Equations

Tuesday, October 13, 2015 8:14 AM

Stuff that may help!

Name______________________________

$$\Delta x = \left[\frac{v_{x_0} + v_x}{2}\right] t$$

$$\Delta x = v_{x_0} \Delta t + \tfrac{1}{2} a_x t^2$$

$$v_x = v_{x_0} + a_x t$$

$$v_x^2 = v_{x_0}^2 + 2 a_x \Delta x$$

$$\sum \vec{F} = m\vec{a}$$

$$\sum F_x = m a_x$$
$$\sum F_y = m a_y$$

$$\Delta y = \left[\frac{v_{y_0} + v_y}{2}\right] t$$

$$\Delta y = v_{y_0} t + \tfrac{1}{2} a_y t^2$$

$$v_y = v_{y_0} + a_y t$$

$$v_y^2 = v_{y_0}^2 + 2 a_y \Delta y$$

$$g = 9.8 m/s^2$$

$$|\vec{A}| = \sqrt{A_x^2 + A_y^2}$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\sin\theta = \frac{A_y}{|\vec{A}|}$$

$$\cos\theta = \frac{A_x}{|\vec{A}|}$$

$$\tan\theta = \frac{A_y}{A_x}$$

$$F_k = \mu_k N$$

$$F_s \le \mu_s N$$

$$W = mg$$

N

F_w

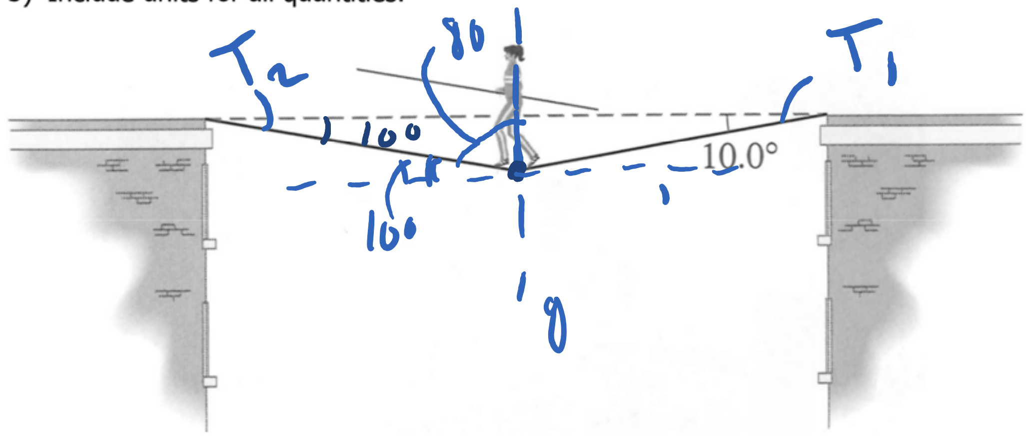
$\mu_s N$

Test 2 Review

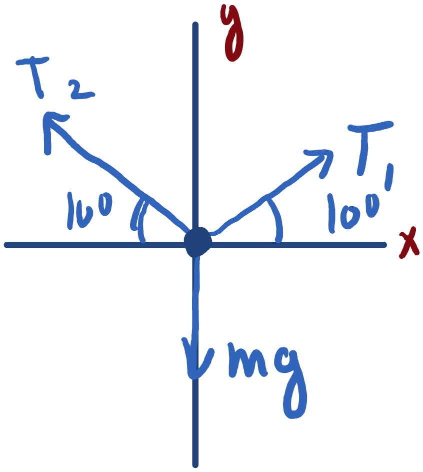
Test 2 Review

Show all work in the spaces provided.
For full credit:

1) Show all your work and for each problem
2) Draw and label a neat Free Body Diagram(s).
3) Include units for all quantities.



1) Arlene is walking is to walk across a "high wire" strung horizontally between two buildings ~~10.0~~ m apart. The sag in the rope when she is at the midpoint is $10°$, as shown above. If her mass is $50\,kg$, what is the tension in the rope at this point? (10 points)



$$\Sigma F_x = 0$$

$$T_1 \cos(10°) - T_2 \cos(10°) = 0$$

$$T_1 - T_2 = 0$$

$$T_1 = T_2 = T$$

$$\Sigma F_y = 0$$

$$T_2 \sin(10°) + T_1 \sin(10°) - mg = 0$$

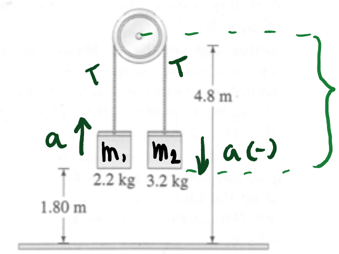
$$2T \sin(10°) = mg$$

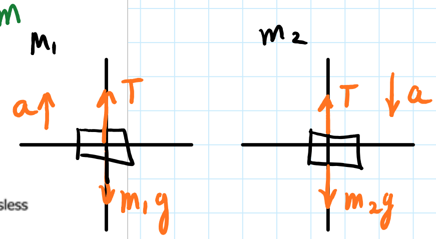
$$T = \frac{mg}{2\sin(10°)}$$

$$T = \frac{(50kg)(9.8m/s^2)}{2\sin(10^\circ)}$$

$$\boxed{T = 1410.9\,N}$$

Tuesday, October 13, 2015 8:15 AM





$v_y = 3.3\,m/s$

2) The two masses shown above are each initially 1.80 m above the ground and the massless frictionless pulley is 4.8 m above the ground.

a) What is the acceleration of the system? (6 points)

$\Sigma F_y = m_1 a$

$T - m_1 g = m_1 a$

$\Sigma F_y = m_2 a$

$T - m_2 g = -m_2 a$

$T = m_2 g - m_2 a$

$m_2 g - m_2 a - m_1 g = m_1 a$

$m_2 g - m_1 g = m_1 a + m_2 a$

$g(m_2 - m_1) = a(m_1 + m_2)$

$a = \left(\frac{m_2 - m_1}{m_1 + m_2}\right) g$

$a = \frac{(3.2\,kg - 2.2\,kg)}{(3.2\,kg + 2.2\,kg)}(9.8\,m/s^2)$

$\boxed{a = 1.81\,m/s^2}$

b) What is the velocity of the lighter object when it gets to the height of the pulley? (3 points)

$v_y = ?$

$a_y = 1.81\,m/s^2$

$\Delta y = 3\,m$

$v_{y_0} = 0$

$v_y^2 = v_{y_0}^2 + 2 a_y \Delta y$

$v_y = \sqrt{2 a_y \Delta y}$

$v_y = \sqrt{2(1.81\,m/s^2)(3\,m)}$

$\boxed{v_y = 3.3\,m/s}$

c) How much further does the lighter object travel? (3 points)

$v_y = 0$

$a_y = -9.8\,m/s^2$

$\Delta y = ?$

$v_{y_0} = 3.3\,m/s$

$v_y^2 = v_{y_0}^2 + 2 a_y \Delta y$

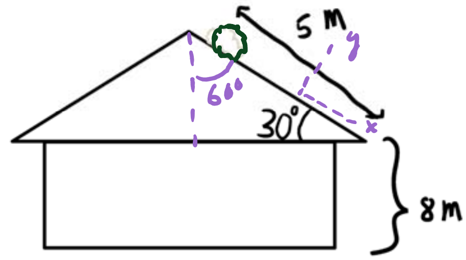
$2 a_y \Delta y = -v_{y_0}^2$

$\Delta y = \frac{-v_{y_0}^2}{2 a_y}$

$\Delta y = \frac{-(3.3\,m/s)^2}{2(-9.8\,m/s^2)}$

$\boxed{\Delta y = .56\,m}$

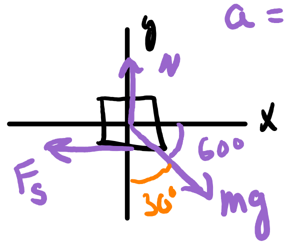
3



$F_s = \mu_s N$

3) Piles of snow on slippery roofs can become dangerous projectiles as they melt. Consider a chunk of snow at the ridge of a roof with a pitch of $30°$.

a) What is the minimum value of the coefficient of static friction that will keep the snow from sliding down? (6 points)



$a = 0$

$\Sigma F_y = 0$

$N - mg\sin(60°) = 0$

$N = mg\sin(60°)$

$\Sigma F_x = 0$

$mg\cos(60°) - F_s = 0$

$mg\cos(60°) - \mu_s N = 0$

$mg\cos(60°) - \mu_s mg\sin(60°) = 0$

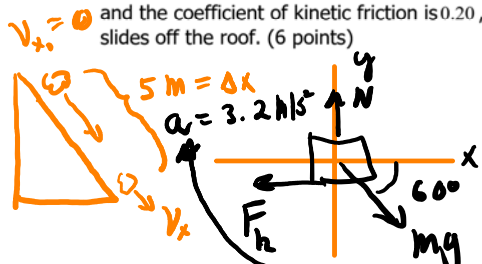
$\mu_s \sin(60°) = \cos(60°)$

$\mu_s = \frac{\cos(60°)}{\sin(60°)} = \cot(60°)$

$\mu_s = .58$

$m = 1kg$

b) As the snow begins to melt, the coefficient of static friction decreases and the snow eventually slips. Assuming that the distance from the chunk to the edge of the roof is $5.0m$ and the coefficient of kinetic friction is 0.20, calculate the speed of the snow chunk when it slides off the roof. (6 points)



$\Sigma F_y = 0$

$N - mg\sin(60°) = 0$

$N = mg\sin(60°)$ ←

$\Sigma F_x = ma_x$

$mg\cos(60°) - F_k = ma$

$mg\cos(60°) - \mu_k N = ma$

$mg\cos(60°) - \mu_k mg\sin(60°) = ma$

$a = g[\cos(60°) - \mu_k \sin(60°)]$

$a = (9.8 m/s^2)[\cos(60°) - (.2)\sin(60°)]$

$a = 3.2 m/s^2$

$v_x^2 = v_{x_0}^2 + 2a_x\Delta x$

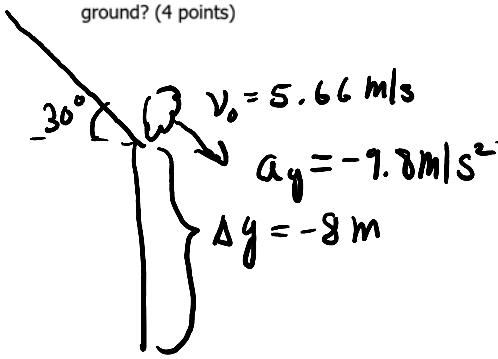
$v_x^2 = 2a_x\Delta x$

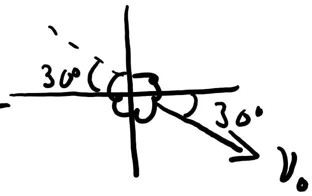
$v_x = \sqrt{2a_x\Delta x}$

$v_x = \sqrt{2(3.2 m/s^2)(5 m)}$

$v_x = 5.66 m/s$

c) If the edge of the roof is $8.0\,m$ above ground, what is the speed of the snow when it hits the ground? (4 points)





$$v_x = v_0 \cos(30°)$$

$$v_x = (5.66\,m/s)\cos(30°)$$

$$\boxed{v_x = 4.9\,m/s}$$

$$v_{y_0} = v_0 \sin(30°)$$

$$v_{y_0} = (5.66\,m/s)\sin(30°)$$

$$v_{y_0} = 2.83\,m/s$$

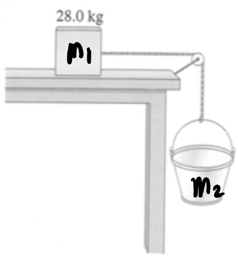
$$v_y^2 = v_{y_0}^2 + 2a_y \Delta y$$

$$v_y = \sqrt{v_{y_0}^2 + 2a_y \Delta y}$$

$$v_y = \sqrt{(2.83\,m/s)^2 + 2(+9.8\,m/s^2)(+8\,m)}$$

$$v_y = 12.63\,m/s$$

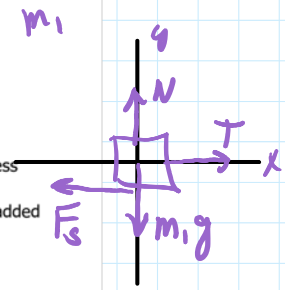
$$|\vec{v}| = \sqrt{v_x^2 + v_y^2} = ?$$

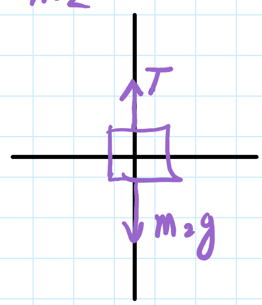


4) A 28.0 kg block is connected to an empty 1.35 kg bucket by a cord running over a frictionless pulley? The coefficient of static friction between the table and the block is 0.450 and the coefficient of kinetic friction between the table and the block is 0.350. Sand is gradually added to the bucket until the system just begins to move.

a) Calculate the mass of sand added to the bucket. (6 points) $F_s = \mu_s N$

$a = 0$





m_1

$\Sigma F_y = 0$

$N - m_1 g = 0$

$N = m_1 g$

$\Sigma F_x = 0$

$T - F_s = 0$

$m_2 g - F_s = 0$

$m_2 g - \mu_s N = 0$

$m_2 g - \mu_s (m_1 g) = 0$

m_2

$\Sigma F_y = 0$

$T - m_2 g = 0$

$T = m_2 g$

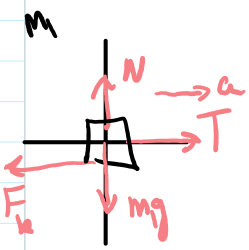
$m_2 = \mu_s m_1$

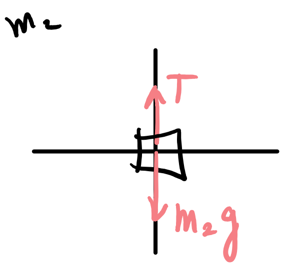
$m_2 = (.45)(28 kg)$

$m_2 = 12.6 kg$

Sand $= 12.6 kg - 1.35 kg = 11.25 kg$

b) Calculate the acceleration of the system. (6 points)





$\Sigma F_y = 0$

$N - m_1 g = 0$

$N = m_1 g$

$\Sigma F_y = m a_y$

$T - m_2 g = -m_2 a$

$T = m_2 g - m_2 a$

$\Sigma F_x = m a_x$

$T - F_k = m_1 a$

$m_2 g - m_2 a - \mu_k N = m_1 a$

$m_2 g - \mu_k N = m_1 a + m_2 a$

$m_2 g - \mu_k m_1 g = a (m_1 + m_2)$

$$a = \frac{g(m_2 - \mu_k m_1)}{(m_1 + m_2)} = \frac{(9.8 m/s^2)[12.6 kg - (.35)(28 kg)]}{(12.6 kg + 28 kg)}$$

$a = .68 m/s^2$

6

$$a = .68\ m/s^2$$