NEWTON'S 3rd LAW PROBLEMS SOLUTIONS

1.

PAINT BALL

$m_b = 0.15 kg$ — let b represent ball

$V_{bi} = 0 m/s$

$V_{bf} = 45 m/s [N]$

$\Delta t = 0.10 s$

$a_b = ?$

$$\vec{a}_{ball} = \frac{V_{bf} - V_{bi}}{\Delta t}$$

$$\vec{a}_b = \frac{45 - 0}{0.10} = 450 m/s^2 [N]$$

$$\vec{F}_{net\ ball} = m_b \cdot \vec{a}_b$$

$$= (0.15)(450)$$

$$= 67.5 N [N]$$

PAINT BALL GUN

$m_g = 5.5 kg$ — let g represent gun

$V_{gi} = 0 m/s$

$V_{gf} = ?$

$\Delta t = 0.10 s$

$a_g = ?$

$$F_{net\ ball} = - F_{net\ gun}$$

$$67.5 = -(m_g \cdot \vec{a}_g)$$

$$67.5 = -(5.5)(\vec{a}_g)$$

$$\frac{67.5}{5.5} = -(\vec{a}_g) \rightarrow -\vec{a}_g = 12.27 m/s^2 [N]$$

$a_g = 12.27 m/s^2 [S]$

*opposite direction (Newton's 3rd law)

$$a_{gun} = \frac{V_{gf} - V_{gi}}{\Delta t}$$

$$(a_{gun})(\Delta t) + V_{gi} = V_{gf}$$

$$(12.27)(0.10) + 0 = V_{gf}$$

$$1.227 = V_{gf}$$

$V_{gf} = 1.23 m/s [S]$

* same direction as acceleration of gun

2.

Given in Newtons, have to convert to kg

$$F_g = mg$$

$$m = \frac{F_g}{g} = \frac{833 N}{9.8 m/s^2}$$

$$F_{diver} = -(F_{boat})$$

$$m_d \cdot \vec{a}_d = -(m_b \cdot \vec{a}_b)$$

$$m_d \cdot \left(\frac{V_{df} - V_{di}}{\Delta t}\right) = -\left[m_b \left(\frac{V_{bf} - V_{bi}}{\Delta t}\right)\right]$$

$$\frac{833 N}{9.8 \frac{N}{kg}} \left(\frac{2.25 m/s [W] - 0 m/s}{0.50 sec}\right) = -\left[375 kg \left(\frac{V_{bf} - 0 m/s}{0.50 sec}\right)\right]$$

$$382.5 = -\left[375 \left(\frac{V_{bf}}{0.50}\right)\right] \rightarrow \frac{382.5 (0.50)}{375} = -\vec{V}_{bf}$$

$$0.51 m/s [W] = -\vec{V}_{bf}$$

$V_{bf} = 0.51 m/s [E]$

3. $m = 999 kg$

$V_i = 26 m/s [N]$

$V_f = 28 m/s [N]$

$\Delta t = 2.5 sec$

$F = ?$

$$\vec{F_{net}} = m \cdot \vec{a}$$

$$\vec{F_{net}} = m\left(\frac{V_f - V_i}{\Delta t}\right)$$

$$\vec{F_{net}} = (999)\left(\frac{28 - 26}{2.5}\right)$$

$$\vec{F_{net}} = 799.2 N [N]$$

4.

$$F_{net\,A} = - F_{net\,B}$$

$$m_A \cdot a_A = - m_B \cdot a_B$$

$$m_A \cdot \left(\frac{V_{fA} - V_{iA}}{\Delta t}\right) = -\left[m_B \cdot \left(\frac{V_{fB} - V_{iB}}{\Delta t}\right)\right]$$

* The Δt can cancel since player A and player B are in contact for the same amount of time

$$m_A \cdot (V_{fA} - V_{iA}) = -[m_b \cdot (V_{fB} - V_{iB})]$$

$$(85kg)(1.5 m/s [W] - 0 m/s) = -[(110kg) \cdot (V_{fB} - 0 m/s)]$$

$$127.5 = -[(110kg) \cdot (V_{fB})]$$

$$\frac{127.5}{110} = -\vec{V_{fB}}$$

$$1.159 m/s [W] = -\vec{V_{fB}}$$

$$\vec{V_{fB}} = 1.16 m/s [E]$$