11. \[ K = \frac{1}{2} mv^2 = \frac{m(v_2^2 - v_1^2)}{2m} = \frac{p^2}{2m} = \frac{(12 \text{ kg m/s})^2}{2(3.0 \text{ kg})} = 24 \text{ J}. \]

12. Since the ball moves in the opposite direction, \( v = -34.7 \text{ m/s} \) and \( v_x = 4.50 \text{ m/s}. \)

\[ \Delta p = mv - m(v_x) = (0.150 \text{ kg})(-34.7 \text{ m/s}) - (0.150 \text{ kg})(4.50 \text{ m/s}) = -5.88 \text{ kg m/s} \]

in the direction opposite initial velocity.

13. Since the bullet moves in the opposite direction, \( v = -120 \text{ m/s} \) and \( v_x = 150 \text{ m/s}. \)

\[ \Delta p = mv - m(v_x) = (0.0150 \text{ kg})(-120 \text{ m/s}) - (0.0150 \text{ kg})(150 \text{ m/s}) = -4.05 \text{ kg m/s} \]

in the direction opposite to initial velocity.

14. (a) The magnitude of the total momentum of the two-proton system will be \( 18 \times 10^{-27} \text{ kg m/s} \) in the direction of the faster proton.

(b) Since they approach each other, \( v_1 = 340 \text{ m/s} \) and \( v_2 = -450 \text{ m/s}. \)

\[ P = p_1 + p_2 = (1.67 \times 10^{-27} \text{ kg})(340 \text{ m/s} - 450 \text{ m/s}) = -1.84 \times 10^{-25} \text{ kg m/s} \]

15. (a) \( p = mv = m(v - v_0) = (0.50 \text{ kg})(0 - (9.80 \text{ m/s})^2)(0.75 \text{ s}) = -1.8 \text{ kg m/s} \) down.

(b) \( v^2 = v_0^2 - 2a \cdot x = 0 - 2(9.80 \text{ m/s})^2(-10 \text{ m}) = 196 \text{ m}^2/\text{s}^2, \quad \text{and} \quad v = -14 \text{ m/s}. \)

So \( p = (0.50 \text{ kg})(-14 \text{ m/s}) = -7.0 \text{ kg m/s} \) down.

16. (a) \( 36 \text{ km/h} = 10 \text{ m/s}. \)

\[ p = mv = (1.29 \text{ kg/m}^3)(1.0 \text{ m})^3(10 \text{ m/s}) = 13 \text{ kg m/s}. \]

(b) \( 74 \text{ m/h} = 33.1 \text{ m/s}. \)

\[ P = p_1 + p_2 = \pm 350 \text{ kg m/s}. \]

It can be either positive or negative because the Exercise does not specify the direction of the momentum.

\( \pm 350 \text{ kg m/s} = (70 \text{ kg})(2.0 \text{ m/s}) - (60 \text{ kg})(2.0 \text{ m/s}). \)

\( v_1 = +3.5 \text{ m/s} \) or \( v_2 = -8.2 \text{ m/s}. \)

The velocity of the light runner is \( 3.5 \text{ m/s in the same direction} \) or \( 8.2 \text{ m/s in the opposite direction} \).