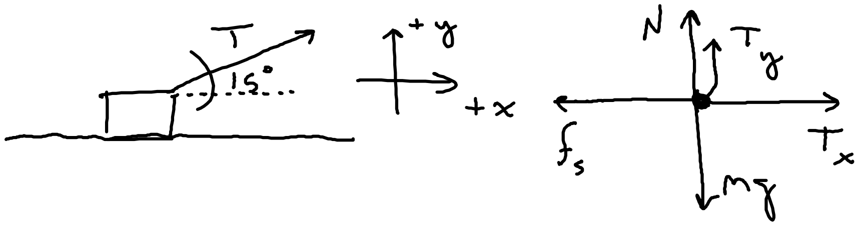
09FEB10

- HW Q & A
- Quiz

13
(13)

•13 A 68 kg crate is dragged across a floor by pulling on a rope attached to the crate and inclined 15° above the horizontal. (a) If the coefficient of static friction is 0.50, what minimum force magnitude is required from the rope to start the crate moving? (b) If $\mu_k = 0.35$, what is the magnitude of the initial acceleration of the crate? SSM



$$\underbrace{\Sigma F_y}_{0} = N + T_y - mg$$

$$0 = N + T\sin\theta - mg \Rightarrow \boxed{N = mg - T\sin\theta}$$

$$\Sigma F_x = T_x - f_s$$

static case
$$0 = T\cos\theta - \mu_s N = T\cos\theta - \mu_s(mg - T\sin\theta)$$

thus, $\boxed{T\cos\theta - \mu_s mg + \mu_s T\sin\theta = 0}$

$$T\cos\theta + \mu_s T\sin\theta = \mu_s mg$$

$$T(\cos\theta + \mu_s\sin\theta) = \mu_s mg$$

$$T = \frac{\mu_s mg}{\cos\theta + \mu_s\sin\theta}$$

$$= \frac{(0.5)(68\text{ kg})(9.8\text{ m/s}^2)}{\cos 15^\circ + 0.5\sin 15^\circ} = \boxed{304.200\text{ N}}$$

(b) $\mu_K = 0.35$

$$\underbrace{\Sigma F_x}_{} = T_x - f_K$$

$$m a_x = T\cos\theta - \mu_K N$$

$$\cancel{m} a_x = \frac{T\cos\theta - \mu_K(mg - T\sin\theta)}{m}$$

$$a_x = \frac{T(\cos\theta + \mu_K\sin\theta) - \mu_K mg}{m}$$

$$= \frac{304.2\,N(\cos 15^\circ + 0.35\sin 15^\circ) - 0.35(68kg)(9.8\,m/s^2)}{68kg}$$

$$= \boxed{1.296\ m/s^2}$$

80
(71)

[redacted]

80 A 5.00 kg stone is rubbed across the horizontal ceiling of a cave passageway (Fig. 6-56). If the coefficient of kinetic friction is 0.65 and the force applied to the stone is angled at $\theta = 70.0°$, what must the magnitude of the force be for the stone to move at constant velocity?

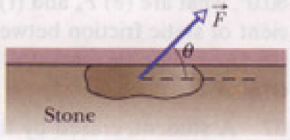
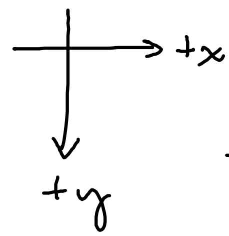
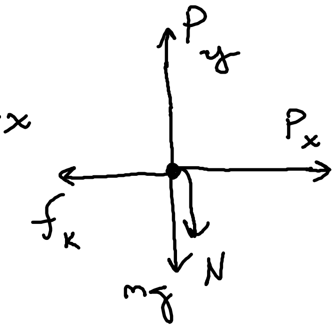


FIG. 6-56 Problem 80.





P ≡ applied "rubbing" force

$$\Sigma F_y = N + mg - P_y$$

$$0 \; \cancel{ma_y} = N + mg - P\sin\theta \Longrightarrow N = P\sin\theta - mg$$

$$\Sigma F_x = P_x - f_k$$

$$0 \; \cancel{ma_x} = P\cos\theta - \mu_k N = P\cos\theta - \mu_k(P\sin\theta - mg)$$

thus, $P\cos\theta - P\mu_k\sin\theta + \mu_k mg = 0$

$$P(\cos\theta - \mu_k\sin\theta) = -\mu_k mg$$

$$P = \frac{-\mu_k mg}{\cos\theta - \mu_k\sin\theta} = \frac{-0.65(5kg)(9.8\,m/s^2)}{\cos70° - 0.65\sin70°}$$

$$= \boxed{118N}$$

96
(66)

96 In Fig. 6-61, block 1 of mass $m_1 = 2.0$ kg and block 2 of mass $m_2 = 1.0$ kg are connected by a string of negligible mass. Block 2 is pushed by force $\vec{F}$ of magnitude 20 N and angle $\theta = 35°$. The coefficient of kinetic friction between each block and the horizontal surface is 0.20. What is the tension in the string?

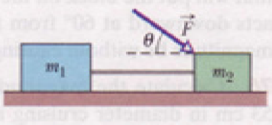
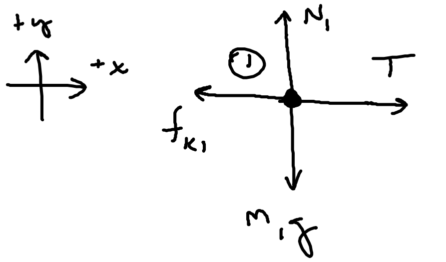
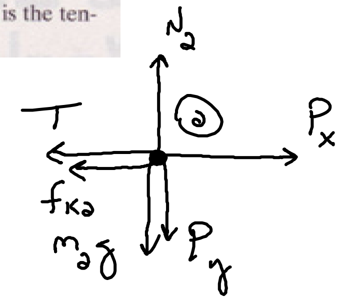


FIG. 6-61 Problem 96.

let P be the pushing force





$$\underbrace{\Sigma F_y}_{0} = N_1 - m_1 g$$

$$0 = N_1 - m_1 g \Rightarrow N_1 = m_1 g$$

$$\underbrace{\Sigma F_x}_{m_1 a} = T - f_{K1}$$

$$m_1 a = T - \mu_K N_1$$

$$\underbrace{\Sigma F_y}_{0} = N_2 - P_y - m_2 g$$

$$0 = N_2 - P\sin\theta - m_2 g$$

$$N_2 = P\sin\theta + m_2 g$$

$$\underbrace{\Sigma F_x}_{m_2 a} = P_x - T - f_{K2}$$

$$m_2 a = P\cos\theta - T - \mu_K N_2$$

$$m_1 a = T - \mu_K N_1$$

$$m_2 a = -T - \mu_K N_2 + P\cos\theta$$

$$(m_1 + m_2) a = P\cos\theta - \mu_K N_1 - \mu_K N_2$$

$$a = \frac{P\cos\theta - \mu_K (N_1 + N_2)}{m_1 + m_2}$$

$$a = \frac{P\cos\theta - \mu_K (m_1 g + P\sin\theta + m_2 g)}{m_1 + m_2}$$

$$a = \frac{P(\cos\theta - \mu_K \sin\theta) - \mu_K g(m_1 + m_2)}{}$$

$$\overline{m_1 + m_2}$$

$$= \boxed{\frac{P(\cos\theta - \mu_k \sin\theta)}{m_1 + m_2} - \mu_k g}$$

$$= \frac{20N\left(\cos 35° - 0.2\sin 35°\right)}{2kg + 1kg} - 0.2\left(9.8\,m/s^2\right)$$

$$= 2.736\,m/s^2$$

then, $m_1 a = T - \mu_k N_1$

$$T = m_1 a + \mu_k m_1 g$$

$$= 2kg\left(2.736\,m/s^2\right) + 0.2\left(2kg\right)\left(9.8\,m/s^2\right)$$

$$= \boxed{9.392\,N}$$

65 (61)

65 A block of mass $m_t = 4.0$ kg is put on top of a block of mass $m_b = 5.0$ kg. To cause the top block to slip on the bottom one while the bottom one is held fixed, a horizontal force of at least 12 N must be applied to the top block. The assembly of blocks is now placed on a horizontal, frictionless table (Fig. 6-51). Find the magnitudes of (a) the maximum horizontal force $\vec{F}$ that can be applied to the lower block so that the blocks will move together and (b) the resulting acceleration of the blocks. SSM

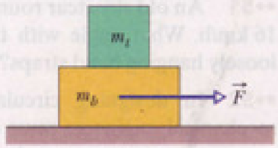
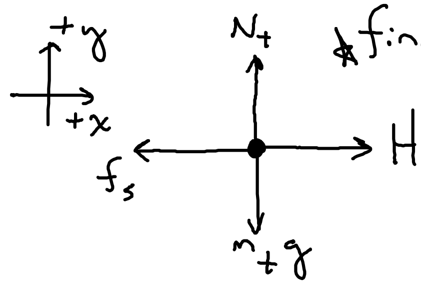


FIG. 6-51 Problem 65.



★ find μ_s first ★

$m_t \equiv$ mass on top

$m_b \equiv$ mass on bottom

$H \equiv$ force from 1st part of problem

$$\underbrace{\Sigma F_y}_{0} = N_t - m_t g$$

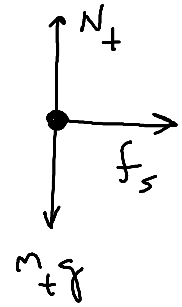
$$0 = N_t - m_t g \Rightarrow N_t = m_t g$$

$$\underbrace{\Sigma F_x}_{0} = H - f_s$$

$$0 = H - \mu_s N$$

$$\underbrace{\mu_s = \frac{H}{N} = \frac{H}{m_t g} = \frac{12\,N}{(4\,kg)(9.8\,m/s^2)} = \boxed{0.31}}_{}$$

this part is fair-game... the rest will not be on this upcoming test.



f_s is now from the bottom block acting on the top block

$$\underbrace{\Sigma F_x} = f_s$$

$$m_t a = \mu_s N_t$$

$$\cancel{m_t} a = \mu_s \cancel{m_t} g$$

$$a = \mu_s g$$

$$= 0.31 \left(9.8 \, m/s^2\right)$$

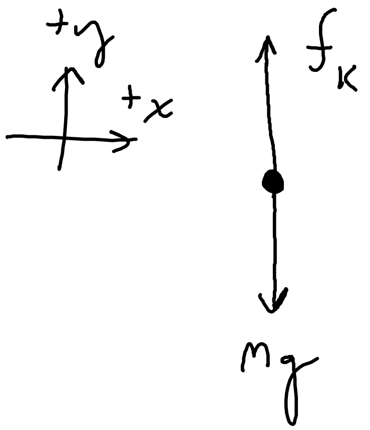
$$= 3 \, m/s^2$$

thus, to yield this acceleration on both masses...

$$m_t + m_b = 9 \, kg \implies F = ma$$

$$= (9 \, kg)(3 \, m/s^2) = 27 \, N$$

A stone falls towards the ground and reaches terminal velocity. If the mass of the stone is 8 kg, what's the magnitude of air friction at terminal velocity?



$$\Sigma F_y = f_K - mg$$

$$0 \quad \cancel{ma} = f_K - mg$$

$$f_K = mg$$

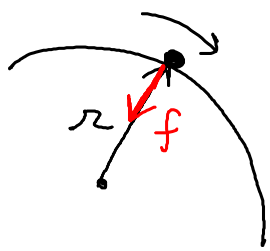
$$= (8\,kg)(9.8\,m/s^2)$$

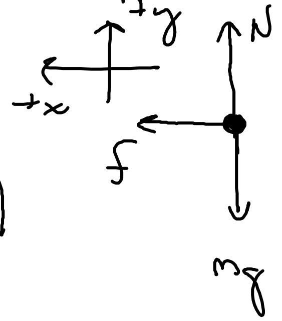
$$= 78.4\,N$$

A car rounds a circular turn of radius 75 m at a speed of 20 m/s. The car's mass is 240 kg.

(a) What frictional force is required to maintain the circular motion?

(b) What is μ? Is it static or kinetic?





$$\underbrace{\Sigma F_y}_{} = N - mg$$

$$0 = N - mg \Rightarrow N = mg$$

$$\underbrace{\Sigma F_x}_{} = f$$

$$m a_c = f$$

$$m\frac{v^2}{r} = f$$

$$\frac{(240\,kg)(20\,m/s)^2}{75\,m} = f$$

$$f = 1280\,N$$

$$f = \mu N \Rightarrow \mu = \frac{f}{N}$$

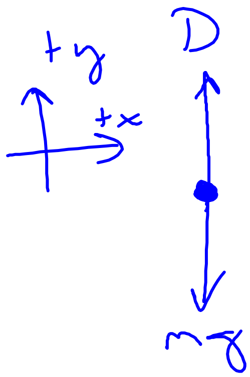
$$\mu = \frac{f}{mg}$$

$$= 1280\,N$$

$$\overline{(240\,kg)(9.8\,m/s^2)}$$

$$= \boxed{0.54}$$

A brick ($m = 10\,\text{kg}$) and feather ($m = 0.01\,\text{kg}$) are dropped in the presence of air friction and both eventually reach terminal velocity. What is the $\underbrace{\text{force of air friction}}_{\equiv D}$ on each object at terminal velocity?



$$\underbrace{\Sigma F_y} = D - mg$$

$$\cancelto{0}{ma} = D - mg$$

$$D = mg$$

brick

$D = 98\,\text{N}$

feather

$D = 0.098\,\text{N}$

HOMEWORK

study