Phy 2A 5/17

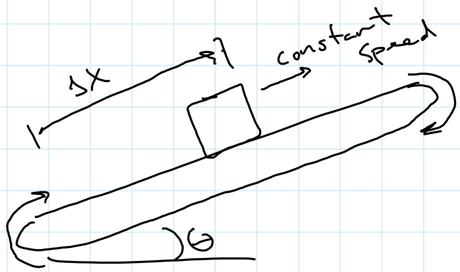
Wednesday, May 17, 2017 9:11 AM

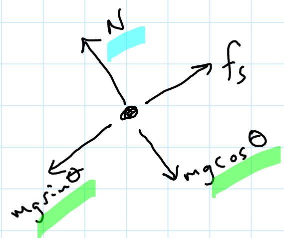
Goals for the Lecture:

1) Use Conservation of Energy to solve problems
2) Understand how defining your system can change external forces and potential energies

From Pre-lecture homework:

A piece of luggage is being loaded onto an airplane by way of an inclined conveyor belt. The bag, which has a mass of 10.0 kg, travels 4.50 m up the conveyor belt at a constant speed without slipping. If the conveyor belt is inclined at a 40.0° angle, calculate the work done on the bag by: the force of gravity (Wg) the normal force (WN) the friction force (Wf) the conveyor belt (Wconveyor) the net force (Wnet)





$W_N = 0$

$W_{gravity} = (mg\sin\theta)(\Delta x)(\cos 180°) = -mg\sin\theta\,(\Delta x)$

$W_{Net} = 0$ speed is constant

$W_{friction} = +|W_{gravity}|$

$W_{friction}$ or $W_{conveyor}$ same thing

$$\underbrace{W_{Net}}_{+} = \Delta K = K_f - K_i = \underbrace{\tfrac{1}{2}mv_f^2}_{\text{bigger}} - \underbrace{\tfrac{1}{2}mv_i^2}_{\text{smaller}}$$

$-$ smaller bigger

Use energy to find v_f, given: $m = 10$ kg

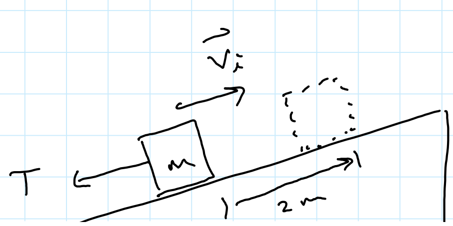
$g = 9.8$ m/s²

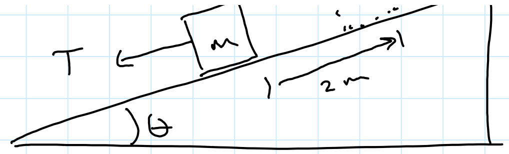
$\theta = 30°$

$v_i = 12$ m/s

$\Delta x = 2$ m

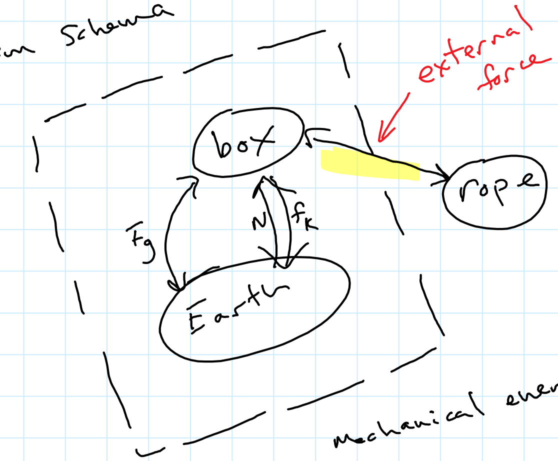
$T = 5$ N





$\Delta x = 2$ m
$T = 5$ N
$\mu_k = 0.15$

System Schema



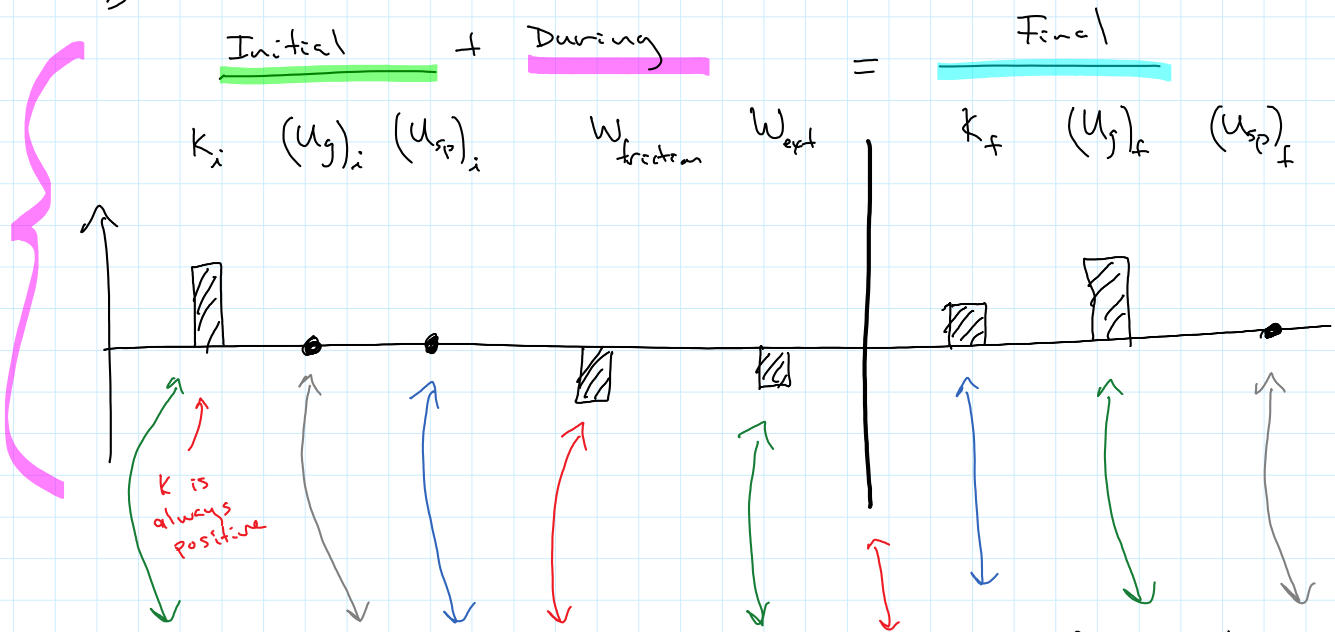
mechanical energy: K, U_g, U_{sp}

1st

$$E_i + \underbrace{W_{friction}}_{\text{Negative}} + W_{ext} = E_f$$

Energy bar chart:

2nd

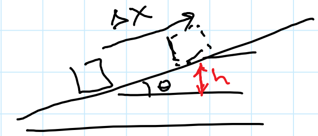


3rd

$$\frac{1}{2} m v_i^2 + 0 + 0 - f_k(\Delta x) - T\,\Delta x = \frac{1}{2} m v_f^2 + mgh + 0$$

$$\frac{1}{2} m v_i^2 - \mu_k(mg\cos\theta)(\Delta x) - T(\Delta x) = \frac{1}{2} m v_f^2 + mg(\Delta x)\sin\theta$$

$h = (\Delta x)\sin\theta$



$$\sin\theta = \frac{h}{\Delta x}$$

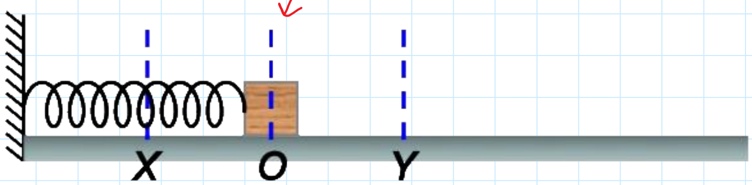
$$h = (\Delta x)\sin\theta$$

$$\frac{1}{2}(10)(12)^2 - (0.15)(10)(9.8)(\cos 30)(2) - (5)(2) = \frac{1}{2}(10)V_f^2 + (10)(9.8)(2)\sin 30^\circ$$

$$V_f = 10.8 \ \frac{m}{s}$$

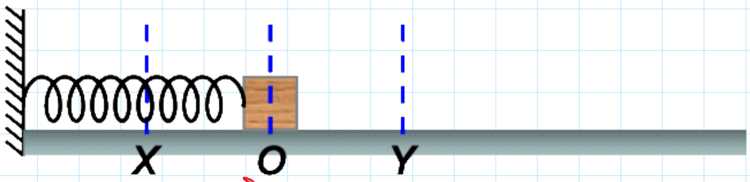
A block attached to a spring is oscillating between point ***X*** (fully compressed) and point ***Y*** (fully stretched). At point X, which of the following quantities would reach its maximum value?

v is maximum here



1. The block's kinetic energy^0 → No → max at O
2. The spring potential energy → yes (also max. at Y) $U_{sp} = \frac{1}{2}kx^2$
3. The magnitude of the block's momentum (mv) → No → max at O
4. The magnitude of the block's acceleration $a = \frac{F}{m}$ → yes (also max Y)
5. Both 1 and 3
6. Both 2 and 4
7. None of the above

A block attached to a spring is oscillating between point ***X*** (fully compressed) and point ***Y*** (fully stretched). As the block moves from point ***X*** to ***O*** (spring relaxed), the spring does work W on the block. How much work does the spring do on the block as it moves from ***O*** to ***Y***?



1. 0
2. W
3. $\boxed{-W}$
4. $2W$
5. $-2W$
6. $W/2$
7. $-W/2$

$F \rightarrow$ $\Delta x \rightarrow$ $W > 0$

$\leftarrow F$ $\rightarrow \Delta x$ $W < 0$

can be + or −

$$W = \pm \frac{1}{2} K X^2$$

always positive

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

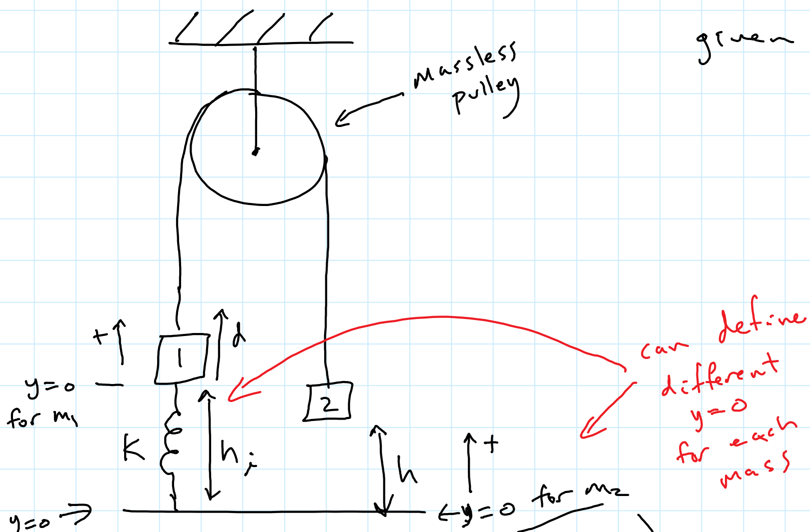
Application of the Day:

Generating energy involves transfer from one type to another:

Solar / hydroelectric / etc

Runaway truck ramps (like on I-5 over the Grapevine) convert KE into other forms (PE, heat, etc)

Problem: Find V_f (just before m_2 hits the ground)



given: $m_1 = 10$ kg

$m_2 = 20$ kg

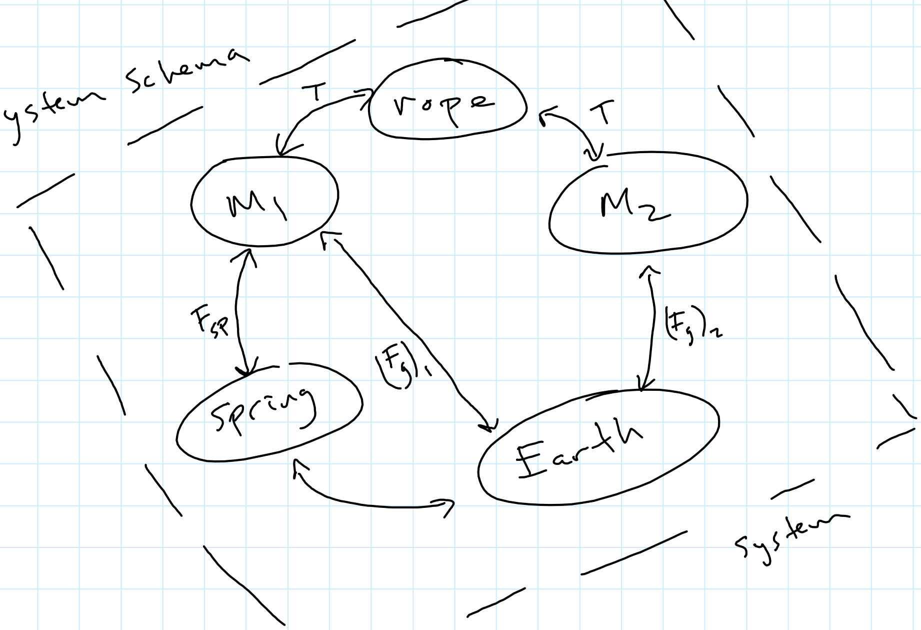
$K = 15 \frac{N}{m}$

$h = 2$ m

$V_i = 0$

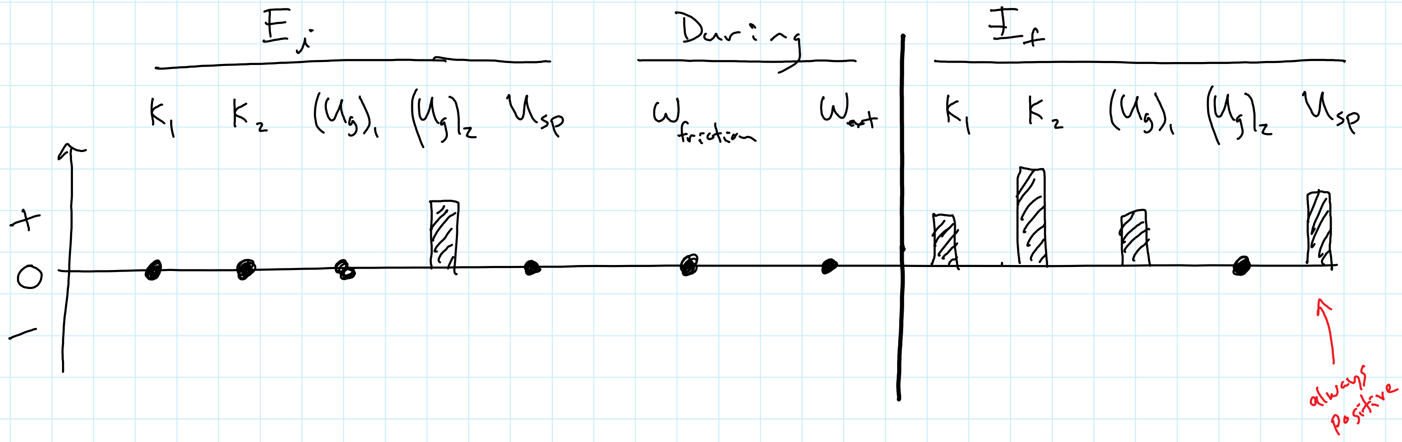
spring start unstretched

1) System Schema



2) $E_i + W_{friction} + W_{ext} = E_f$

3)



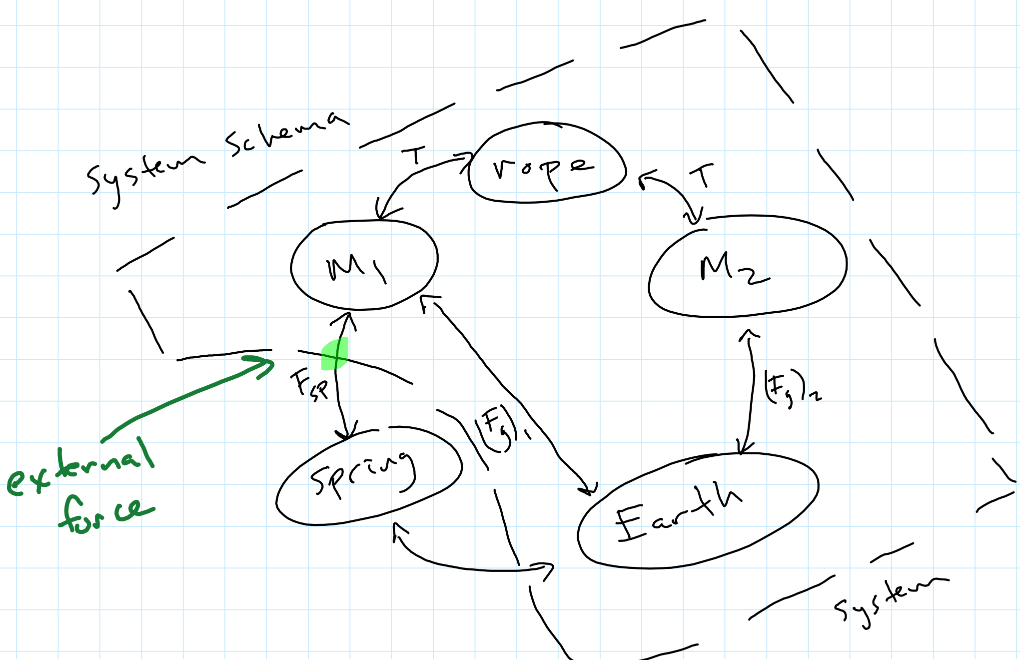
$$m_2 g h = \frac{1}{2} m_1 v_{1f}^2 + \frac{1}{2} m_2 v_{2f}^2 + m_1 g h + \frac{1}{2} k x^2$$

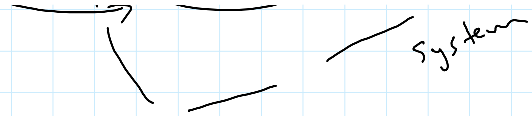
$x = h$

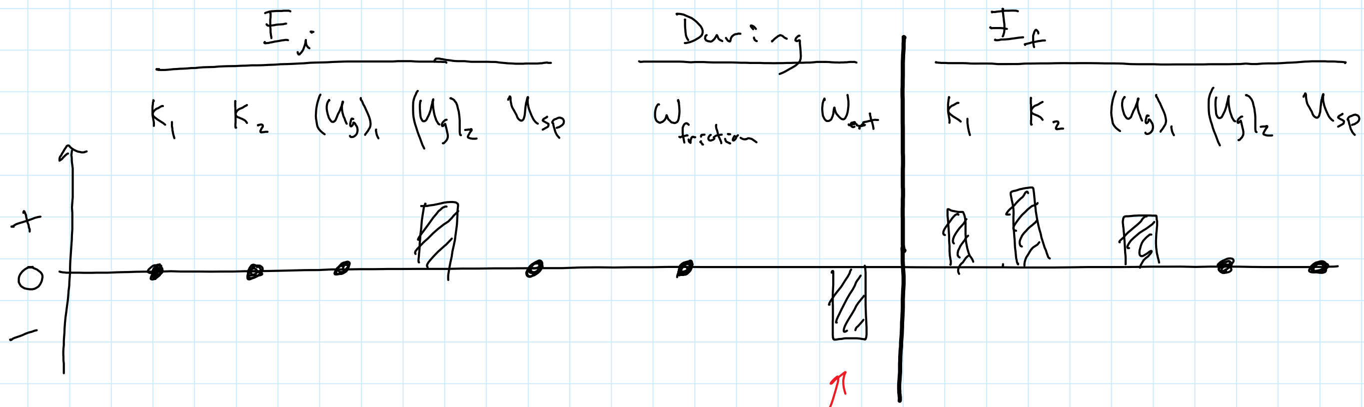
$$(20)(9.8)(2) = \frac{1}{2}(10) v_f^2 + \frac{1}{2}(20) v_f^2 + (10)(9.8)(2) + \frac{1}{2}(15)(2^2)$$

$$v_f = 3.33 \ \frac{m}{s}$$

Same problem again: Different system definition (spring Not in the system)







Work by spring can be + or −
(In this case it is Negative)

$$m_2 g h - \frac{1}{2} k h^2 = \frac{1}{2} m_1 V_f^2 + \frac{1}{2} m_2 V_f^2 + m_1 g h$$

⋮

$V_f = 3.33 \frac{m}{s}$ should be same as above