08 FEB 10

- Reading Check
- HW Q & A
- static friction
- LAB: Determine μ_s

2 (4)

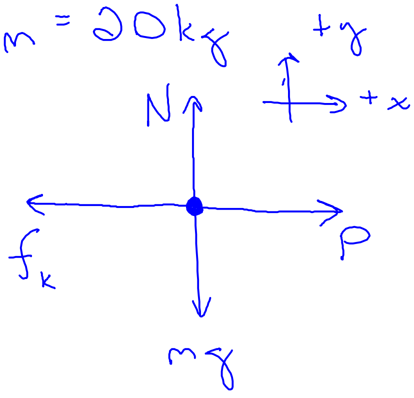
•2 *The mysterious sliding stones.* Along the remote Racetrack Playa in Death Valley, California, stones sometimes gouge out prominent trails in the desert floor, as if the stones had been migrating (Fig. 6-19). For years curiosity mounted about why the stones moved. One explanation was that strong winds during occasional rainstorms would drag the rough stones over ground softened by rain. When the desert dried out, the trails behind the stones were hard-baked in place. According to measurements, the coefficient of kinetic friction between the stones and the wet playa ground is about 0.80. What horizontal force must act on a 20 kg stone (a typical mass) to maintain the stone's motion once a gust has started it moving? (Story continues with Problem 39.)

FIG. 6-19 Problem 2. What moved the stone? *(Jerry Schad/Photo Researchers)*

P = wind force

$\mu_k = 0.8$

$m = 20\,kg$



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

$$0 = N - mg$$

$$N = mg$$

to find minimum force required to keep it sliding (constant nonzero velocity)

$$\underbrace{\Sigma F_x}_{0 \cancel{ma}} = P - f_k$$

$$0 \cancel{ma} = P - f_k \Longrightarrow P = f_k$$

$$= \mu_k N$$

$$= \mu_k m g$$

$$P_{min} = 0.8\,(20\,kg)(9.8\,m/s^2)$$

$$= \boxed{156.8\,N}$$

25
(23)

••25 When the three blocks in Fig. 6-33 are released from rest, they accelerate with a magnitude of 0.500 m/s². Block 1 has mass M, block 2 has $2M$, and block 3 has $2M$. What is the coefficient of kinetic friction between block 2 and the table?

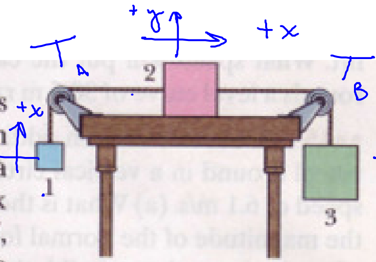
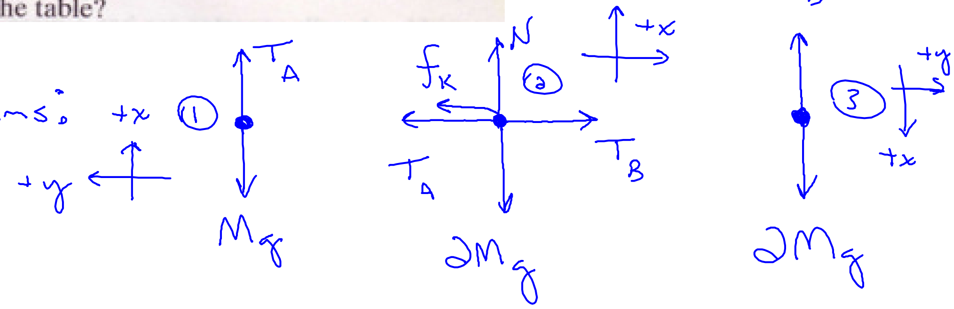


FIG. 6-33 Problem 25

free body diagrams:



① $\Sigma F_y = 0$

$\underbrace{\Sigma F_x} = T_A - Mg$

$\boxed{Ma = T_A - Mg}$

② $\underbrace{\Sigma F_y} = N - 2Mg$

$0 = N - 2Mg$

$N = 2Mg$

$\underbrace{\Sigma F_x} = T_B - T_A - f_k$

$2Ma = T_B - T_A - \mu_k N$

$\boxed{2Ma = T_B - T_A - \mu_k \cdot 2Mg}$

③ $\Sigma F_y = 0$

$\underbrace{\Sigma F_x} = 2Mg - T_B$

$\boxed{2Ma = 2Mg - T_B}$

$$Ma = \cancel{T_A} - Mg$$
$$2Ma = \cancel{T_B} \cancel{- T_A} - 2\mu_k Mg$$
$$+ \quad 2Ma = 2Mg \cancel{- T_B}$$

$$5\cancel{M}a = 1\cancel{M}g - 2\mu_k \cancel{M}g$$

$$\frac{5a}{g} = \frac{\cancel{g}}{\cancel{g}} - \frac{2\mu_k \cancel{g}}{\cancel{g}}$$

$$\frac{5a}{g} = 1 - 2\mu_k$$

$$\left(\frac{-1}{2}\right)\frac{5a}{g} - 1\left(\frac{-1}{2}\right) = \left(\frac{-1}{2}\right) - 2\mu_k \Longrightarrow \frac{1}{2} - \frac{5a}{2g} = \mu_k$$

$$\boxed{\mu_k = \frac{1}{2} - \frac{5a}{2g}}$$

$$\mu_k = \frac{1}{2} - \frac{5(0.5\,m/s^2)}{2(9.8\,m/s^2)} = \boxed{0.372}$$

63
(57)

63 In Fig. 6-49, the coefficient of kinetic friction between the block and inclined plane is 0.20, and angle θ is 60°. What are the (a) magnitude a and (b) direction (up or down the plane) of the block's acceleration if the block is sliding down the plane? What are (c) a and (d) the direction if the block is sent sliding up the plane?

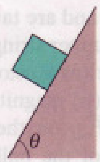
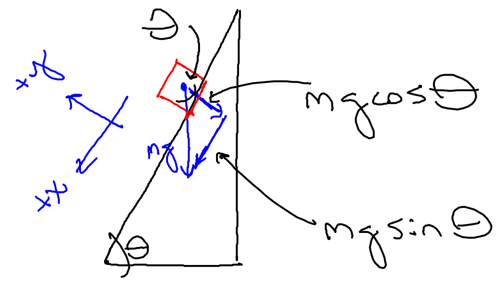
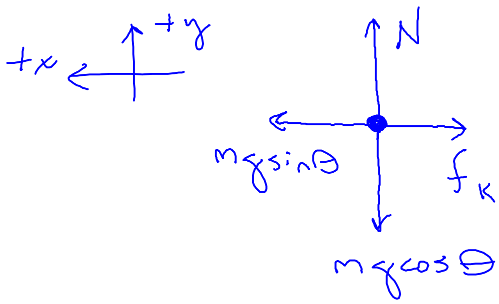


FIG. 6-49 Problem 63.





$\mu_k = 0.20$
$\theta = 60°$

(a) & (b)

$$\underbrace{\sum F_y}_{0} = N - mg\cos\theta$$

$$0 = N - mg\cos\theta \Longrightarrow \boxed{N = mg\cos\theta}$$

$$\underbrace{\sum F_x}_{ma} = mg\sin\theta - f_k$$

$$ma = mg\sin\theta - \mu_k N$$

$$\cancel{m} a = \cancel{m} g\sin\theta - \mu_k \cancel{m} g\cos\theta$$

$$a = g\sin\theta - \mu_k g\cos\theta = (\sin\theta - \mu_k\cos\theta)g$$

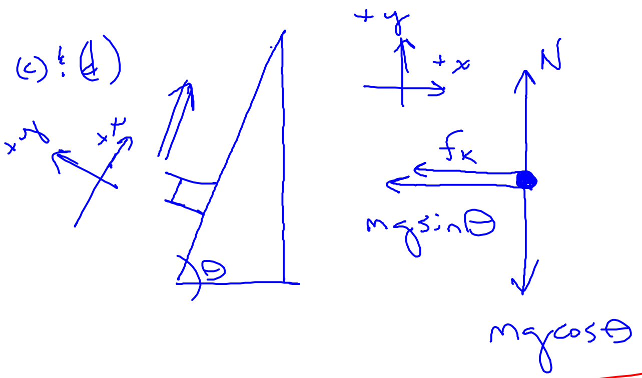
$$= (\sin 60° - 0.2\cos 60°)(9.8\,m/s^2)$$

$$= 7.507\,m/s^2$$

$\therefore$ the acceleration has magnitude $7.507\,m/s^2$ directed "down" the incline

or, $\vec{a} = +7.507\,m/s^2\,\hat{x}$

(c) & (d)



$$N = mg\cos\theta$$

$$\underbrace{\sum F_x}_{ma} = -mg\sin\theta - f_K$$

$$ma = -mg\sin\theta - \mu_K N$$

$$\cancel{m}a = -\cancel{m}g\sin\theta - \mu_K \cancel{m}g\cos\theta$$

$$a = -g\sin\theta - \mu_K g\cos\theta$$

$$= -(\sin\theta + \mu_K\cos\theta)g$$

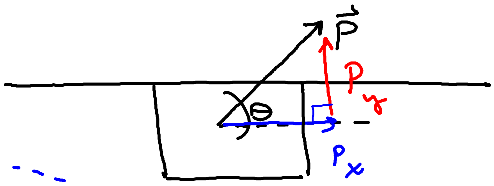
$$= \boxed{-9.467\ m/s^2}$$

the sign here is a matter of "style". Leave it as is and the sign resulting will give direction. Insert the sign beforehand and you'll get just the magnitude... at the end you'll need to interpret the direction.

∴ the acceleration has "magnitude $9.467\ m/s^2$ directed "down" the incline.

87

(90)

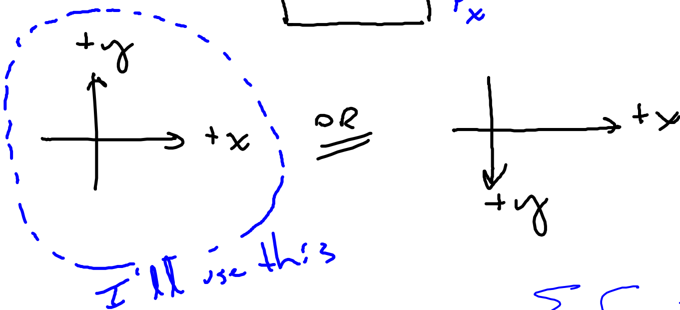


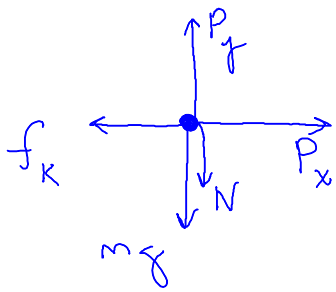
$\theta = 70^\circ$

$m = 5\,\text{kg}$

$\|\vec{P}\| = 80\,\text{N}$

$\mu_k = 0.40$





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

$$0 = P\sin\theta - mg - N$$

$$N = P\sin\theta - mg$$

$$\underbrace{\Sigma F_x}_{ma} = P_x - f_k$$

$$ma = P\cos\theta - \mu_k N$$

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

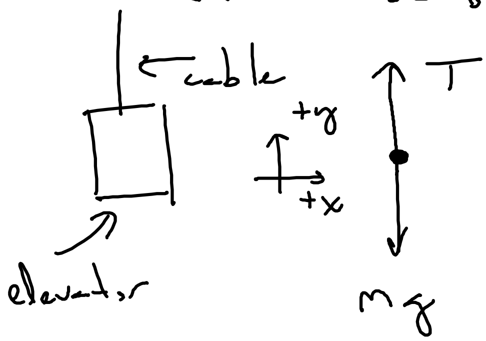
$$a = \frac{P\cos\theta - \mu_k\left(P\sin\theta - mg\right)}{m}$$

$$a = \frac{80\,\text{N}\cos 70^\circ - 0.4\left[80\,\text{N}\sin 70^\circ - (5.0\,\text{kg})(9.8\,\text{m/s}^2)\right]}{5.0\,\text{kg}}$$

$$\boxed{\vec{a} = +3.378\,\text{m/s}^2\ \hat{x}}$$

THE ELEVATOR

TRIVIAL CASE: $a = 0$, velocity could be either zero or nonzero

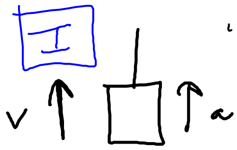


$$\underbrace{\Sigma F_y} = T - mg$$

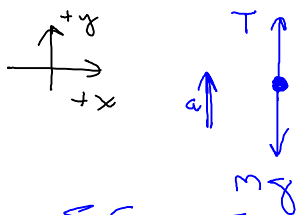
$$0 \leftarrow \cancel{ma} = T - mg$$

$$\boxed{T = mg}$$

I



"moving up and speeding up"

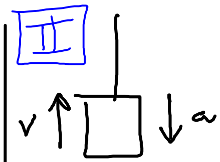


$$\underbrace{\Sigma F_y}_{+ma} = T - mg$$

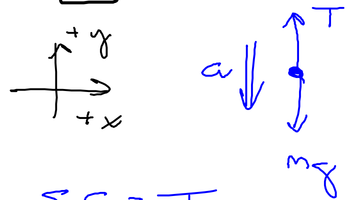
$$+ma = T - mg \Rightarrow \boxed{T = ma + mg}$$

$$T > mg$$

II



"moving up and slowing down"

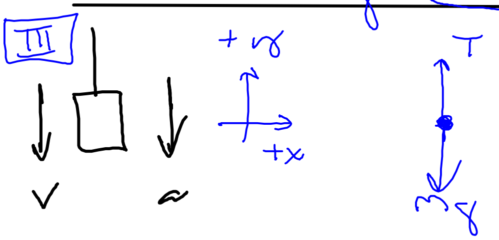


$$\underbrace{\Sigma F_y}_{-ma} = T - mg$$

$$-ma = T - mg \Rightarrow \boxed{T = mg - ma}$$

$$T < mg$$

III



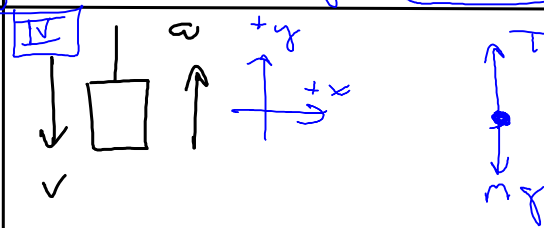
$$\underbrace{\Sigma F_y}_{-ma} = T - mg$$

$$-ma = T - mg$$

$$\boxed{T = mg - ma}$$

$$T < mg$$

IV



$$\underbrace{\Sigma F_y}_{+ma} = T - mg$$

$$+ma = T - mg$$

$$\boxed{T = mg + ma}$$

$$T > mg$$

finally, if the elevator is in free fall,

$$T = 0$$

#1

8N exerted for 4s on 16kg object initially at rest. Find change in velocity.

$$F = ma \Longrightarrow a = \frac{F}{m} = \frac{8\,N}{16\,kg} = \frac{1}{2}\,\frac{m}{s^2}$$

$$v_0 = 0\ m/s$$

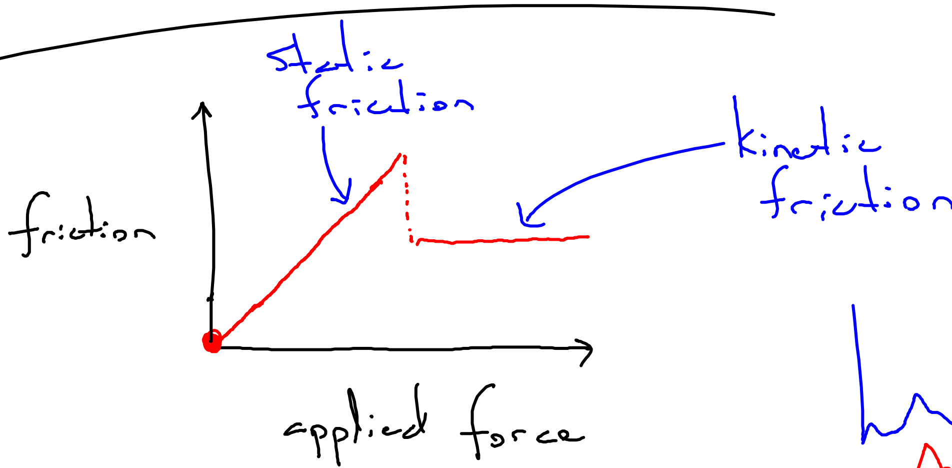
$$a = \frac{v - \cancel{v_0}^{\,0}}{t} \Longrightarrow a = \frac{v}{t} \Longrightarrow v = at$$

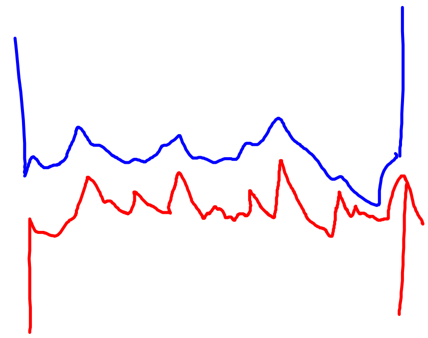
$$= \left(\frac{1}{2}\,m/s^2\right)(4\,s)$$

$$v = 2\ m/s$$

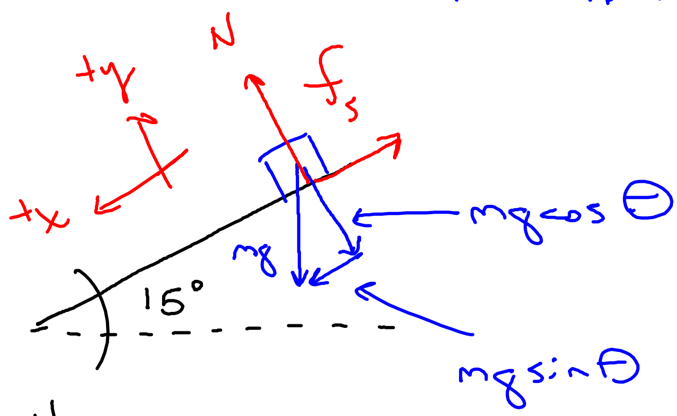
$$\Delta v = v - v_0 = 2\ m/s - 0\ m/s = \boxed{+2\ m/s}$$

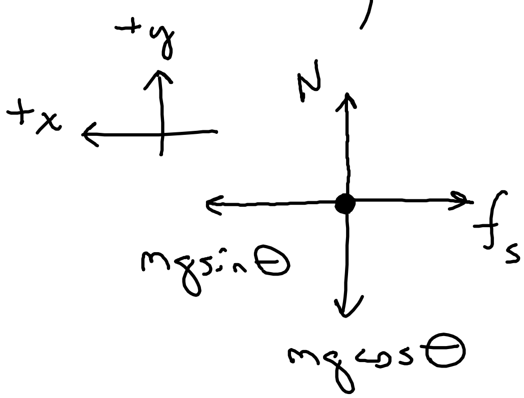
STATIC FRICTION





$m = 1.9\text{ kg}$





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

$$0 = N - mg\cos\theta$$

$$N = mg\cos\theta$$

$$\underbrace{\Sigma F_x}_{} = mg\sin\theta - f_s$$

$$0 = mg\sin\theta - \mu_s N$$

$$0 = mg\sin\theta - \mu_s mg\cos\theta$$

$$\frac{\mu_s \cancel{m}\cancel{g}\cos\theta}{\cos\theta} = \frac{\cancel{m}\cancel{g}\sin\theta}{\cos\theta}$$

$\mu_s = \tan\theta$ at the

the θ is really threshold

θ_{max}

let's say it transitions from static case to kinetic case when $\theta = 15°$

$$\mu_s = \tan(15°) = 0.268$$

$$f_s \leq mg\sin\theta$$

Homework

HRW Chapter 6 problems

13 80 96 65

(13) (71) (66) (61)