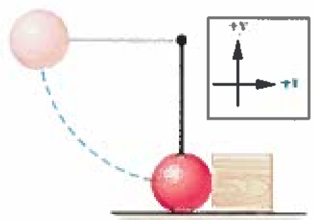
Physics 10154 - Exam #3B

Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

1. (30 pts) A 1.50-kg ball is attached to the ceiling by a light string of length 85.0 cm, which is initially horizontal and released from rest. It swings down and strikes the 2.00-kg block initially at rest in an elastic collision.

a) After the collision, the ball (still attached to the string) reaches what maximum height about the surface?

b) The coefficient of kinetic friction between the block and surface is 0.290. How far does the block slide on the horizontal surface after the collision before stopping?



Falling: $\Sigma W_F = W_{grav} = \Delta K$

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

$\Rightarrow v = \sqrt{2gh} = 4.08\ m/s$

↙ use as v_{1i}

Collision: $V_{1f} = \frac{1.50-2.00}{1.50+2.00}(4.08) + 0 = -0.583\ m/s$

use as v_0

Rising: $W_{grav} = \Delta K$

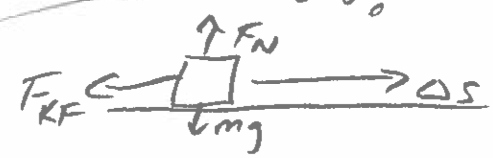
$-mgh = 0 - \frac{1}{2}mv_0^2$

$h = \frac{v_0^2}{2g} = \frac{(-.583)^2}{19.6} = \boxed{1.73\ cm}$

b) Collision $V_{2f} = \frac{2(1.50)}{1.50+2.00}(4.08) + 0 = 3.50\ m/s$

use as v_0

Sliding $\Sigma W_F = W_{KF} = \Delta K$

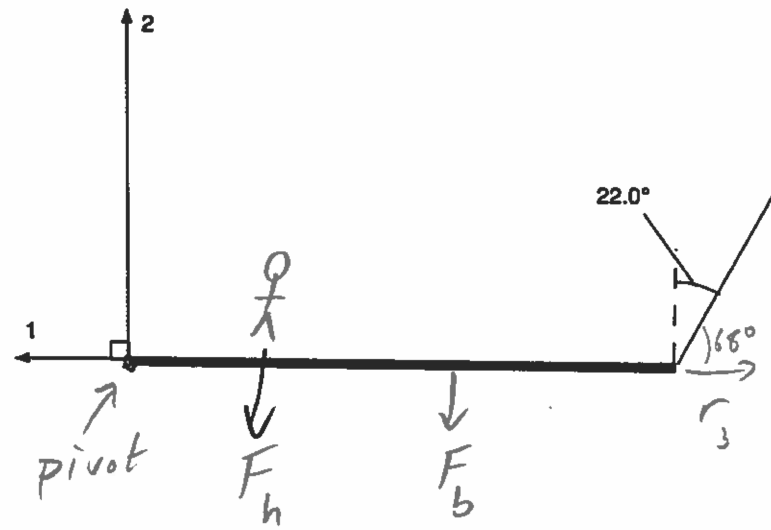


$-\mu_K F_N \Delta s = 0 - \frac{1}{2}mv_0^2$

$-\mu_K mg \Delta s = -\frac{1}{2}mv_0^2$

$\Delta s = \frac{v_0^2}{2\mu_K g} = \boxed{2.15\ m}$

2. (35 pts) A 925-N hiker is crossing a small horizontal bridge. The bridge is uniform and weighs 4210 N. The bridge has 3 numbered supporting ropes, as shown. The hiker stops 1/4 of the way from the left end of the bridge. What is the magnitude of the force that each rope exerts on the bridge? Answer with 3 SF.



$$\tau_h = -(.25\ell)(925)\sin 90^\circ$$

$$\tau_b = -(.50\ell)(4210)\sin 90^\circ$$

$$\tau_3 = +(\ell)(F_3)\sin 68^\circ$$

$$\Sigma F_x = F_3 \cos 68^\circ - F_1 = 0$$

$$\Sigma F_y = F_2 + F_3 \sin 68^\circ - 925 - 4210 = 0$$

$$\Sigma \tau = \tau_h + \tau_b + \tau_3 = 0$$

$$= (-.25\ell)(925) - (.50\ell)(4210) + \ell F_3 \sin 68^\circ = 0$$

$$= -231.25 - 2105 + .927 F_3 = 0$$

$$\boxed{F_3 = 2520\ N}$$

$$F_1 = F_3 \cos 68^\circ = \boxed{944\ N}$$

$$F_2 = 5135 - F_3 \sin 68^\circ = \boxed{2800\ N}$$

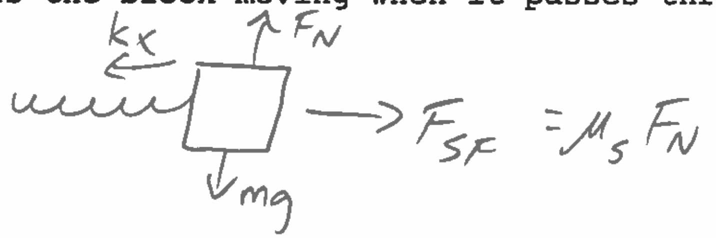
3. (35 pts) A 3.50-kg mass is attached to one end of a horizontal spring (k = 1240 N/m) while the other end of the spring is fixed in place.

a) If the coefficient of static friction between the block and surface is 0.550, what is the maximum length to which the spring can be compressed for which the mass will not move in response to the spring force?

b) Suppose the spring is compressed a distance 25.0% larger than your answer to (a) and released. If the coefficient of kinetic friction between the block and surface is [redacted], how fast is the block moving when it passes through equilibrium?

0.115

a)

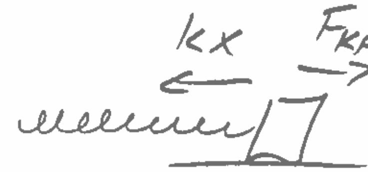


$$\Sigma F_x : +\mu_s F_N - k_s x = 0$$

$$\mu_s mg - k_s x = 0$$

$$x = \frac{\mu_s mg}{k_s} = \boxed{1.52\,cm}$$

b) $x = 1.25(1.52) = 1.90\ cm$



$$\Sigma W_F = W_{spr} + W_{KF} = \Delta K$$

$$W_{KF} = F_{KF} \cdot \Delta s \cdot \cos\theta$$

$$= \mu_K F_N \cdot x \cdot \cos 180$$

$$= -\mu_K mgx$$

$$= \frac{1}{2}kx^2 - \mu_K mgx = \frac{1}{2}mv^2 - 0$$

$$= 0.224 - .075 = \frac{1}{2}(3.50)v^2$$

$$0.149 = 1.75 v^2$$

$$\boxed{v = 0.292\ m/s}$$