Problem

12. A 40-kg football player leaps through the air to collide with and tackle a 50-kg player heading toward him, also in the air. If the 40-kg player is heading to the right at 9 m/s and the 50-kg player is heading toward the left at 2 m/s, what is the speed and direction of the tangled players?
13. A 5-kg blob of clay moving horizontally at 4 m/s has a head-on collision with a 4-kg blob of clay that moves toward it at 2 m/s. What is the speed of the two blobs stuck together immediately after the collision?
14. A 70-kg free-floating astronaut fires 0.10-kg of gas at a speed of 30 m/s from her propulsion pistol. What is the astronaut's recoil speed?
15. What velocity must a 1340 kg car have in order to have the same momentum as a 2680 kg truck traveling at a velocity of 15 m/s to the west?
16. A cricket ball with a mass of 0.11 kg moves at a speed of 12 m/s. Then the ball is hit by a bat and rebounds in the opposite direction at a speed of 15 m/s. What is the change in momentum of the ball?
17. A train with a mass of 1.8×10^3 kg is moving at 15 m/s when the engineer applies the brakes. If the braking force is constant at 3.5×10^4 N, how long does it take the train to stop? How far does the train travel during this time?
18. A 65.0 kg ice-skater standing on frictionless ice throws a 0.15 kg snowball horizontally at a speed of 32.0 m/s. At what speed does the skater move backward?

PROBLEM

12. 2.9 m/s toward the right
13. 1.3 m/s
14. 0.04 m/s
15. 30 m/s to the west

Given

$m_1 = 2680\ \text{kg}$

$\mathbf{v_1} = 15\ \text{m/s to the west}$

$m_2 = 1340\ \text{kg}$

Solution

$m_1\mathbf{v_1} = m_2\mathbf{v_2}$

$$\mathbf{v_2} = \frac{m_1\mathbf{v_1}}{m_2} = \frac{\left(2.68 \times 10^3\ \text{kg}\right)(15\ \text{m/s west})}{\left(1.34 \times 10^3\ \text{kg}\right)} = 3.0 \times 10^1\ \text{m/s west}$$

16. –3.0 kg•m/s

Given
$m = 0.11\,\text{kg}$

$v_i = 12\,\text{m/s}$

$v_f = -15\,\text{m/s}$

Solution
$\Delta p = m\left(v_f - v_i\right) = \left(0.11\,\text{kg}\right)(-15\,\text{m/s} - 12\,\text{m/s}) = -3.0\,\text{kgm/s}$

17. 77 s; 5.8×10^2 m

Given
$m = 1.8 \times 10^5\,\text{kg}$

$v_i = 15\,\text{m/s}$

$v_f = 0\,\text{m/s}$

$F = -3.5 \times 10^4\,\text{N}$

Solution
$\mathbf{F}\Delta t = \Delta\mathbf{p}$

$$\Delta t = \frac{\Delta p}{F} = \frac{m\left(v_f - v_i\right)}{F} = \frac{\left(1.8 \times 10^5\,\text{kg}\right)(0\,\text{m/s} - 15\,\text{m/s})}{-3.5 \times 10^4\,\text{N}} = 77\,\text{s}$$

$\Delta x = \frac{1}{2}\left(v_i + v_f\right)\Delta t = \frac{1}{2}(15\,\text{m/s} + 0\,\text{m/s})(77\,\text{s}) = 5.8 \times 10^2\,\text{m}$

18. 7.4×10^{-2} m/s

Given

$m_1 = 0.15\,\text{kg}$

$m_2 = 65.0\,\text{kg}$

$v_{1,i} = v_{2,i} = 0\,\text{m/s}$

$v_{1,f} = 32\,\text{m/s}$

Solution

$m_1\mathbf{v_{1,i}} + m_2\mathbf{v_{2,i}} = m_1\mathbf{v_{1,f}} + m_2\mathbf{v_{2,f}} = 0$

$m_2\mathbf{v_{2,f}} = -m_1\mathbf{v_{1,f}}$

$$\mathbf{v_{2,f}} = -\frac{m_1\mathbf{v_{1,f}}}{m_2} = -\frac{(0.15\,\text{kg})\,(32\,\text{m/s})}{65.0\,\text{kg}} = -7.4 \times 10^{-2}\,\text{m/s} = 7.4 \times 10^{-2}\,\text{m/s backward}$$