

## PROBLEM #1

**Golf** Rocío strikes a 0.058-kg golf ball with a force of 272 N and gives it a velocity of 62.0 m/s. How long was Rocío's club in contact with the ball?

## PROBLEM #2

A 0.145-kg baseball is pitched at 42 m/s. The batter hits it horizontally to the pitcher at 58 m/s.

- a. Find the change in momentum of the ball.
- b. If the ball and bat are in contact for  $4.6 \times 10^{-4}$  s, what is the average force during contact?

## PROBLEM #3

**Bowling** A force of 186 N acts on a 7.3-kg bowling ball for 0.40 s. What is the bowling ball's change in momentum? What is its change in velocity?

## PROBLEM #4

A 5500-kg freight truck accelerates from 4.2 m/s to 7.8 m/s in 15.0 s by the application of a constant force.

- a. What change in momentum occurs?
- b. How large of a force is exerted?

## PROBLEM #5

**Hockey** A hockey player makes a slap shot, exerting a constant force of 30.0 N on the hockey puck for 0.16 s. What is the magnitude of the impulse given to the puck?

## PROBLEM #6

**Skateboarding** Your brother's mass is 35.6 kg, and he has a 1.3-kg skateboard. What is the combined momentum of your brother and his skateboard if they are moving at 9.50 m/s?

## **PROBLEM #7**

A hockey puck has a mass of 0.115 kg and is at rest. A hockey player makes a shot, exerting a constant force of 30.0 N on the puck for 0.16 s. With what speed does it head toward the goal?

## PROBLEM #8

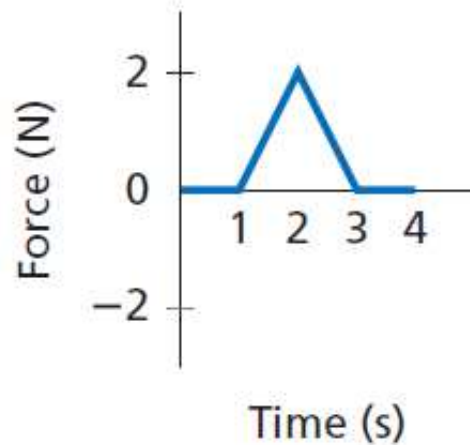
Before a collision, a 25-kg object was moving at +12 m/s. Find the impulse that acted on the object if, after the collision, it moved at the following velocities.

- a. +8.0 m/s
- b. -8.0 m/s



## PROBLEM #9

A 0.150-kg ball, moving in the positive direction at 12 m/s, is acted on by the impulse shown in the graph in **Figure 9-16**. What is the ball's speed at 4.0 s?



■ Figure 9-16

## PROBLEM #10

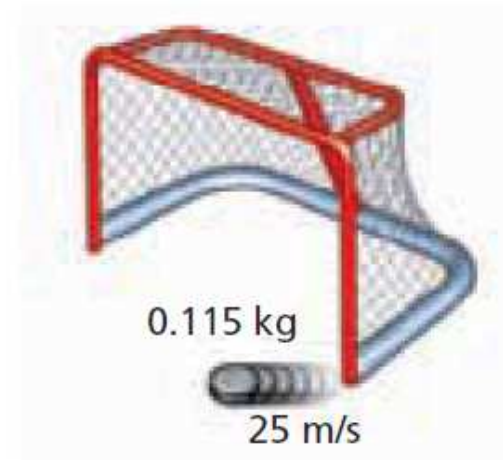
**Baseball** A 0.145-kg baseball is moving at 35 m/s when it is caught by a player.

- a. Find the change in momentum of the ball.
- b. If the ball is caught with the mitt held in a stationary position so that the ball stops in 0.050 s, what is the average force exerted on the ball?
- c. If, instead, the mitt is moving backward so that the ball takes 0.500 s to stop, what is the average force exerted by the mitt on the ball?

## PROBLEM #11

**Hockey** A hockey puck has a mass of 0.115 kg and strikes the pole of the net at 37 m/s. It bounces off in the opposite direction at 25 m/s, as shown in **Figure 9-17**.

- What is the impulse on the puck?
- If the collision takes  $5.0 \times 10^{-4}$  s, what is the average force on the puck?



■ Figure 9-17

## PROBLEM #12

A nitrogen molecule with a mass of  $4.7 \times 10^{-26}$  kg, moving at 550 m/s, strikes the wall of a container and bounces back at the same speed.

- a. What is the impulse the molecule delivers to the wall?
- b. If there are  $1.5 \times 10^{23}$  collisions each second, what is the average force on the wall?

## PROBLEM #13

**Rockets** Small rockets are used to make tiny adjustments in the speeds of satellites. One such rocket has a thrust of 35 N. If it is fired to change the velocity of a 72,000-kg spacecraft by 63 cm/s, how long should it be fired?