Problems

1. What is the magnitude of the momentum of a 28-g sparrow flying with a speed of 8.4 m/s?

$$p = mv = (.028\,kg)(8.4\,\tfrac{m}{s}) = 0.235\,C$$

2. A constant friction force of 25 N acts on a 65-kg skier for 20 s. What is the skier's change in velocity?

$$F\Delta t = m\Delta v$$

$$(25)(20) = 65\Delta v$$

$$\Delta v = 7.69\,m/s$$

3. A 0.145-kg baseball pitched at 39.0 m/s is hit on a horizontal line drive straight back toward the pitcher at 52.0 m/s. If the contact time between bat and ball is 3.00×10^{-3}s, calculate the average force between the ball and bat during contact.

$$F\Delta t = m\Delta v \qquad \Delta v = v' - v = 52 - {}^{-}39 = +91\,m/s$$

$$F(3\times10^{-3}) = (.145)(91)$$

$$F = 4398N$$

4. Calculate the force exerted on a rocket, given that the propelling gases are expelled at a rate of 1500 kg/s with a speed of 4.00×10^{4}m/s (at the moment of takeoff). The force on the gas can be found from its change in momentum.

$$F\Delta t = m\Delta v \qquad F = \left(1500\,\tfrac{kg}{s}\right)\left(4\times10^{4}\,\tfrac{m}{s}\right)$$

$$F = \frac{m\Delta v}{\Delta t}\ kg/s \qquad F = 6.0\times10^{7}N$$

5. A golf ball of mass 0.045 kg is hit off the tee at a speed of 45 m/s. The golf club was in contact with the ball for 3.5×10^{-3} s. Find (*a*) the impulse imparted to the golf ball, and (*b*) the average force exerted on the ball by the golf club.

$$F\Delta t = m\Delta v$$

$$m\Delta v = (.045)(+45) = 2.025\,C = \text{impulse and momentum}$$

$$F\Delta t = 2.025$$

$$F = 579N$$

6. A 12-kg hammer strikes a nail at a velocity of 8.5 m/s and comes to rest in a time interval of 8.0 ms. (*a*) What is the impulse given to the nail? (*b*) What is the average force acting on the nail?

$F\Delta t = m\Delta v$

$F\Delta t = (12)(-8.5) = -102$ C impulse

$F = 12,750$N

7. You are the design engineer in charge of the crashworthiness of new automobile models. Cars are tested by smashing them into fixed, massive barriers at 50 km/h (30 mph). A new model of mass 1500 kg takes 0.15 s from the time of impact until it is brought to rest. (*a*) Calculate the average force exerted on the car by the barrier. (*b*) Calculate the average deceleration of the car.

$\Delta v = 0 - 13.9 = -13.9 \frac{m}{s}$

$F\Delta t = m\Delta v$

$F(.15) = (1500)(-13.9)$

$F = 139,000$N

$a = \frac{\Delta v}{\Delta t} = 93 m/s^2$