SAMPLE PROBLEM B

Force and Impulse

PROBLEM

A 1400 kg car moving westward with a velocity of 15 m/s collides with a utility pole and is brought to rest in 0.30 s. Find the force exerted on the car during the collision.

SOLUTION

Given: $m = 1400$ kg $\quad \mathbf{v_i} = 15$ m/s to the west, $v_i = -15$ m/s
$\Delta t = 0.30$ s $\quad \mathbf{v_f} = 0$ m/s

Unknown: $\mathbf{F} = ?$

TIP *Create a simple convention for describing the direction of vectors. For example, always use a negative speed for objects moving west or south and a positive speed for objects moving east or north.*

Use the impulse-momentum theorem.

$$\mathbf{F}\Delta t = \Delta \mathbf{p} = m\mathbf{v_f} - m\mathbf{v_i}$$

$$\mathbf{F} = \frac{m\mathbf{v_f} - m\mathbf{v_i}}{\Delta t}$$

$$F = \frac{(1400 \text{ kg})(0 \text{ m/s}) - (1400 \text{ kg})(-15 \text{ m/s})}{0.30 \text{ s}} = \frac{21\,000 \text{ kg} \cdot \text{m/s}}{0.30 \text{ s}}$$

$$\mathbf{F} = 7.0 \times 10^4 \text{ N to the east}$$

PRACTICE B

Force and Impulse

1. A 0.50 kg football is thrown with a velocity of 15 m/s to the right. A stationary receiver catches the ball and brings it to rest in 0.020 s. What is the force exerted on the ball by the receiver?
2. An 82 kg man drops from rest on a diving board 3.0 m above the surface of the water and comes to rest 0.55 s after reaching the water. What is the net force on the diver as he is brought to rest?
3. A 0.40 kg soccer ball approaches a player horizontally with a velocity of 18 m/s to the north. The player strikes the ball and causes it to move in the opposite direction with a velocity of 22 m/s. What impulse was delivered to the ball by the player?
4. A 0.50 kg object is at rest. A 3.00 N force to the right acts on the object during a time interval of 1.50 s.
   a. What is the velocity of the object at the end of this interval?
   b. At the end of this interval, a constant force of 4.00 N to the left is applied for 3.00 s. What is the velocity at the end of the 3.00 s?