Exam #2 **PS150**

April 2, 2009

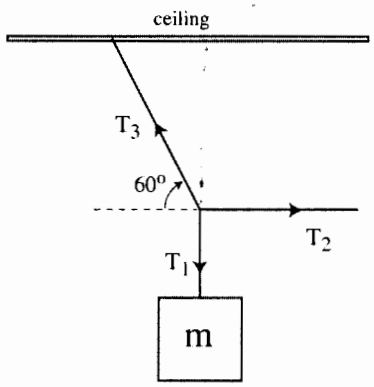
Please Show Your Work!

Answer Key

Name

10 points

1. A block of mass *m* is suspended motionless from the ceiling as shown in the figure to the right. Calculate the three tensions.



$T_3 \sin 60^\circ = T_1 \qquad T_1 = 1\ mg$

$T_3 = \frac{T_1}{\sin 60^\circ} = \frac{mg}{\sqrt{3}/2} = 1.155\ mg$

$T_2 = T_3 \cos 60^\circ = mg\left(\frac{1}{2}\right)$

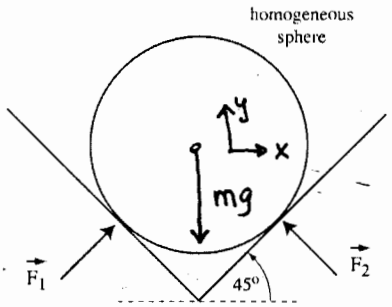
$T_1 =$ 1.00 mg

$T_2 =$ 0.500 mg

$T_3 =$ 1.155 mg

10 points

2. A homogenous sphere of mass *m* is resting in a frictionless gutter whose edges form a right angle (90°). Calculate the magnitude of the external forces $\vec{F}_1$ and $\vec{F}_2$.



$\sum \vec{F} = \vec{0} \qquad \vec{F}_1 + \vec{F}_2 + m\vec{g} = 0$

$\sum F_y = 0 \Rightarrow F_1 \sin 45^\circ + F_2 \sin 45^\circ - mg = 0$

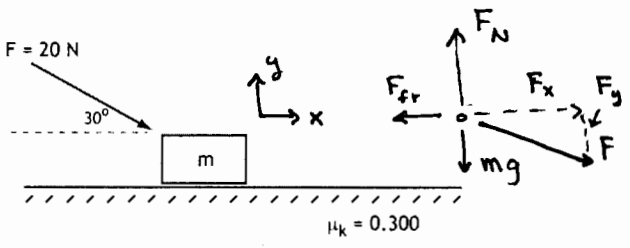
$\Rightarrow 2F \sin 45^\circ = mg$

$F = \frac{mg}{2 \sin 45^\circ} = 0.707\ mg$

$|\vec{F}_1| = |\vec{F}_2| =$ 0.707 mg

10 points

3. A block of mass *m* (2.00 kg) is pushed by a 20 N force on a level surface having a coefficient of kinetic friction of 0.300.



   a. What is the normal force applied to the block due to the surface?

$\sum F_y = 0 \Rightarrow F_N - F \sin 30^\circ - mg = 0$

$F_N = F \sin 30^\circ + mg = 20N\left(\frac{1}{2}\right) + (2\ kg)(9.8\ m/s^2)$

$F_N = 29.6\ N$

$F_N =$ 29.6 N

b. What is the acceleration of the block?

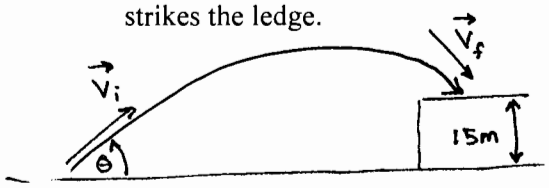
$\Sigma F_x = ma_x \Rightarrow -F_{fr} + F\cos 30^\circ = ma_x \Rightarrow -\mu_k F_N + F\cos 30^\circ = ma_x$

$\Rightarrow a_x = \dfrac{F\cos 30^\circ - \mu_k F_N}{m} = \dfrac{(20\text{ N})\cos 30^\circ - 0.300(29.6\text{ N})}{2.00\text{ kg}} = 4.22\text{ m/s}^2$

a = 4.22 m/s²

10 points

4. A 1.00-kg projectile is launched at an angle θ above level ground. Its initial velocity is 20.0 m/s and it lands on top of ledge whose elevation is 15.0 meters high. What is its speed just before it strikes the ledge.



$W_{TOT} = \Delta K \quad -\Delta U_{grav} = \frac{1}{2}m(v_f^2 - v_i^2)$

$-(mgh - 0) = \frac{1}{2}m(v_f^2 - v_i^2) \Rightarrow v_f^2 = v_i^2 - 2gh$

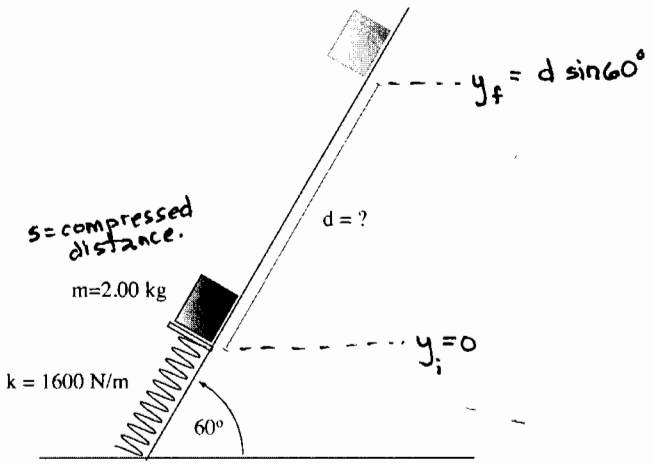
$v_f^2 = (20\text{ m/s})^2 - 2(9.8)(15)$

$v_f^2 = 106\text{ m}^2/\text{s}^2 \quad v_f = 10.3\text{ m/s}$

v_f = 10.3 m/s

10 points

5. A 2.00-kg mass is released from rest after compressing a spring 15.0 cm. After the mass is released, it travels up the 60° incline until it reaches a maximum distance d from its initial position. Find the distance d.



$W_{TOT} = \Delta K \quad W_{el} + W_{grav} = K_f - K_i = 0 - 0 = 0$

$\Rightarrow -\Delta U_{el} - \Delta U_{grav} = 0$

$-\left(\frac{1}{2}kx_f^2 - \frac{1}{2}x_i^2\right) - (mgy_f - mgy_i) = 0$

($x_f = 0$, $x_i = s$)

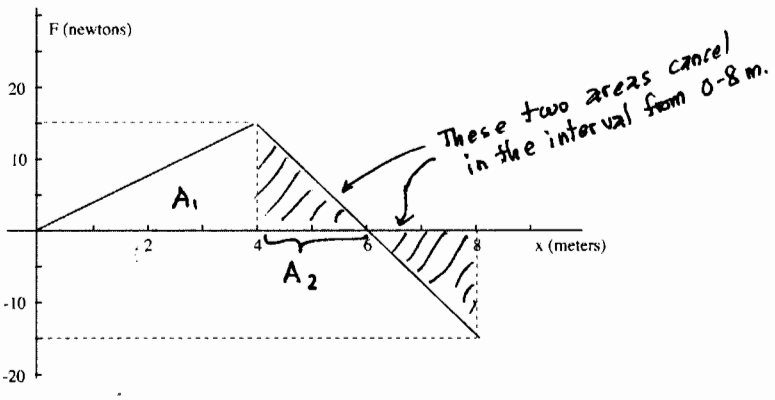
$\frac{1}{2}ks^2 = mg\,d\sin 60^\circ \Rightarrow d = \dfrac{ks^2}{2mg\sin 60^\circ}$

$d = \dfrac{1600\text{ N}/\text{m}\,(0.15\text{ m})^2}{2(2\text{ kg})(9.8\text{ m/s}^2)\sin 60^\circ} = 1.06\text{ meters}$

d = 1.06 meters

10 points

6. A 2.00-kg mass is acted upon by a force parallel to the x-axis. If the mass is initially at rest, and the motion is constrained to be only along the x direction,



a. What is the velocity of the mass after 8.00 meters?

Work = Area = 30 J = $\frac{1}{2}mv^2$

$v = \sqrt{\frac{2}{m}(30\text{ J})} = 5.48\text{ m/s}$

v = 5.48 m/s

b. As the mass moves between 0.00 to 8.00 meters, what is its maximum velocity?

$W = A_1 + A_2 = 30\text{ J} + 15\text{ J} = 45\text{ J} = \frac{1}{2}mv^2$

$v = \sqrt{\frac{2}{m}(45\text{ J})} = 6.71\text{ m/s}$

v_{max} = 6.71 m/s