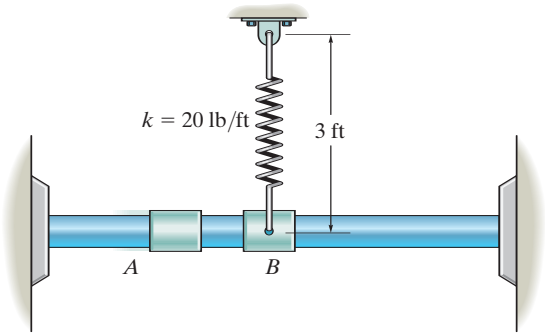
15–83.

The 10-lb collar B is at rest, and when it is in the position shown the spring is unstretched. If another 1-lb collar A strikes it so that B slides 4 ft on the smooth rod before momentarily stopping, determine the velocity of A just after impact, and the average force exerted between A and B during the impact if the impact occurs in 0.002 s. The coefficient of restitution between A and B is $e = 0.5$.



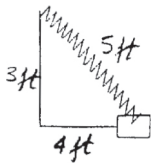
SOLUTION

Collar B after impact:

$$T_2 + V_2 = T_3 + V_3$$

$$\frac{1}{2}\left(\frac{10}{32.2}\right)(v_B)_2^2 + 0 = 0 + \frac{1}{2}(20)(5-3)^2$$

$$(v_B)_2 = 16.05 \text{ ft/s}$$



System:

$$\left(\stackrel{+}{\rightarrow}\right) \quad \Sigma m_1 v_1 = \Sigma m_1 v_2$$

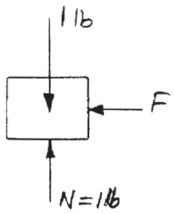
$$\frac{1}{32.2}(v_A)_1 + 0 = \frac{1}{32.2}(v_A)_2 + \frac{10}{32.2}(16.05)$$

$$(v_A)_1 - (v_A)_2 = 160.5$$

$$\left(\stackrel{+}{\rightarrow}\right) \quad e = \frac{(v_B)_2 - (v_A)_2}{(v_A)_1 - (v_B)_1}$$

$$0.5 = \frac{16.05 - (v_A)_2}{(v_A)_1 - 0}$$

$$0.5(v_A)_1 + (v_A)_2 = 16.05$$



Solving:

$$(v_A)_1 = 117.7 \text{ ft/s} = 118 \text{ ft/s} \rightarrow$$

$$(v_A)_2 = -42.8 \text{ ft/s} = 42.8 \text{ ft/s} \leftarrow \qquad \textbf{Ans.}$$

Collar A:

$$\left(\stackrel{+}{\rightarrow}\right) \quad mv_1 + \Sigma \int F\,dt = mv_2$$

$$\left(\frac{1}{32.2}\right)(117.7) - F(0.002) = \left(\frac{1}{32.2}\right)(-42.8)$$

$$F = 2492.2 \text{ lb} = 2.49 \text{ kip} \qquad \textbf{Ans.}$$

Ans:
$(v_A)_2 = 42.8 \text{ ft/s} \leftarrow$
$F = 2.49 \text{ kip}$