

Halliday ♦ Resnick ♦ Walker

**FUNDAMENTALS OF PHYSICS  
SIXTH EDITION**

Selected Solutions

Chapter 10

10.9

10.29

10.41

29. Let  $m_F$  be the mass of the freight car and  $v_F$  be its initial velocity. Let  $m_C$  be the mass of the caboose and  $v$  be the common final velocity of the two when they are coupled. Conservation of the total momentum of the two-car system leads to  $m_F v_F = (m_F + m_C)v$ , so  $v = v_F m_F / (m_F + m_C)$ . The initial kinetic energy of the system is

$$K_i = \frac{1}{2} m_F v_F^2$$

and the final kinetic energy is

$$K_f = \frac{1}{2} (m_F + m_C) v^2 = \frac{1}{2} (m_F + m_C) \frac{m_F^2 v_F^2}{(m_F + m_C)^2} = \frac{1}{2} \frac{m_F^2 v_F^2}{(m_F + m_C)}.$$

Since 27% of the original kinetic energy is lost, we have  $K_f = 0.73 K_i$ . Thus,

$$\frac{1}{2} \frac{m_F^2 v_F^2}{(m_F + m_C)} = (0.73) \left( \frac{1}{2} m_F v_F^2 \right).$$

Simplifying, we obtain  $m_F / (m_F + m_C) = 0.73$ , which we use in solving for the mass of the caboose:

$$m_C = \frac{0.27}{0.73} m_F = 0.37 m_F = (0.37) (3.18 \times 10^4 \text{ kg}) = 1.18 \times 10^4 \text{ kg}.$$

41. (a) Let  $m_1$  be the mass of the body that is originally moving,  $v_{1i}$  be its velocity before the collision, and  $v_{1f}$  be its velocity after the collision. Let  $m_2$  be the mass of the body that is originally at rest and  $v_{2f}$  be its velocity after the collision. Then, according to Eq. 10-30,

$$v_{1f} = \frac{m_1 - m_2}{m_1 + m_2} v_{1i} .$$

We solve for  $m_2$  to obtain

$$m_2 = \frac{v_{1i} - v_{1f}}{v_{1f} + v_{1i}} m_1 .$$

We combine this with  $v_{1f} = v_{1i}/4$  to obtain  $m_2 = 3m_1/5 = 3(2.0)/5 = 1.2 \text{ kg}$ .

- (b) The speed of the center of mass is

$$v_{\text{com}} = \frac{m_1 v_{1i} + m_2 v_{2i}}{m_1 + m_2} = \frac{(2.0)(4.0)}{2.0 + 1.2} = 2.5 \text{ m/s} .$$