Example 1

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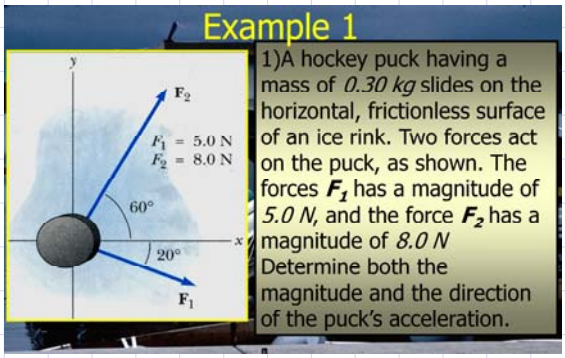

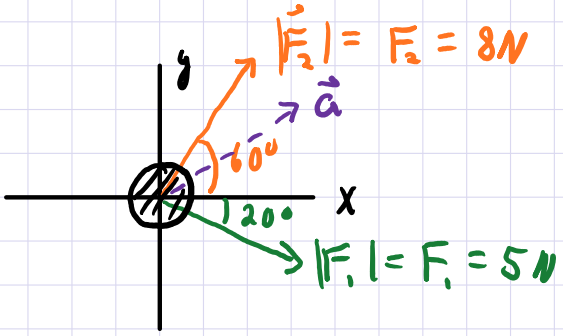

$$\Sigma F_x = m a_x$$

$$F_1 \cos(20°) + F_2 \cos(60°) = m a_x$$

$$a_x = \frac{F_1 \cos(20°) + F_2 \cos(60°)}{m} = \frac{(5N)\cos(20°) + (8N)\cos(60°)}{.30kg}$$

$$a_x = 28.99\ m/s^2 \approx 29\ m/s^2$$

$$\Sigma F_y = m a_y$$

$$-F_1 \sin(20°) + F_2 \sin(60°) = m a_y$$

$$a_y = \frac{-F_1 \sin(20°) + F_2 \sin(60°)}{m} = \frac{-(5N)\sin(20°) + (8N)\sin(60°)}{.3kg}$$

($kg\,m/s^2$)

$$a_y = 17.4\ m/s^2$$

$$|\vec{a}| = \sqrt{a_x^2 + a_y^2} = \sqrt{(29 m/s^2)^2 + (17.4 m/s^2)^2}$$

$$|\vec{a}| = 33.8\ m/s^2$$

$$\theta = \tan^{-1}\left(\frac{a_y}{a_x}\right) = \tan^{-1}\left(\frac{17.4 m/s^2}{29 m/s^2}\right) = 30.9° \approx 31°$$

Example 2

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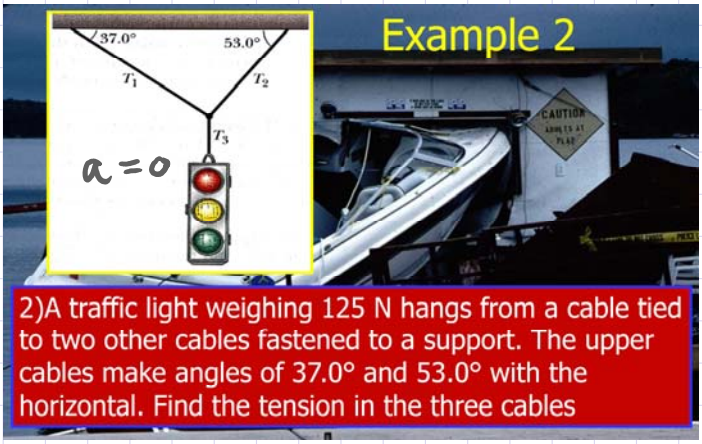
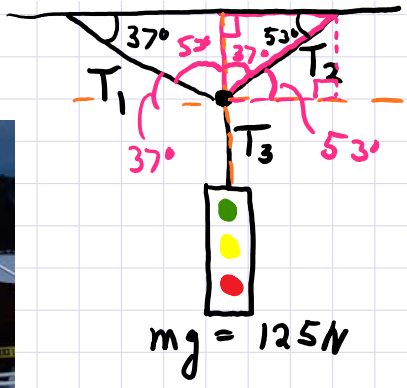
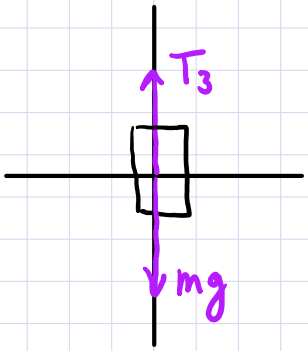


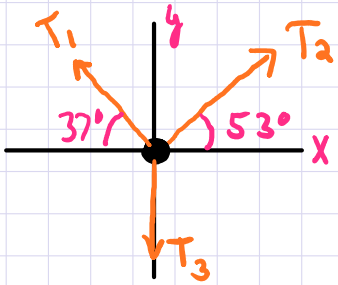




$\Sigma F_y = 0$

$T_3 - mg = 0$

$\boxed{T_3 = mg = 125N}$



$\Sigma F_x = 0$

$-T_1 \cos(37°) + T_2 \cos(53°) = 0$

$T_2 \cos(53°) = T_1 \cos(37°)$

$T_2 = T_1 \frac{\cos(37°)}{\cos(53°)} = (75.3N) \frac{\cos(37°)}{\cos(53°)} = \boxed{99.9N}$

$\Sigma F_y = 0$

$T_1 \sin(37°) + T_2 \sin(53°) - T_3 = 0$

$T_1 \sin(37°) + \left[T_1 \frac{\cos(37°)}{\cos(53°)}\right] \sin(53°) = T_3$

$T_1 \left[\sin(37°) + \frac{\cos(37°)}{\cos(53°)} \sin(53°)\right] = T_3$

$T_1 = \frac{T_3}{\sin(37°) + \frac{\cos(37°)}{\cos(53°)} \sin(53°)}$

$T_1 = \frac{125\,N}{\sin(37°) + \frac{\cos(37°)}{\cos(53°)} \sin(53°)}$

$\boxed{T_1 = 75.3N}$

Example 3

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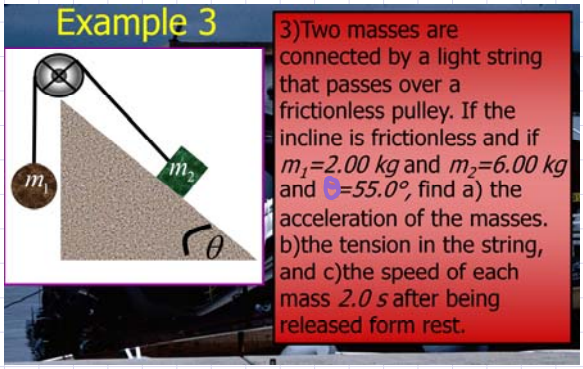

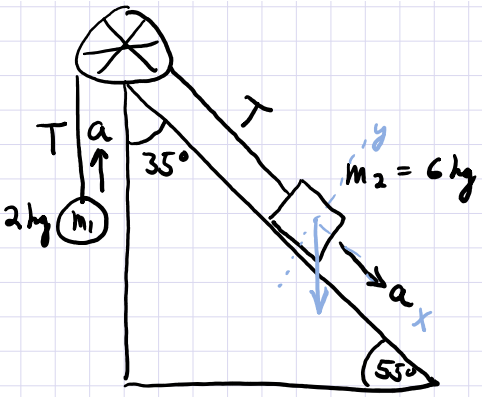

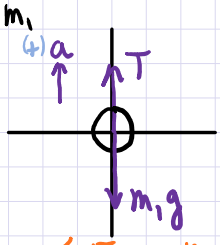

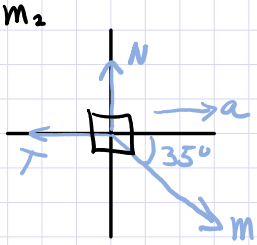

$\Sigma F_y = m a_y$

$T - m_1 g = m_1 a$

$T = m_1 g + m_1 a$

$T = m_1 (g + a)$

$T = (2kg)(9.8 m/s^2 + 3.57 m/s^2)$

$\boxed{T = 26.74 N}$

$\Sigma F_y = m a_y$

$N - m_2 g \sin(35°) = 0$

$\Sigma F_x = m a_x$

$\boxed{m_2 g \cos(35°) - T = m_2 a}$

$m_2 g \cos(35°) - (m_1 g + m_1 a) = m_2 a$

$m_2 g \cos(35°) - m_1 g - m_1 a = m_2 a$

$m_2 a + m_1 a = m_2 g \cos(35°) - m_1 g$

$a(m_2 + m_1) = m_2 g \cos(35°) - m_1 g$

$$a = \frac{m_2 g \cos(35°) - m_1 g}{m_2 + m_1}$$

$$a = (9.8 m/s^2)\frac{[6kg \cos(35°) - 2kg]}{8kg}$$

$\boxed{a = 3.57 m/s^2}$

c) $v = \cancel{v_0}^{\,0} + a t$

$v = 0 + (3.57 m/s^2)(2s)$

$\boxed{v = 7.14 m/s}$

$\Delta x = \cancel{v_0 t}^{\,0} + \frac{1}{2} a_x t^2$

Example 4

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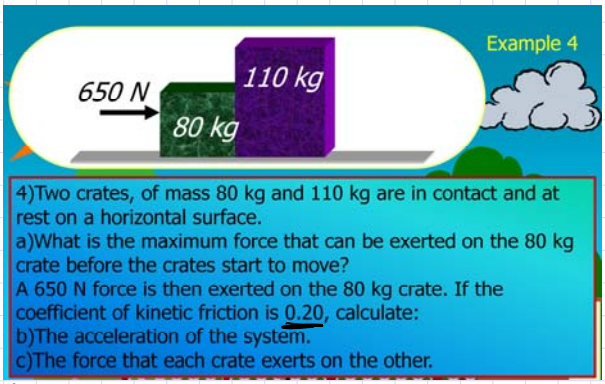
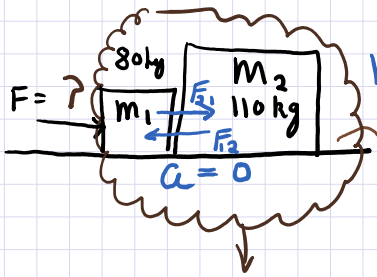


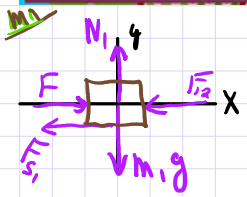
4)Two crates, of mass 80 kg and 110 kg are in contact and at rest on a horizontal surface.
a)What is the maximum force that can be exerted on the 80 kg crate before the crates start to move?
A 650 N force is then exerted on the 80 kg crate. If the coefficient of kinetic friction is 0.20, calculate:
b)The acceleration of the system.
c)The force that each crate exerts on the other.



$|\vec{F}_{21}| = |\vec{F}_{12}|$

$\mu_s = .3$ $F_s \leq \mu_s N$

190g μ_s



$\Sigma F_y = 0$

$N_1 - m_1 g = 0$

$N_1 = m_1 g$

$\Sigma F_x = 0$

$F - F_{12} - F_{s_1} = 0$

$F - F_{s_2} - F_{s_1} = 0$

$F = F_{s_2} + F_{s_1}$

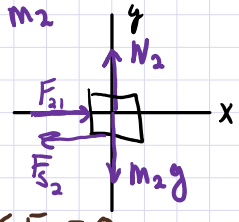
$F = \mu_s N_2 + \mu_s N_1$

$F = \mu_s m_2 g + \mu_s m_1 g$

$F = \mu_s g (m_2 + m_1)$

$F = (.3)(9.8 m/s^2)(190 kg)$

$F = 558.6 N$



$\Sigma F_y = 0$

$N_2 - m_2 g = 0$

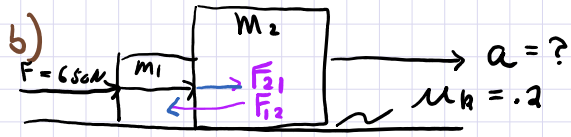
$N_2 = m_2 g$

$\Sigma F_x = 0$

$F_{21} - F_{s_2} = 0$

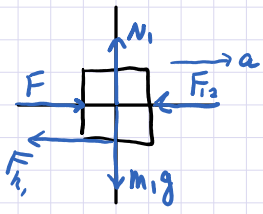
$F_{21} = F_{s_2}$

b)



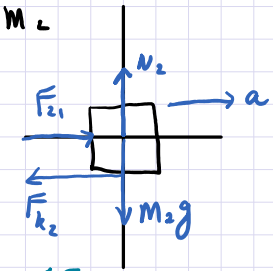
$F_k = \mu_k N$

m_1



$\Sigma F_y = ma_y$

m_2



$\Sigma F_y = ma_y$

$N_2 - m_2 g = 0$

$\Sigma F_y = ma_y$

$N_1 - m_1 g = 0$

$N_1 = m_1 g$

$\Sigma F_x = ma_x$

$F - F_{12} - F_{k_1} = m_1 a$

$F - (F_{k_2} + m_2 a) - F_{k_1} = m_1 a$

$F - F_{k_2} - m_2 a - F_{k_1} = m_1 a$

$m_1 a + m_2 a = F - F_{k_2} - F_{k_1}$

$a(m_1 + m_2) = F - \mu_k N_2 - \mu_k N_1$

$$a = \frac{F - \mu_k m_2 g - \mu_k m_1 g}{(m_1 + m_2)} = \frac{F - \mu_k g (m_2 + m_1)}{m_1 + m_2}$$

$kg\ m/s^2$

$$a = \frac{650N - (.2)(9.8 m/s^2)(190 kg)}{190 kg}$$

$a = 1.46 m/s^2$

$\Sigma F_y = ma_y$

$N_2 - m_2 g = 0$

$N_2 = m_2 g$

$\Sigma F_x = ma_x$

$F_{21} - F_{k_2} = m_2 a$

$F_{21} = F_{k_2} + m_2 a$

$F_{21} = \mu_k m_2 g + m_2 a$

$F_{21} = m_2 (\mu_k g + a)$

$F_{21} = (110 kg)[(.2)(9.8 m/s^2) + 1.46 m/s^2]$

$F_{21} = 376.2 N$

Example 5

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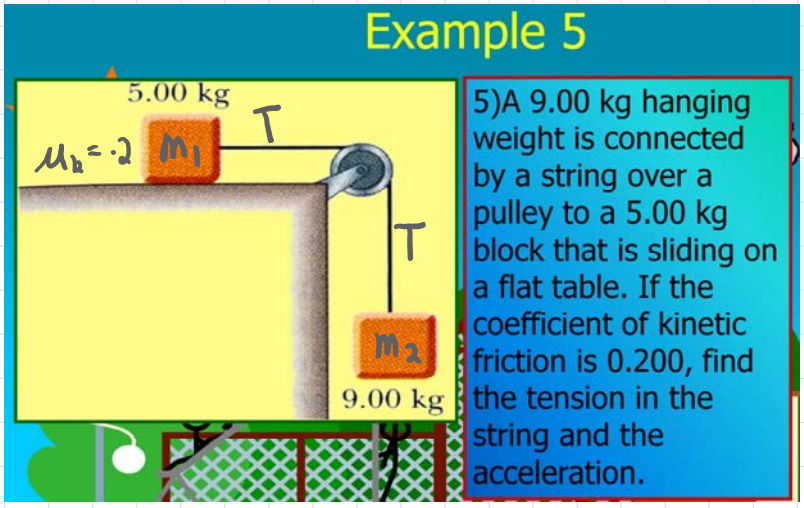
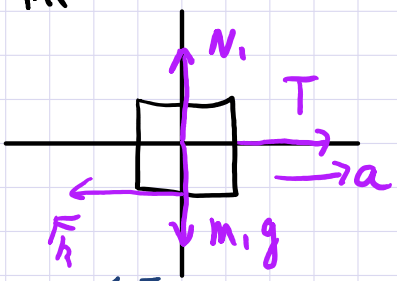


m_1



$\Sigma F_y = 0$

$N_1 - m_1 g = 0$

$N_1 = m_1 g$ ←

$\Sigma F_x = ma_x$

$T - F_k = m_1 a$

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

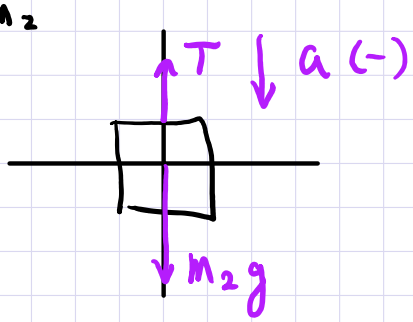
$m_2 g - F_k = m_1 a + m_2 a$

$m_2 g - \mu_k N_1 = a(m_1 + m_2)$

$$a = \frac{m_2 g - \mu_k m_1 g}{(m_1 + m_2)} = \frac{(9.8\,m/s^2)[9\,kg - (.2)\,5\,kg]}{14\,kg}$$

$a = 5.6\,m/s^2$

m_2



$\Sigma F_y = ma_y$

$T - m_2 g = -m_2 a$

$T = m_2 g - m_2 a$

$T = m_2 (g - a)$

$T = (9\,kg)[9.8\,m/s^2 - 5.6\,m/s^2]$

$T = 37.8\,N$

Example 6

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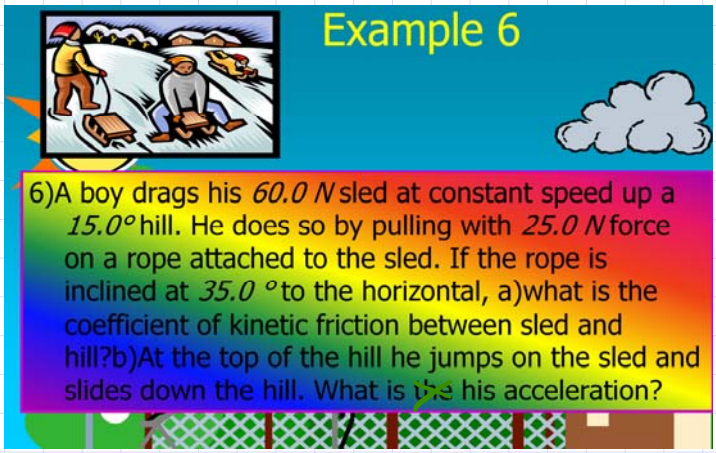
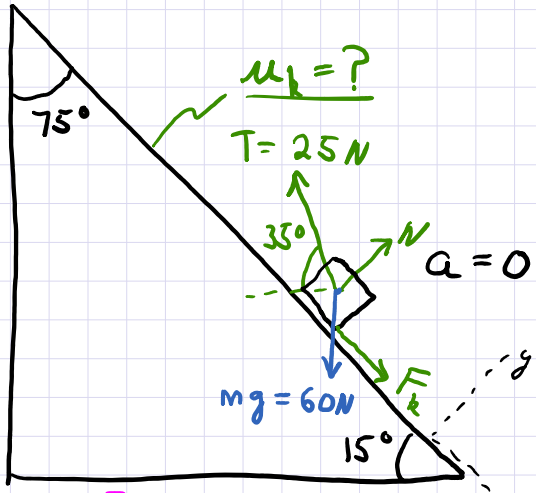
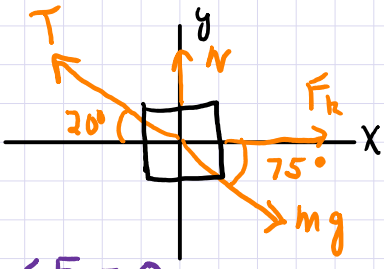
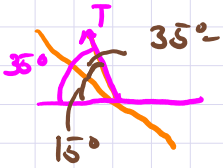








$\Sigma F_y = 0$

$N + T\sin(20°) - mg\sin(75°) = 0$

$N = mg\sin(75°) - T\sin(20°)$

$\Sigma F_x = 0$

$F_k + mg\cos(75°) - T\cos(20°) = 0$

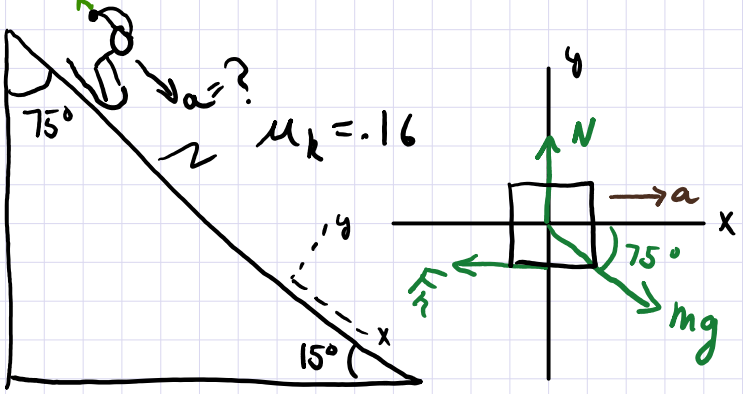
$\mu_k N = T\cos(20°) - mg\cos(75°)$

$\mu_k = \frac{T\cos(20°) - mg\cos(75°)}{N} = \frac{T\cos(20°) - mg\cos(75°)}{mg\sin(75°) - T\sin(20°)}$

$\mu_k = \frac{25N\cos(20°) - 60N\cos(75°)}{60N\sin(75°) - 25N\sin(20°)}$

$\mu_k = .16$

b)



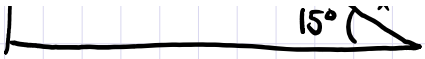
$\Sigma F_y = 0$

$N - mg\sin(75°) = 0$

$N = mg\sin(75°)$

$\Sigma F_x = ma_x$

$mg\cos(75°) - F_k = ma$



$$mg\cos(75°) - F_k = ma$$

$$mg\cos(75°) - \mu_k N = ma$$

$$mg\cos(75°) - \mu_k mg\sin(75°) = ma$$

$$a = g\left[\cos(75°) - \mu_k \sin(75°)\right]$$

$$a = (9.8\,m/s^2)\left[\cos(75°) - (.16)\sin(75°)\right]$$

$$\boxed{a = 1.02\,m/s^2}$$

Example 7

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