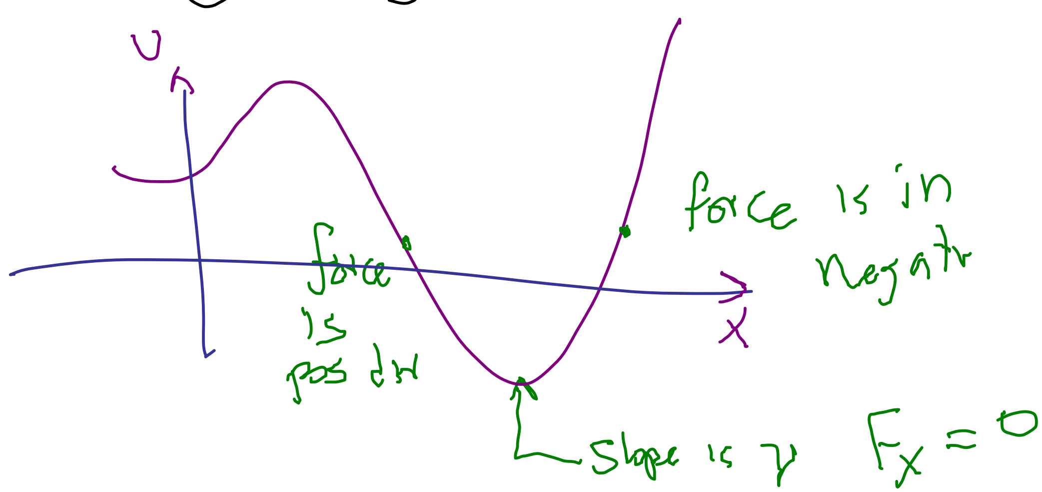
$$U = -\int_0^y -mg\, dy' = -(-mgy')\Big|_0^y = mgy$$

Conversely,

$$F_x = -\frac{dU}{dx}$$

Force is neg deriv. of potential energy.

Gives a way to understand potential energy curves



$F = 0$ Equilibr.

Stable