P9.9 $\Delta\vec{p} = \vec{F}\Delta t$

$$\Delta p_y = m\left(v_{fy} - v_{iy}\right) = m(v\cos 60.0°) - mv\cos 60.0° = 0$$

$$\Delta p_x = m(-v\sin 60.0° - v\sin 60.0°) = -2mv\sin 60.0°$$

$$= -2(3.00\ \text{kg})(10.0\ \text{m/s})(0.866)$$

$$= -52.0\ \text{kg}\cdot\text{m/s}$$

$$F_{\text{avg}} = \frac{\Delta p_x}{\Delta t} = \frac{-52.0\ \text{kg}\cdot\text{m/s}}{0.200\ \text{s}} = \boxed{-260\ \text{N}}$$

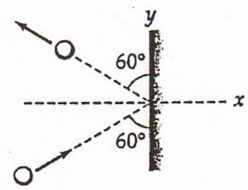


FIG. P9.9

***P9.11** (a) The impulse is to the right and equal to the area under the F-t graph:

$$I = [(0 + 4\ \text{N})/2](2\ \text{s} - 0) + (4\ \text{N})(3\ \text{s} - 2\ \text{s}) + (2\ \text{N})(2\ \text{s}) = \boxed{12.0\ \text{N}\cdot\text{s}\ \hat{\mathbf{i}}}$$

(b) $m\vec{v}_i + \vec{F}t = m\vec{v}_f$ $\quad (2.5\ \text{kg})(0) + 12\ \hat{\mathbf{i}}\ \text{N}\cdot\text{s} = (2.5\ \text{kg})\ \vec{v}_f$ $\quad \vec{v}_f = \boxed{4.80\ \hat{\mathbf{i}}\ \text{m/s}}$

(c) From the same equation, $(2.5\ \text{kg})(-2\ \hat{\mathbf{i}}\ \text{m/s}) + 12\ \hat{\mathbf{i}}\ \text{N}\cdot\text{s} = (2.5\ \text{kg})\ \vec{v}_f$ $\quad \vec{v}_f = \boxed{2.80\ \hat{\mathbf{i}}\ \text{m/s}}$

(d) $\vec{F}_{avg}\Delta t = 12.0\hat{\mathbf{i}}\ \text{N}\cdot\text{s} = \vec{F}_{avg}(5\ \text{s})$ $\quad \vec{F}_{avg} = \boxed{2.40\hat{\mathbf{i}}\ \text{N}}$

P9.19 First we find v_1, the speed of m_1 at B before collision.

$$\frac{1}{2}m_1 v_1^2 = m_1 gh$$

$$v_1 = \sqrt{2(9.80)(5.00)} = 9.90\ \text{m/s}$$

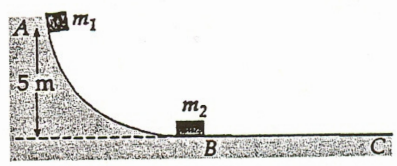


FIG. P9.19

Now we use the text's analysis of one-dimensional elastic collisions to find v_{1f}, the speed of m_1 at B just after collision.

$$v_{1f} = \frac{m_1 - m_2}{m_1 + m_2}v_1 = -\frac{1}{3}(9.90)\ \text{m/s} = -3.30\ \text{m/s}$$

Now the 5-kg block bounces back up to its highest point after collision according to

$$m_1 g h_{\text{max}} = \frac{1}{2}m_1(-3.30)^2 \qquad h_{\text{max}} = \frac{(-3.30\ \text{m/s})^2}{2\left(9.80\ \text{m/s}^2\right)} = \boxed{0.556\ \text{m}}$$

P9.29 $p_{xf} = p_{xi}$

$$mv_{\text{O}}\cos 37.0° + mv_{\text{Y}}\cos 53.0°$$

$$= m(5.00\ \text{m/s})$$

$$0.799v_{\text{O}} + 0.602v_{\text{Y}} = 5.00\ \text{m/s} \qquad (1)$$

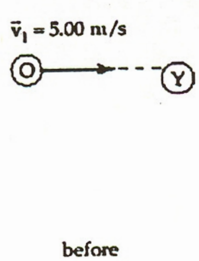
$$p_{yf} = p_{yi}$$

$$mv_{\text{O}}\sin 37.0° - mv_{\text{Y}}\sin 53.0° = 0$$

$$0.602v_{\text{O}} = 0.799v_{\text{Y}} \qquad (2)$$

Solving (1) and (2) simultaneously,

$$\boxed{v_{\text{O}} = 3.99\ \text{m/s}} \text{ and } \boxed{v_{\text{Y}} = 3.01\ \text{m/s}}$$



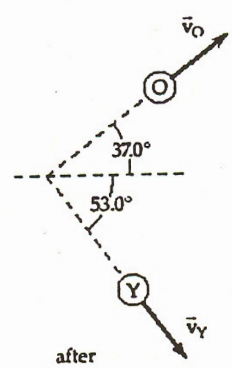


FIG. P9.29

P9.35 The x-coordinate of the center of mass is

$$x_{CM} = \frac{\sum m_i x_i}{\sum m_i} = \frac{0+0+0+0}{(2.00\text{ kg}+3.00\text{ kg}+2.50\text{ kg}+4.00\text{ kg})}$$

$$\boxed{x_{CM} = 0}$$

and the y-coordinate of the center of mass is

$$y_{CM} = \frac{\sum m_i y_i}{\sum m_i} = \frac{(2.00\text{ kg})(3.00\text{ m})+(3.00\text{ kg})(2.50\text{ m})+(2.50\text{ kg})(0)+(4.00\text{ kg})(-0.500\text{ m})}{2.00\text{ kg}+3.00\text{ kg}+2.50\text{ kg}+4.00\text{ kg}}$$

$$\boxed{y_{CM} = 1.00\text{ m}}$$

P9.67 (a) Find the speed when the bullet emerges from the block by using momentum conservation:

$$mv_i = MV_i + mv$$

The block moves a distance of 5.00 cm. Assume for an approximation that the block quickly reaches its maximum velocity, V_i, and the bullet kept going with a constant velocity, v. The block then compresses the spring and stops.

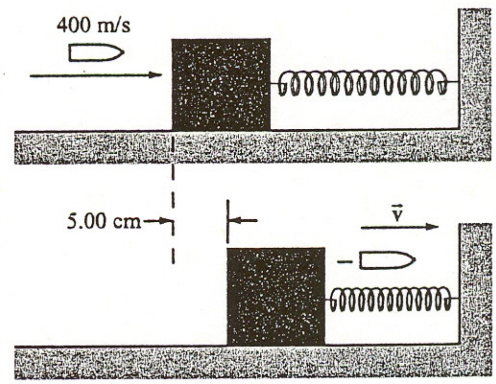


FIG. P9.67

$$\frac{1}{2}MV_i^2 = \frac{1}{2}kx^2$$

$$V_i = \sqrt{\frac{(900\text{ N/m})(5.00\times10^{-2}\text{ m})^2}{1.00\text{ kg}}} = 1.50\text{ m/s}$$

$$v = \frac{mv_i - MV_i}{m} = \frac{(5.00\times10^{-3}\text{ kg})(400\text{ m/s})-(1.00\text{ kg})(1.50\text{ m/s})}{5.00\times10^{-3}\text{ kg}}$$

$$v = \boxed{100\text{ m/s}}$$

(b) $$\Delta E = \Delta K + \Delta U = \frac{1}{2}(5.00\times10^{-3}\text{ kg})(100\text{ m/s})^2 - \frac{1}{2}(5.00\times10^{-3}\text{ kg})(400\text{ m/s})^2 + \frac{1}{2}(900\text{ N/m})(5.00\times10^{-2}\text{ m})^2$$

$\Delta E = -374$ J, or there is a mechanical energy loss of $\boxed{374\text{ J}}$.