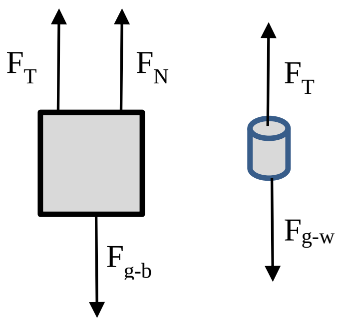
GIANCOLI HOMEWORK SOLUTIONS

Section 4-7, #19-32



19.

a. $F_T = F_{g-w} = 30N$

$F_{g-b} = 77N$

$F_N + F_T = F_{F_{g-b}}$

$F_N = F_{F_{g-b}} - F_T$

$F_N = 77 - 30 = 47N$

b. $F_T = F_{g-w} = 30N$

$F_{g-b} = 77N$

$F_N + F_T = F_{F_{g-b}}$

$F_N = F_{F_{g-b}} - F_T$

$F_N = 77 - 60 = 17N$

c. $F_T = F_{g-w} = 30N$

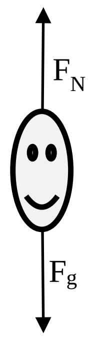
$F_{g-b} = 77N$

$F_N + F_T = F_{F_{g-b}}$

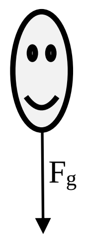
$F_N = F_{F_{g-b}} - F_T$

$F_N = 77 - 90 = 0N$, *This is because the tension is greater than the weight of the box so it will, in fact, start moving upward.*

20. .

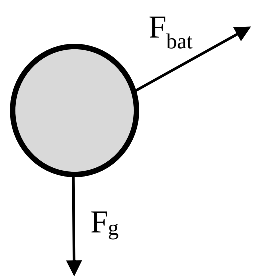


a.

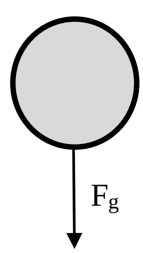


b.

21. Assume air resistance is negligible, so the only forces are weight and the bat.

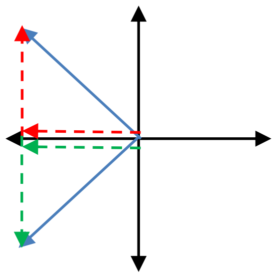


a.

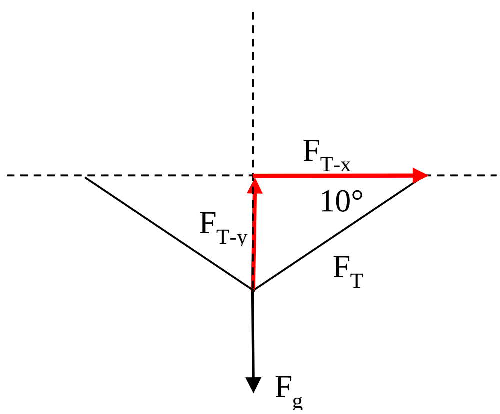


b.

22. *If the second vector is southwesterly, the y-components will cancel out and the x-components will add together.*



23. *The y-component of the tension force on each side of the tightrope walker (2 of them) supports the weight of the walker.*



$$F_g = mg = (50)(9.81) = 491N$$

$$2F_{T-y} = F_g$$

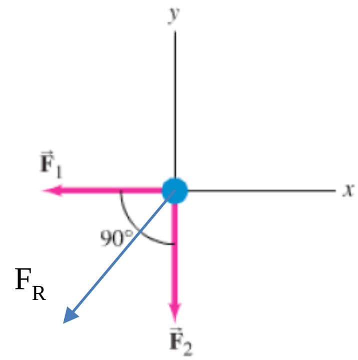
$$\sin 10° = \frac{F_{T-y}}{F_T}$$

$$F_T \sin 10° = F_{T-y}$$

$$2\,F_T \sin 10° = F_g$$

$$F_T = \frac{F_g}{2\sin 10°} == \frac{491}{2\sin 10°} = 1.41x10^3 N$$

24.



(a)

a. $m = 27.0kg$

$$F_1 = 10.2$$

$$F_{1x} = -10.2$$

$$F_{1y} = 0$$

$$F_2 = 16.0$$

$$F_{2x} = 0$$

$$F_{2y} = -16.0$$

$$R_x = F_{1x} + F_{2x} = -10.2 + 0 = -10.2$$

$$R_y = F_{1y} + F_{2y} = 0 + -16.0 = -16.0$$

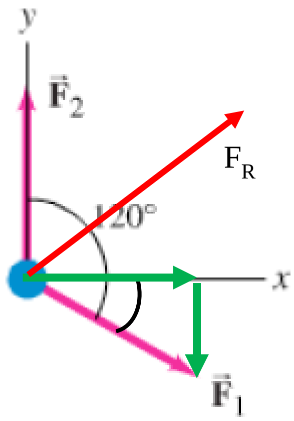
$$R = \sqrt{{R_x}^2 + {R_y}^2} = 19.0N$$

$$\tan\theta = \frac{R_y}{R_x}$$

$\theta = \tan^{-1}\frac{R_y}{R_x} = \tan^{-1}\frac{-16.0}{-10.2} =$ 57° below negative x-axis

$$F = ma$$

$$\frac{F}{m} = a = \frac{19.0}{27.0} = 0.703\,m/s^2$$



b. $m = 27.0kg$

$F_1 = 10.2$

$F_{1x} = 10.2\cos 30° = 8.83$

$F_{1y} = 10.2\sin 30° = -5.10$

$F_2 = 16.0$

$F_{2x} = 0$

$F_{2y} = 16.0$

$R_x = F_{1x} + F_{2x} = 8.83 + 0 = 8.83$

$R_y = F_{1y} + F_{2y} = -5.10 + 16.0 = 10.9$

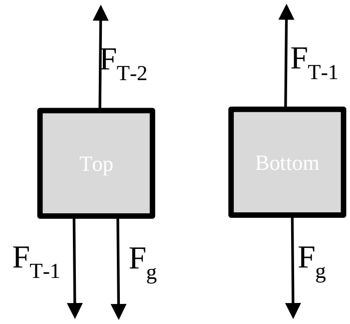
$R = \sqrt{{R_x}^2 + {R_y}^2} = 14.0N$

$\tan\theta = \frac{R_y}{R_x}$

$\theta = \tan^{-1}\frac{R_y}{R_x} = \tan^{-1}\frac{10.9}{8.83} =$ 51.0° above positive x-axis

$F = ma$

$\frac{F}{m} = a = \frac{14.0}{27.0} = 0.519\, m/s^2$



25. $m = 3.2kg$

a. $F_{T-1} = F_g = mg = (3.2)(9.81) = 31.4\text{N}$

$F_{T-2} = F_g + F_{T-1} = mg + F_{T-1}$

$F_{T-2} = (3.2)(9.81) + 31.4 = 62.8N$

$F_{T-1} = F_g = mg = (3.2)(9.81) = 31.4N$

$F_{T-2} = F_g + F_{T-1} = mg + F_{T-1}$

$F_{T-2} = (3.2)(9.81) + 31.4 = 62.8N$

b. $a = 1.60\, m/s^2$

$F_{T-1} - F_g = ma$

$F_{T-1} = ma + F_g$

$F_{T-1} = (3.2)(1.60) + (3.2)(9.81) = 36.5N$

$F_{T-2} - F_{T-1} - F_g = ma$

$F_{T-2} = ma + F_{T-1} + F_g$

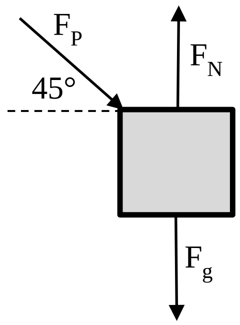
$F_{T-2} = (3.2)(1.60) + 36.5 + (3.2)(9.81)$

$F_{T-2} = 73.0N$

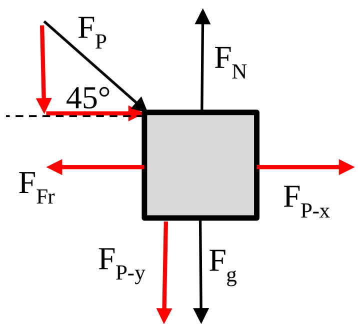
26. $m = 14.0kg$

$F_P = 88.0N$

Constant speed means $a = 0$



a.



b.

If speed is constant, a = 0 and the friction force equals the x-component of the push force

$F_{Fr} = F_{P-x} = F_P \cos 45° = 62.2N$

c. *The normal force of the ground has to support not only the weight of the mower, but also the y-component of the push force*

$F_N = F_g + F_{P-y} = mg + F_P \sin 45°$

$F_N = (14)(9.81) + (88) \sin 45° = 200N$

d. $v = 1.5\, m/s$

$t = 2.5s$

$v = \cancel{v_0 +} at$

$\frac{v}{t} = a = \frac{1.5}{2.5} = 0.6\, m/s^2$

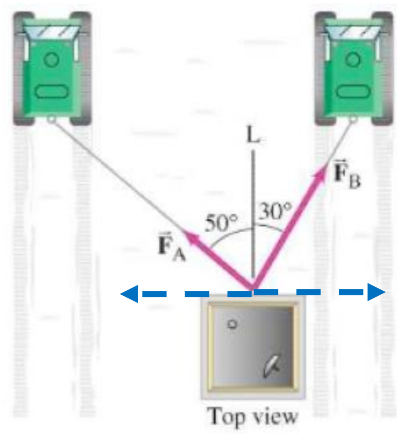
$\sum F = ma$

$F_{P-x} - F_{Fr} = ma$

$F_{P-x} = ma + F_{Fr} = (14)(0.6) + 62.2$

$F_{P-x} = 70.6$

$F_P = \frac{F_{P-x}}{\cos 45°} = \frac{70.6}{\cos 45°} = 99.8N$



27.

In order for the housing unit to travel in a straight line, the x-components of the two pulling forces must be the same so they cancel each other out. The vector sum of the two forces will be the sum or their y-components.

$F_A = 4500N$

$F_{A-x} = F_A \sin 50° = 3447N$

$F_{A-x} = F_{B-x} = 3447N$

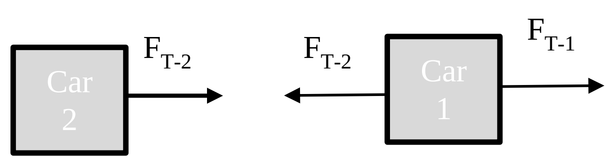
$F_B = \frac{F_{A-x}}{\sin 30°} = \frac{3447}{\sin 30°} = 6894N$

$F_R = F_{A-y} + F_{B-y}$

$F_{A-y} = F_A \cos 50° = 2893N$

$F_{B-y} = F_B \cos 30° = 5970N$

$F_R = 2893 + 5970 = 8863N$



28.

Find: $\frac{F_{T-1}}{F_{T-2}}$

$F_{T-2} = ma$

$F_{T-1} - F_{T-2} = ma$

$F_{T-1} = ma + F_{T-2} = ma + ma = 2ma$

$\frac{F_{T-1}}{F_{T-2}} = \frac{2ma}{ma} = 2$

29. $m = 65kg$

a. *Constant speed means a = 0*

$$F_T = F_P$$

$$F_T + F_P - F_g = 0$$

$$2F_P = F_g$$

$$F_P = \frac{F_g}{2} = \frac{mg}{2}$$

$$F_P = \frac{mg}{2} = \frac{(65)(9.81)}{2} = 319N$$

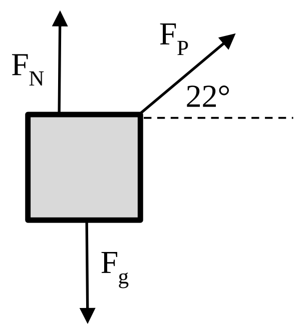
b. $F_{P-new} = 1.15F_P = (1.15)(319) = 367N$

$$F_T = F_P$$

$$F_T + F_P - F_g = ma$$

$$\frac{2F_P - F_g}{m} = a$$

$$\frac{2(367) - (65)(9.81)}{(65)} = a = 1.48\, m/s^2$$



30.

The force exerted on the sprinter by the block is equal to that of the sprinter on the block (3rd Law) which is equal to the x-component of the sprinter's force

$$F_P = 720N$$

$$m = 65kg$$

a. $F_{P-x} = ma$

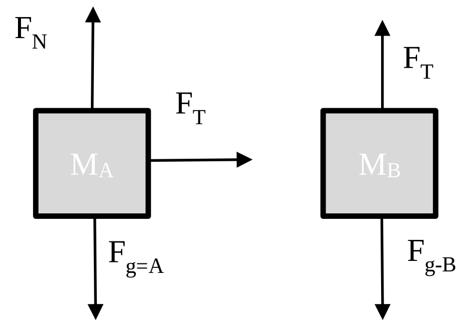
$$F_{P-x} = F_P \cos 22° = 668N$$

$$\frac{F_{P-x}}{m} = a = \frac{668}{65} = 10.3\, m/s^2$$

b. $v = \cancel{v_0 +} at$

$$v = at = (10.3)(0.32) = 3.29\, m/s$$

31.



a.

b. $F_T - F_{g-B} = m_B a$

$$F_T - m_B g = m_B a$$

$$F_T = m_A a$$

Substitute 3rd equation into 2nd

$$m_A a - m_B g = m_B a$$

$$m_A a - m_B a = m_B g$$

$$(m_A - m_B)a = m_B g$$

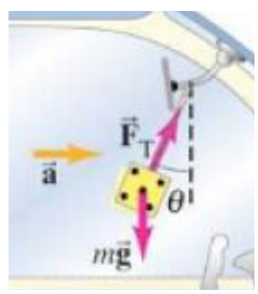
$$a = \frac{m_B g}{(m_A - m_B)}$$

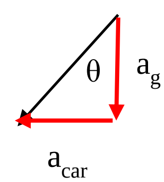
Substitute equation for a into 3rd equation

$$F_T = m_A a$$

$$F_T = m_A\left(\frac{m_B g}{(m_A - m_B)}\right) = \frac{m_A m_B g}{(m_A - m_B)}$$

32.





$$v = 28\, m/s$$

$$t = 6.0s$$

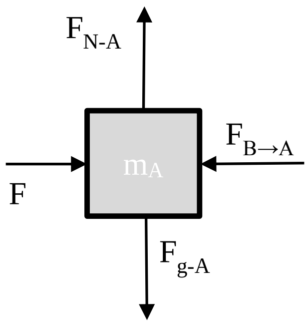
$$v = \cancel{v_0 +} at$$

$$\frac{v}{t} = a = \frac{28}{6.0} = 4.67\, m/s^2$$

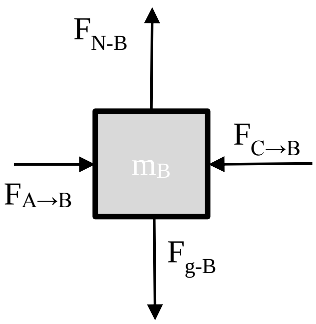
$$\tan\theta = \frac{a_{car}}{a_g}$$

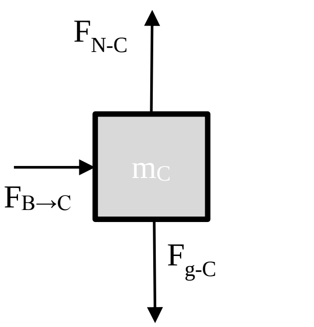
$$\theta = \tan^{-1}\frac{a_{car}}{a_g} = \tan^{-1}\frac{(4.67)}{(9.81)} = 25.4°$$

33.



a.





b. $F - F_{B\to A} = m_A a$

$F_{A\to B} - F_{C\to B} = m_B a$

$F_{B\to C} = m_C a$

$F_{B\to C} = F_{C\to B} = m_C a$

$F_{A\to B} - F_{C\to B} = m_B a$

$F_{A\to B} - m_C a = m_B a$

$F_{A\to B} = m_B a + m_C a$

$F_{A\to B} = F_{B\to A} = m_B a + m_C a$

$F - F_{B\to A} = m_A a$

$F - m_B a - m_C a = m_A a$

$F = m_A a + m_B a + m_C a$

$F = a(m_A + m_B + m_C)$

$$\frac{F}{(m_A + m_B + m_C)} = a$$

c. $F_{netA} = m_A a = m_A \left(\frac{F}{(m_A+m_B+m_C)}\right)$

$$F_{netA} = \frac{m_A F}{(m_A + m_B + m_C)}$$

$F_{netB} = m_B a = m_B \left(\frac{F}{(m_A + m_B + m_C)}\right)$

$$F_{netB} = \frac{m_B F}{(m_A + m_B + m_C)}$$

$F_{netC} = m_C a = m_C \left(\frac{F}{(m_A + m_B + m_C)}\right)$

$$F_{netC} = \frac{m_C F}{(m_A + m_B + m_C)}$$

d. $F_{B\to C} = F_{C\to B} = m_C a$

$F_{B\to C} = F_{C\to B} = m_C \left(\frac{F}{(m_A + m_B + m_C)}\right)$

$$F_{B\to C} = F_{C\to B} = \frac{m_C F}{(m_A + m_B + m_C)}$$

$F_{A\to B} = F_{B\to A} = m_B a + m_C a$

$F_{A\to B} = F_{B\to A} = (m_B + m_C)\left(\frac{F}{(m_A + m_B + m_C)}\right)$

$$F_{A\to B} = F_{B\to A} = \left(\frac{(m_B + m_C)F}{(m_A + m_B + m_C)}\right)$$

e. $F = 96N$

$m_A = m_B = m_B = 12.0kg$

$$\frac{F}{(m_A + m_B + m_C)} = a = 2.67$$

$$F_{netA} = F_{netB} = F_{netC} = \frac{m_A F}{(m_A + m_B + m_C)} 32N$$

$$F_{B\to C} = F_{C\to B} = \frac{m_C F}{(m_A + m_B + m_C)}$$

$$F_{A\to B} = F_{B\to A} = \left(\frac{(m_B + m_C)F}{(m_A + m_B + m_C)}\right) = 64\ N$$

34. $m_1 = 2.2kg$

$m_2 = 3.2kg$

$h = 1.80m$

$F_T - m_1 g = m_1 a$

$F_T - m_2 g = -m_2 a$

Subtract 2nd from 1st

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

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

$$\frac{m_2 g - m_1 g}{(m_1 + m_2)} = a = 1.82\, m/s^2$$

The lighter block will accelerate at the above rate as the heavier block falls 1.8m. At that point, the lighter block will continue upward with the velocity obtained from its acceleration until gravity dissipates it to zero.

$v^2 = \cancel{v_0{}^2 +} 2ay$

$v = \sqrt{2ay}$

$v = \sqrt{2(1.82)(1.8)}$

$v = 2.56\, m/s$

$\cancel{v^2} = v_0{}^2 - 2gy$

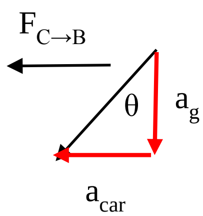
$0 = v_0{}^2 - 2gy$

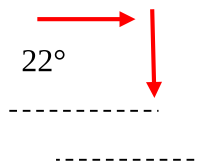
$2gy = v_0{}^2$

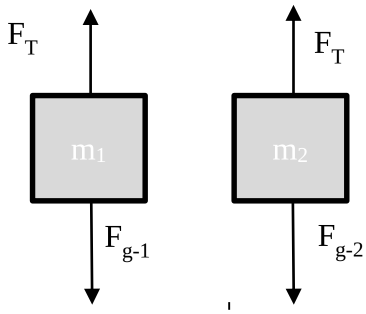
$$y = \frac{v_0{}^2}{2g} = \frac{(2.56)^2}{2(9.81)} = 0.33m$$

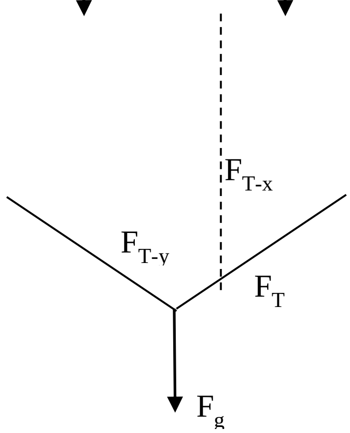
The total height will then be original height (1.8m) plus height gained while accelerating (1.8m) plus height gained dissipating its gained velocity.

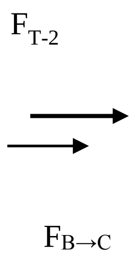
$y = 1.8 + 1.8 + 0.33 = 3.93m$

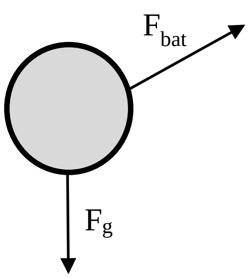

$F_{C\to B}$
θ
a_g
a_{car}


22°


F_T
F_T
m_1
m_2
F_{g-1}
F_{g-2}


F_{T-x}
F_{T-y}
F_T
F_g


F_{T-2}
$F_{B\to C}$


F_{bat}
F_g