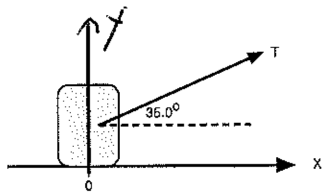
Your Name: ______________________

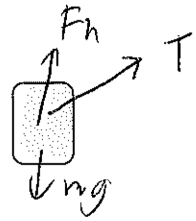
PHY203

Exam #2
Chapters 4-7
Fri., 3/20/20

Solutions

Exam2S20





1. A block of mass m is at rest on a smooth surface. A string is attached to the block and the string is pulled at an angle of 35.0°. The block slides across the surface.

a. Above and to the right draw a free body diagram of the block while it is sliding. **(5)**

b. Write out Newton's 2nd Law for the block in both directions while it is sliding. **(20)**

$x: \quad T\cos 35^\circ = ma$

$y: \quad F_n + T\sin 35^\circ - mg = 0$

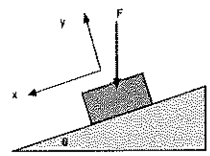
Assume m=4.50 kg and T=30.0 N.

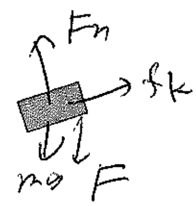
c. Find the magnitude of the acceleration of the block. **(5)**

$$a = \frac{(30.0)\cos 35^\circ}{4.50} = 5.46 \text{ m/s}^2$$

d. Find the distance the block travels in 15.0 s. **(5)**

$$x = 0 + 0 + \frac{1}{2} a t^2$$
$$= \frac{1}{2}(5.46)(15.0)^2 = 614 \text{ m}$$





2. A vertical force, F, pushes a block of mass, m, down a rough ramp which makes an angle of θ with respect to the horizontal. The coefficient of kinetic friction between block and ramp is μ_k.

a. Above and to the right draw a free body diagram of the block while it is sliding down the ramp. (**5**)

b. Write out Newton's 2nd Law for the block in both directions. (**20**)

$$x: \; mg\sin\theta + F\sin\theta - \mu_k F_n = ma$$

$$y: \; F_n - mg\cos\theta - F\cos\theta = 0$$

Assume F=125 N, m=4.00 kg, θ =40.0°, and μ_k =0.300.

c. Find the magnitude of the normal force on the block. (**5**)

$$F_n = (mg + F)\cos\theta$$

$$= (4.00g + 125)\cos 40^\circ$$

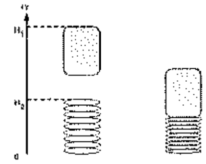
$$= 126\,N$$

d. Find the magnitude of the acceleration of the block. (**5**)

$$a = \frac{1}{m}\left[(mg + F)\sin\theta - \mu_k F_n\right]$$

$$= \frac{1}{4.00}\left[(4.00g + 125)\sin 40^\circ - 0.300\,(126)\right]$$

$$= 16.9\,m/s^2$$



3. An 8.50 kg block is held at a height H_1 = 7.50 m. The block is released and lands on a spring whose initial height before the collision is H_2 = 3.00 m. The spring has a spring constant of 1.50x10^3 N/m. (Ignore the size of the block.)
a. Use Conservation of Energy to find the speed of the block just before it touches the spring. (**5**)

$$mg(7.50) = mg(3.00) + \frac{1}{2}mv^2$$

$$v^2 = 2g(7.50 - 3.00)$$

$$v = 9.40 \text{ m/s}$$

b. Find the maximum compression of the spring. (**20**)

$$mg(7.50) = mg(3.00 - x) + \frac{1}{2}kx^2$$

$$(8.50)g(7.50) = (8.50g)(3.00 - x) + 750x^2$$

$$750x^2 - 83.4x - 375 = 0$$

$$x = \frac{83.4 \pm \sqrt{83.4^2 + 4 \cdot 750 \cdot 375}}{1500}$$

$$= 0.765 \text{ m}$$

c. Find the maximum height the block reaches after leaving the spring. (**5**)

$$mg(7.50) = mgH$$

$$H = 7.50 \text{ m}$$

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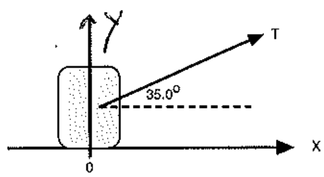
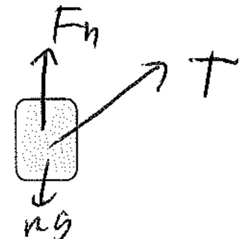




1. A block of mass m is at rest on a smooth surface. A string is attached to the block and the string is pulled at an angle of 35.0°. The block slides across the surface.

a. Above and to the right draw a free body diagram of the block while it is sliding. (**5**)

b. Write out Newton's 2nd Law for the block in both directions while it is sliding. (**20**)

$x: \quad T\cos 35^\circ = ma$

$y: \quad F_n + T\sin 35^\circ - mg = 0$

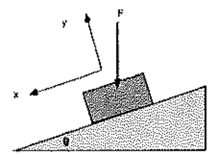
Assume m=5.50 kg and T=40.0 N.

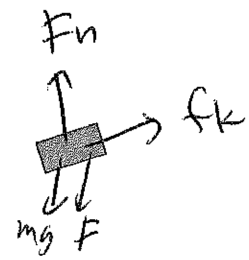
c. Find the magnitude of the acceleration of the block. (**5**)

$$a = \frac{(40.0)\cos 35^\circ}{5.50} = 5.96 \text{ m/s}^2$$

d. Find the distance the block travels in 15.0 s. (**5**)

$$x = 0 + 0 + \frac{1}{2} a t^2$$
$$= \frac{1}{2}(5.96)(15.0)^2 = 670 \text{ m}$$





2. A vertical force, F, pushes a block of mass, m, down a rough ramp which makes an angle of θ with respect to the horizontal. The coefficient of kinetic friction between block and ramp is μ_k.

a. Above and to the right draw a free body diagram of the block while it is sliding down the ramp. (**5**)

b. Write out Newton's 2nd Law for the block in both directions. (**20**)

$$x: \; mg\sin\theta + F\sin\theta - \mu_k F_n = ma$$

$$y: \; F_n - mg\cos\theta - F\cos\theta = 0$$

Assume F=105 N, m=5.00 kg, θ =40.0°, and μ_k =0.300.

c. Find the magnitude of the normal force on the block. (**5**)

$$F_n = (mg + F)\cos\theta$$

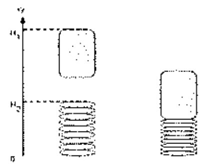
$$= (5.00g + 105)\cos 40.0° = 118\,N$$

d. Find the magnitude of the acceleration of the block. (**5**)

$$a = \frac{1}{m}\left[(mg + F)\sin\theta - \mu_k F_n\right]$$

$$= \frac{1}{5.00}\left[(5.00g + 105)\sin 40.0° - 0.300(118)\right]$$

$$= 12.7\,m/s^2$$



3. An 7.50 kg block is held at a height H_1 = 6.50 m. The block is released and lands on a spring whose initial height before the collision is H_2 = 3.00 m. The spring has a spring constant of 1.25x10^3 N/m. (Ignore the size of the block.)

a. Use Conservation of Energy to find the speed of the block just before it touches the spring. (**5**)

$$mg(6.50) = mg(3.00) + \frac{1}{2}mv^2$$

$$v^2 = 2g(6.50 - 3.00)$$

$$v = 8.29 \text{ m/s}$$

b. Find the maximum compression of the spring. (**20**)

$$mg(6.50) = mg(3.00 - x) + \frac{1}{2}kx^2$$

$$7.50g(6.50) = 7.50g(3.00 - x) + 625x^2$$

$$625x^2 - 73.6x - 258 = 0$$

$$x = \frac{(73.6) \pm \sqrt{(73.6)^2 + 4 \cdot 625 \cdot 258}}{1250}$$

$$= 0.704 \text{ m}$$

c. Find the maximum height the block reaches after leaving the spring. (**5**)

Back to initial height

$$mg(6.50) = mg\,H_f$$

$$H_f = 6.50 \text{ m}$$