Module 5-1. P5. 3

•3 If the 1 kg standard body has an acceleration of 2.00 m/s^2 at 20.0° to the positive direction of an x axis, what are (a) the x component and (b) the y component of the net force acting on the body, and (c) what is the net force in unit-vector notation?

M=1kg, a=2m/s^2 at θ (to +x) = 20˚

(a) X component, Newton's second law:
$F_{\text{net},\,x} = ma_x$ = ma cos20.0˚ =(1.00kg)(2.00m/s^2) cos20.0˚=1.88N.

(b) The y component : $F_y = ma_y = ma \sin 20.0° = (1.0\,\text{kg})\left(2.00\,\text{m/s}^2\right)\sin 20.0° = 0.684\,\text{N}.$

(c) In unit-vector notation, the force vector is

$$\vec{F} = F_x\hat{\text{i}} + F_y\hat{\text{j}} = (1.88\ \text{N})\hat{\text{i}} + (0.684\ \text{N})\hat{\text{j}}$$

Module 5-2, P. 5. 13

which four disks are suspended by cords. The longer, top cord loops over a frictionless pulley and pulls with a force of magnitude 98 N on the wall to which it is attached. The tensions in the three shorter cords are $T_1 = 58.8$ N, $T_2 = 49.0$ N, and $T_3 = 9.8$ N. What are the masses of (a) disk A, (b) disk B, (c) disk C, and (d) disk D?

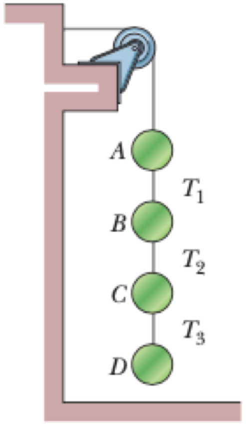


Figure 5-33

4 disks, frictionless pully pulls with F=98N,
T1=58.8N, T2=49.0N, T3=9.8N.
Masses of disks?
($a=g=9.8 m/s^2$, $W=F_g=ma$)

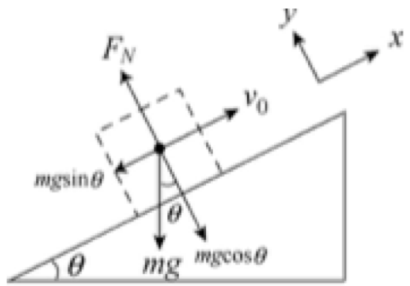
T3=9.8N=$m_D g$, then m_D =9.8/9.8=1kg

(a) m_A is 4.0 kg ($T_{all} - T_1 = m_A g$, then m_A= (98–58.8)/9.8=4)
(b) m_B = 1.0 kg ($T_1 - T_2 = m_B g$, then m_B= (58.8–49.0)/9.8=1)
(c) m_C = 4.0 kg ($T_2 - T_3 = m_C g$, then m_C= (49.0–9.8)/9.8=4)
(d) m_D = 1.0 kg

Module 5-3, P. 5. 31

A block is projected up a frictionless plane with v_0 = 3.50 m/s. θ of incline = 32.0˚.

(a) How far up the plane does the block go?
(b) How long does it take to get there?
(c) What is its speed when it gets back to the bottom?



The x component of Newton's second law is then:
mg sin θ = –ma; thus, acceleration =a = – g sin θ.

the kinematic equations (Table 2-1) for motion along the x axis which we will use are $v^2 = v_0^2 + 2ax$ and $v = v_0 + at$.
The block momentarily stops at its highest point, where v = 0, according to the second equation, this occurs at time $t = -v_0/a$.
(a) The position where the block stops is

$$x = v_0 t + \frac{1}{2}at^2 = v_0\left(\frac{-v_0}{a}\right) + \frac{1}{2}a\left(\frac{-v_0}{a}\right)^2 = -\frac{1}{2}\frac{v_0^2}{a} = -\frac{1}{2}\left(\frac{(3.50 \text{ m/s})^2}{-(9.8 \text{ m/s}^2)\sin 32.0°}\right) = 1.18 \text{ m}$$

(b) The time it takes for the block to get there is

$$t = \frac{v_0}{a} = -\frac{v_0}{-g\sin\theta} = -\frac{3.50\text{m/s}}{-(9.8\text{m/s}^2)\sin 32.0°} = 0.674 \text{ s}.$$

Module 5-3, P. 5. 31

(c) return speed is identical to the initial speed

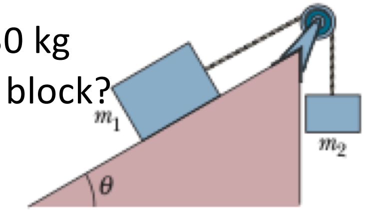
$$t=-\frac{2v_0}{a}=-\frac{2v_0}{-g\sin\theta}=-\frac{2(3.50\text{ m/s})}{-(9.8\text{ m/s}^2)\sin 32.0^\circ}=1.35\text{ s}.$$

The velocity when it returns is:

$$v=v_0+at=v_0-gt\sin\theta=3.50\text{ m/s}-(9.8\text{ m/s}^2)(1.35\text{ s})\sin 32^\circ=-3.50\text{ m/s}$$

The direction is down the plane.

••57 ILW A block of mass $m_1 = 3.70$ kg on a frictionless plane inclined at angle $\theta = 30.0°$ is connected by a cord over a massless, frictionless pulley to a second block of mass $m_2 = 2.30$ kg (Fig. 5-52). What are (a) the magnitude of the acceleration of each block, (b) the direction of the acceleration of the hanging block, and (c) the tension in the cord?

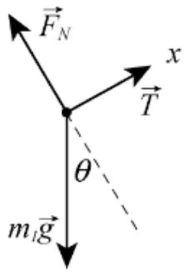


m1=3.70 kg, θ=30.0˚, m2=2.30 kg

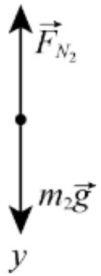
(a) Magnitude of ‘a’ for each block?

Free body diagram for each:

m1:



m2:



We take +y to be down direction for block m2, In this way, the accelerations of the two blocks can be represented by the same symbol ‘a’.

$$T - m_1 g \sin\theta = m_1 a$$
$$F_N - m_1 g \cos\theta = 0$$
$$m_2 g - T = m_2 a$$

2nd equation is not needed

Take first and third equations:

$$m_2 g - m_1 g \sin\theta = m_1 a + m_2 a.$$

$$a = \frac{(m_2 - m_1 \sin\theta)g}{m_1 + m_2} = \frac{[2.30\text{ kg} - (3.70\text{ kg})\sin 30.0°](9.80\text{ m/s}^2)}{3.70\text{ kg} + 2.30\text{ kg}} = 0.735\text{m/s}^2$$

(b) Direction of a for hanging block?

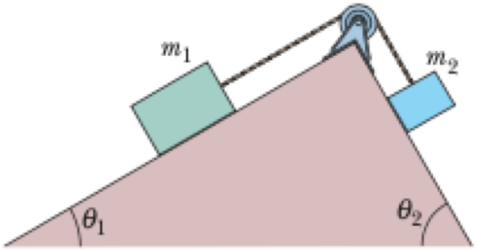
the acceleration of block 2 is vertically down.

(c) Tension in the cord?

$$T = m_1 a + m_1 g \sin\theta =$$
$$(3.70\text{ kg})(0.735\text{ m/s}^2) + (3.70\text{ kg})(9.80\text{ m/s}^2)\sin 30.0° = 20.8\text{N}$$

71 **SSM** Figure 5-60 shows a box of dirty money (mass $m_1 = 3.0$ kg) on a frictionless plane inclined at angle $\theta_1 = 30°$. The box is connected via a cord of negligible mass to a box of laundered money (mass $m_2 = 2.0$ kg) on a frictionless plane inclined at angle $\theta_2 = 60°$. The pulley is frictionless and has negligible mass. What is the tension in the cord?

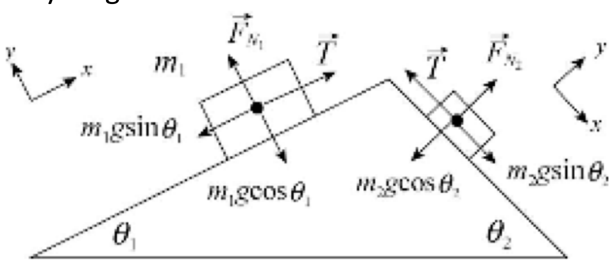
tension in the cord ?



We take +x axis "uphill" for m1 = 3.0 kg and "downhill" for m2 = 2.0 kg (so they both accelerate with the same sign)

x components of the two masses m1g sinθ1 and m2 g sinθ2

free-body diagram:



$$\begin{aligned} T - m_1 g \sin\theta_1 &= m_1 a \\ m_2 g \sin\theta_2 - T &= m_2 a \end{aligned} \quad \Rightarrow \quad a = \left(\frac{m_2 \sin\theta_2 - m_1 \sin\theta_1}{m_2 + m_1} \right) g$$

a = 0.45 m/s^2 .

Substitute back to find T:

$$T = \frac{m_1 m_2 g}{m_2 + m_1} (\sin\theta_2 + \sin\theta_1) = 16.1\ \text{N}$$