



$$\begin{aligned}
 m &= ? & m &= 4.5 \times 10^2 \text{ kg} \\
 v &= -45 \text{ m/s} & v &= 1.4 \times 10^3 \text{ m/s} \\
 p &= -6.3 \times 10^5 \text{ kg}\cdot\text{m/s} & p &= 6.3 \times 10^5 \text{ kg}\cdot\text{m/s} \\
 p_{\text{after}} &= 0
 \end{aligned}$$

$$\begin{aligned}
 m &= \frac{p}{v} \\
 &= \frac{-6.3 \times 10^5 \text{ kg}\cdot\text{m/s}}{-45 \text{ kg}} \\
 &= 1.4 \times 10^4 \text{ kg}
 \end{aligned}$$

9. before



$$\begin{aligned}
 m &= 7.0 \text{ kg} \\
 v &= 0 \\
 p &= 0
 \end{aligned}$$

$$p_{\text{before}} = 0$$



$$\begin{aligned}
 m &= 5.0 \text{ kg} & m &= 2.0 \text{ kg} \\
 v &= ? & v &= 10.0 \text{ m/s} \\
 p &= -20.0 \text{ kg}\cdot\text{m/s} & p &= 20.0 \text{ kg}\cdot\text{m/s} \\
 p_{\text{after}} &= 0
 \end{aligned}$$

$$\begin{aligned}
 v &= \frac{p}{m} \\
 &= \frac{-20.0 \text{ kg}\cdot\text{m/s}}{5.0 \text{ kg}} \\
 &= -4.0 \text{ m/s left}
 \end{aligned}$$

10. before collision



$$\begin{aligned}
 m &= 1.0 \times 10^5 \text{ N} & m &= 1.0 \times 10^4 \text{ N} \\
 v &= 15 \text{ m/s} & v &= -25 \text{ m/s} \\
 p &= 1.5 \times 10^6 \text{ N}\cdot\text{m/s} & p &= -2.5 \times 10^5 \text{ N}\cdot\text{m/s}
 \end{aligned}$$

$$p_{\text{before}} = 1.25 \times 10^6 \text{ N}\cdot\text{m/s}$$

after collision



$$\begin{aligned}
 m &= 1.1 \times 10^5 \text{ N} \\
 v &= ? \\
 p &= 1.25 \times 10^6 \text{ N}\cdot\text{m/s}
 \end{aligned}$$

$$p_{\text{after}} = 1.25 \times 10^6 \text{ N}\cdot\text{m/s}$$

$$\begin{aligned}
 v &= \frac{p}{m} \\
 &= \frac{1.25 \times 10^6 \text{ N}\cdot\text{m/s}}{1.1 \times 10^5 \text{ kg}} \\
 &= 11 \text{ m/s north}
 \end{aligned}$$

11. before collision



$$\begin{aligned}
 m &= 225 \text{ g} & m &= 125 \text{ kg} \\
 v &= 30.0 \text{ cm/s} & v &= 10.0 \text{ cm/s} \\
 p &= 6.75 \times 10^3 \text{ g}\cdot\text{cm/s} & p &= 1.25 \times 10^3 \text{ g}\cdot\text{cm/s}
 \end{aligned}$$

$$p_{\text{before}} = 8.00 \times 10^3 \text{ g}\cdot\text{cm/s}$$

after collision



$$\begin{aligned}
 m &= 225 \text{ kg} & m &= 125 \text{ kg} \\
 v &= ? & v &= 24.0 \text{ cm/s} \\
 p &= 5.00 \times 10^3 \text{ g}\cdot\text{cm/s} & p &= 3.00 \times 10^3 \text{ g}\cdot\text{cm/s}
 \end{aligned}$$

$$p_{\text{after}} = 8.00 \times 10^3 \text{ g}\cdot\text{cm/s}$$

$$\begin{aligned}
 v &= \frac{p}{m} \\
 &= \frac{5.00 \times 10^3 \text{ kg}\cdot\text{m/s}}{225 \text{ g}} \\
 &= 22.2 \text{ cm/s right}
 \end{aligned}$$

12. a) before



$$\begin{aligned}
 m &= 10.0 \text{ g} & m &= 30.0 \text{ g} \\
 v &= 20.0 \text{ cm/s} & v &= 0 \\
 p &= 200 \text{ g}\cdot\text{cm/s} & p &= 0
 \end{aligned}$$

$$p_{\text{before}} = 200 \text{ g}\cdot\text{cm/s}$$