Honors Physics - Chapter 6 Practice Answers

1)

$v = 40.3$ km/h

$p = 6.60 \times 10^2$ kg•m/s

$$m = \frac{p}{v} = \frac{6.60 \times 10^2 \text{ kg•m/s}}{(40.3 \times 10^3 \text{ m/h})(1 \text{ h}/3600 \text{ s})} = \boxed{59.0 \text{ kg}}$$

2)

$h = 12.0$ cm

$\mathbf{F} = 330$ N, upward

$m = 65$ kg

$g = 9.81$ m/s^2

The speed of the pogo stick before and after it presses against the ground can be determined from the conservation of energy.

$$PE_g = KE$$

$$mgh = \tfrac{1}{2}mv^2$$

$$v = \pm\sqrt{2gh}$$

For the pogo stick's downward motion,

$$v_i = -\sqrt{2gh}$$

For the pogo stick's upward motion,

$$v_f = +\sqrt{2gh}$$

$$\Delta p = mv_f - mv_i = m\sqrt{2gh} - m\left(-\sqrt{2gh}\right)$$

$$\Delta p = 2m\sqrt{2gh}$$

$$\Delta t = \frac{\Delta p}{F} = \frac{2m\sqrt{2gh}}{F} = \frac{(2)(65 \text{ kg})\sqrt{(2)(9.81 \text{ m/s}^2)(0.120 \text{ m})}}{330 \text{ N}}$$

$$\Delta t = \boxed{0.60 \text{ s}}$$

3)

$\mathbf{F} = 2.85 \times 10^6$ N backward $= -2.85 \times 10^6$ N

$m = 2.0 \times 10^7$ kg

$\mathbf{v_i} = 3.0$ m/s forward $= +3.0$ m/s

$\mathbf{v_f} = 0$ m/s

$\Delta t = 21$ s

$$\Delta\mathbf{p} = \mathbf{F}\Delta t = (-2.85 \times 10^6 \text{ N})(21 \text{ s})$$

$$\Delta\mathbf{p} = \boxed{-6.0 \times 10^7 \text{ kg•m/s forward or } 6.0 \times 10^7 \text{ kg•m/s backward}}$$

$$\Delta\mathbf{x} = \tfrac{1}{2}(\mathbf{v_i} + \mathbf{v_f})\Delta t = \tfrac{1}{2}(3.0 \text{ m/s} + 0 \text{ m/s})(21 \text{ s}) = \boxed{32 \text{ m forward}}$$

4)

$m_i = 3.6$ kg

$m_2 = 3.0$ kg

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

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

$\mathbf{v_{2,f}} = 2.0$ m/s to the left $= -2.0$ m/s

Because the initial momentum is zero, the final momentum must also equal zero.

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

$$\mathbf{v_{1,f}} = \frac{-m_2\mathbf{v_{2,f}}}{m_1} = \frac{-(3.0 \text{ kg})(-2.0 \text{ m/s})}{3.6 \text{ kg}} = 1.7 \text{ m/s} = \boxed{1.7 \text{ m/s to the right}}$$

5)

$m_1 = 155$ kg

$\mathbf{v_{1,i}} = 6.0$ m/s forward

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

$\mathbf{v_f} = 2.2$ m/s forward

$$m_2 = \frac{m_1\mathbf{v_{1,i}} - m_1\mathbf{v_f}}{\mathbf{v_f} - \mathbf{v_{2,i}}} = \frac{(155\text{ kg})(6.0\text{ m/s}) - (155\text{ kg})(2.2\text{ m/s})}{2.2\text{ m/s} - 0\text{ m/s}}$$

$$m_2 = \frac{930\text{ kg}\bullet\text{m/s} - 340\text{ kg}\bullet\text{m/s}}{2.2\text{ m/s}} = \frac{590\text{ kg}\bullet\text{m/s}}{2.2\text{ m/s}}$$

$$m_2 = \boxed{270\text{ kg}}$$

6)

$v_{1,i} = 10.8$ m/s

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

$v_f = 10.1$ m/s

$m_1 = 63.0$ kg

$$m_2 = \frac{m_1 v_{1,i} - m_1 v_f}{v_f - v_{2,i}} = \frac{(63.0\text{ kg})(10.8\text{ m/s}) - (63.0\text{ kg})(10.1\text{ m/s})}{10.1\text{ m/s} - 0\text{ m/s}}$$

$$m_2 = \frac{6.80 \times 10^2\text{ kg}\bullet\text{m/s} - 6.36 \times 10^2\text{ kg}\bullet\text{m/s}}{10.1\text{ m/s}} = \frac{44\text{ kg}\bullet\text{m/s}}{10.1\text{ m/s}} = \boxed{4.4\text{ kg}}$$

7)

$m_1 = 313$ kg

$\mathbf{v_{1,i}} = 6.00$ m/s away from shore

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

$\mathbf{v_f} = 2.50$ m/s away from shore

$$m_2 = \frac{m_1\mathbf{v_{1,i}} - m_1\mathbf{v_f}}{\mathbf{v_f} - \mathbf{v_{2,i}}} = \frac{(313\text{ kg})(6.00\text{ m/s}) - (313\text{ kg})(2.50\text{ m/s})}{2.50\text{ m/s} - 0\text{ m/s}}$$

$$m_2 = \frac{1880\text{ kg}\bullet\text{m/s} - 782\text{ kg}\bullet\text{m/s}}{2.50\text{ m/s}} = \frac{1.10 \times 10^3\text{ kg}\bullet\text{m/s}}{2.50\text{ m/s}} = 4.4 \times 10^2\text{ kg}$$

$$KE_i = \tfrac{1}{2}m_1 v_{1,i}^2 + \tfrac{1}{2}m_2 v_{2,i}^2$$

$$KE_i = \tfrac{1}{2}(313\text{ kg})(6.00\text{ m/s})^2 + \tfrac{1}{2}(4.40 \times 10^2\text{ kg})(0\text{ m/s})^2 = 5630\text{ J}$$

$$KE_f = \tfrac{1}{2}(m_1 + m_2)v_f^2$$

$$KE_f = \tfrac{1}{2}(313\text{ kg} + 4.40 \times 10^2\text{ kg})(2.50\text{ m/s})^2 = \tfrac{1}{2}(753\text{ kg})(2.50\text{ m/s})^2 = 2350\text{ J}$$

$$\Delta KE = KE_f - KE_i = 2350\text{ J} - 5630\text{ J} = \boxed{-3280\text{ J}}$$

8)

$m_1 = 45.0$ g

$\mathbf{v_{1,i}} = 273$ km/h to the right

$= +273$ km/h

$\mathbf{v_{2,i}} = 0$ km/h

$\mathbf{v_{1,f}} = 91$ km/h to the left

$= -91$ km/h

$\mathbf{v_{2,f}} = 182$ km/h to the right

$= +182$ km/h

Momentum conservation

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

$$m_2 = \frac{m_1\mathbf{v_{1,f}} - m_1\mathbf{v_{1,i}}}{\mathbf{v_{2,i}} - \mathbf{v_{2,f}}} = \frac{(45.0\text{ g})(-91\text{ km/h}) - (45.0\text{ g})(273\text{ km/h})}{0\text{ km/h} - 182\text{ km/h}}$$

$$m_2 = \frac{-4.1 \times 10^3\text{ g}\bullet\text{km/h} - 12.3 \times 10^3\text{ g}\bullet\text{km/h}}{-182\text{ km/h}} = \frac{-16.4 \times 10^3\text{ g}\bullet\text{km/h}}{-182\text{ km/h}}$$

$$m_2 = \boxed{90.1\text{ g}}$$

Conservation of kinetic energy (check)

$$\tfrac{1}{2}m_1 v_{1,i}^2 + \tfrac{1}{2}m_2 v_{2,i}^2 = \tfrac{1}{2}m_1 v_{1,f}^2 + \tfrac{1}{2}m_2 v_{2,f}$$

$$\tfrac{1}{2}(45.0\text{ g})(273 \times 10^3\text{ m/h})^2(1\text{ h}/3600\text{ s})^2 + \tfrac{1}{2}(90.1\text{ g})(0\text{ m/s})^2$$
$$= \tfrac{1}{2}(45.0\text{ g})(-91 \times 10^3\text{ m/h})^2(1\text{ h}/3600\text{ s})^2 + \tfrac{1}{2}(90.1\text{ g})(182 \times 10^3\text{ m/h})^2(1\text{ h}/3600\text{ s})^2$$

$$129\text{ J} + 0\text{ J} = 14\text{ J} + 115\text{ J}$$

$$129\text{ J} = 129\text{ J}$$