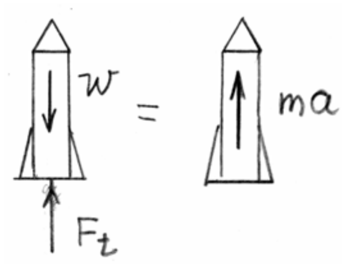
Chapter 12, Solution 9.



For the thrust phase, $+\uparrow \; \Sigma F = ma: \quad F_t - W = ma = \frac{W}{g}a$

$$a = g\left(\frac{F_t}{W} - 1\right) = (32.2)\left(\frac{2}{0.2} - 1\right) = 289.8 \text{ ft/s}^2$$

At $t = 1$ s,

$$v = at = (289.8)(1) = 289.8 \text{ ft/s}$$

$$y = \frac{1}{2}at^2 = \frac{1}{2}(289.8)(1)^2 = 144.9 \text{ ft}$$

For the free flight phase, $t > 1$ s. $a = -g = -32.2$ ft/s

$$v = v_1 + a(t-1) = 289.8 + (-32.2)(t-1)$$

At $v = 0$, $\quad t - 1 = \frac{289.8}{32.2} = 9.00$ s, $\quad t = 10.00$ s

$$v^2 - v_1^2 = 2a(y - y_1) = -2g(y - y_1)$$

$$y - y_1 = -\frac{v^2 - v_1^2}{2g} = -\frac{0 - (289.8)^2}{(2)(32.2)} = 1304.1 \text{ ft}$$

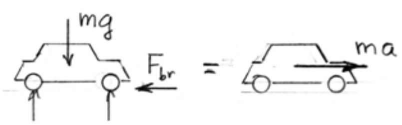
(*a*) $y_{max} = h = 1304.1 + 144.9$ $\qquad h = 1449$ ft ◀

(*b*) As already determined, $\qquad t = 10.00$ s ◀

Chapter 12, Solution 11.

Calculation of braking force/mass (F_b/m) from data for level pavement.

$$v_0 = 100 \text{ km/hr} = 27.778 \text{ m/s}$$



$$\frac{v^2}{2} - \frac{v_0^2}{2} = a(x - x_0)$$

$$a = \frac{v^2 - v_0^2}{2(x - x_0)} = \frac{0 - (27.778)^2}{(2)(60)}$$

$$= -6.43 \text{ m/s}^2$$

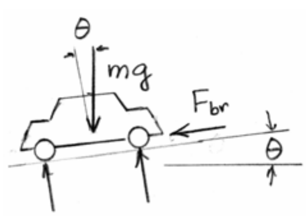
$$\Sigma F_x = ma: \quad -F_{br} = ma$$

$$\frac{F_{br}}{m} = -a = 6.43 \text{ m/s}^2$$

(*a*) Going up a 6° incline. $(\theta = 6°)$

$$+\nearrow \Sigma F = ma: \quad -F_{br} - mg\sin\theta = ma$$

$$a = -\frac{F_{br}}{m} - g\sin\theta$$



$$= -6.43 - 9.81\sin 6° = -7.455 \text{ m/s}^2$$

$$x - x_0 = \frac{v^2 - v_0^2}{2a} = \frac{0 - (27.778)^2}{(2)(-7.455)}$$

$$x - x_0 = 51.7 \text{ m} \blacktriangleleft$$

(*b*) Going down a 2% incline. $(\tan\theta = -0.02, \ \theta = -1.145°)$

$$+\nearrow \Sigma F = ma: \quad -F_{br} - mg\sin\theta = ma$$

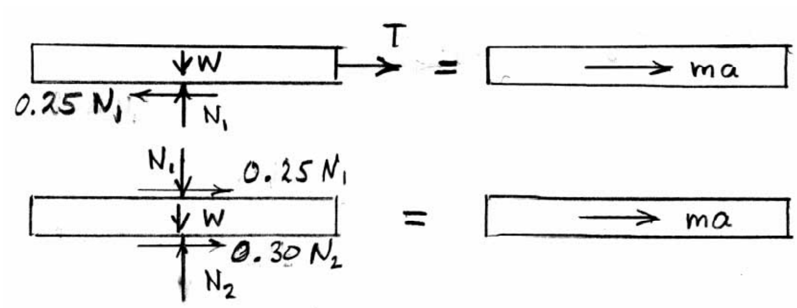
$$a = -\frac{F_{br}}{m} - g\sin\theta$$

$$= -6.43 - 9.81\sin(-1.145°) = -6.234 \text{ m/s}^2$$

$$x - x_0 = \frac{v^2 - v_0^2}{2a} = \frac{0 - (27.778)^2}{(2)(-6.234)} \qquad x - x_0 = 61.9 \text{ m} \blacktriangleleft$$

Chapter 12, Solution 21.

(*a*) Maximum acceleration. The cable secures the upper beam; only the lower beam can move.



For the upper beam, $\Sigma F_y = 0: \quad N_1 - W = 0$

$$N_1 = W = mg$$

For the lower beam, $\Sigma F_y = 0: \quad N_2 - N_1 - W = 0 \quad$ or $\quad N_2 = 2W$

$$\xrightarrow{+} \Sigma F_x = ma: \quad 0.25\, N_1 + 0.30\, N_2 = (0.25 + 0.60)W = ma$$

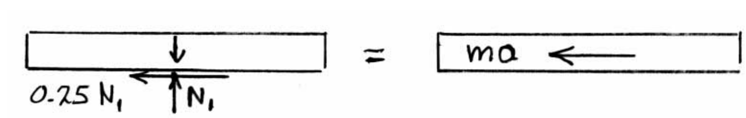
$$a = 0.85\,\frac{W}{m} = (0.85)(32.2) = 23.37 \text{ ft/s}^2 \qquad\qquad \mathbf{a} = 27.4 \text{ ft/s}^2 \longrightarrow \blacktriangleleft$$

For the upper beam, $\xrightarrow{+} \Sigma F_x = ma: \quad T - 0.25\, N_1 = ma$

$$T = 0.25W + ma = (0.25)(3000) + \left(\frac{3000}{32.2}\right)(23.37) = 2927 \text{ lb} \qquad\qquad T = 2930 \text{ lb} \blacktriangleleft$$

(*b*) Maximum deceleration of trailer.

Case 1: Assume that only the top beam slips. As in Part (*a*) $N_1 = mg$.

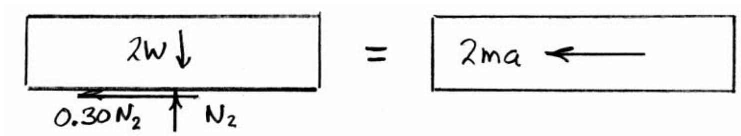


$$\xleftarrow{+} \Sigma F = ma: \quad 0.25W = ma$$

$$a = 0.25g = 8.05 \text{ ft/s}^2$$

continued

Case 2: Assume that both beams slip. As before $N_2 = 2W$.



$$\overset{+}{\leftarrow} \Sigma F = (2m)a: \quad (0.30)(2W) = (2m)a$$

$$a = 0.30g = 9.66 \text{ ft/s}^2$$

The smaller deceleration value governs. $a = 8.05 \text{ ft/s}^2$ ◀