after collision

$m_1 = 30.0 \text{ kg}$ $\quad m_2 = 20.0 \text{ kg}$
$\vec{v}_1' = ?$ $\quad \vec{v}_2' = -1.25 \text{ m/s}$
$\vec{p}_1' = ?$ $\quad \vec{p}_2' = -25.0 \text{ kg} \cdot \text{m/s}$

$$\vec{p}_{\text{sys(after)}} = \vec{p}_{\text{sys(before)}} = -70.0 \text{ kg} \cdot \text{m/s}$$

$$\vec{p}_{\text{sys(after)}} = \vec{p}_1' + \vec{p}_2' = -70.0 \text{ kg} \cdot \text{m/s}$$
$$\Rightarrow \vec{p}_1' = -70.0 \text{ kg} \cdot \text{m/s} - (-25.0 \text{ kg} \cdot \text{m/s})$$
$$\therefore \vec{p}_1' = -45.0 \text{ kg} \cdot \text{m/s}$$

$$\vec{p}_1' = m_1 \vec{v}_1'$$
$$\vec{v}_1' = \frac{\vec{p}_1'}{m_1}$$
$$= \frac{-45.0 \text{ kg} \cdot \text{m/s}}{30.0 \text{ kg}}$$
$$= -1.50 \text{ m/s}$$

The velocity of the 30.0 kg ball after the collision is 1.50 m/s left

2. before collision

Consider east as positive

$m_1 = 4.50 \times 10^3 \text{ kg}$ $\quad m_2 = 6.50 \times 10^3 \text{ kg}$
$\vec{v}_1 = 5.0 \text{ m/s}$ $\quad \vec{v}_2 = 0 \text{ m/s}$
$\vec{p}_1 = 2.25 \times 10^4 \text{ kg} \cdot \text{m/s}$ $\quad \vec{p}_2 = 0 \text{ kg} \cdot \text{m/s}$

$$\therefore \vec{p}_{\text{before}} = \vec{p}_1 + \vec{p}_2 = 2.25 \times 10^4 \text{ kg} \cdot \text{m/s}$$

after collision

$$m = m_1 + m_2 = 1.10 \times 10^4 \text{ kg}$$
$$\vec{v} = ?$$
$$\vec{p} = \vec{p}_{\text{after}} = 2.25 \times 10^4 \text{ kg} \cdot \text{m/s}$$

$$\vec{p} = m\vec{v}$$
$$\vec{v} = \frac{\vec{p}}{m}$$
$$= \frac{2.25 \times 10^4 \text{ kg} \cdot \text{m/s}}{1.10 \times 10^4 \text{ kg}}$$
$$= 2.1 \text{ m/s east}$$

3. before collision

$m_1 = 925 \text{ kg}$ $\quad m_2 = ?$
$\vec{v}_1 = 18.0 \text{ m/s}$ $\quad \vec{v}_2 = 0 \text{ m/s}$
$\vec{p}_1 = 1.67 \times 10^4 \text{ kg} \cdot \text{m/s}$ $\quad \vec{p}_2 = 0 \text{ kg} \cdot \text{m/s}$

$$\therefore \vec{p}_{\text{before}} = \vec{p}_1 + \vec{p}_2 = 1.67 \times 10^4 \text{ kg} \cdot \text{m/s}$$

after collision

$m = ?$
$\vec{v} = 6.50 \text{ m/s}$
$\vec{p} = \vec{p}_{\text{after}}$
$= 1.67 \times 10^4 \text{ kg} \cdot \text{m/s}$

$$m = \frac{\vec{p}}{\vec{v}}$$
$$= \frac{1.67 \times 10^4 \text{ kg} \cdot \text{m/s}}{6.50 \text{ kg}}$$
$$= 2.57 \times 10^3 \text{ kg}$$
$$m_2 = 2.57 \times 10^3 \text{ kg} = 925 \text{ kg}$$
$$= 1.65 \times 10^3 \text{ kg}$$

4. before collision

bullet block

$m_1 = 0.050 \text{ kg}$ $\quad m_2 = 7.00 \text{ kg}$
$\vec{v}_1 = ?$ $\quad \vec{v}_2 = 0 \text{ m/s}$
$\vec{p}_1 = ?$ $\quad \vec{p}_2 = 0 \text{ kg} \cdot \text{m/s}$

after collision

bullet and block

$$m = m_1 + m_2 = 7.05 \text{ kg}$$
$$\vec{v} = 5.00 \text{ m/s}$$
$$\vec{p} = \vec{p}_{\text{after}} = 35.25 \text{ kg} \cdot \text{m/s}$$
$$\vec{p}_{\text{before}} = \vec{p}_{\text{after}} = 35.25 \text{ kg} \cdot \text{m/s}$$
$$\vec{p}_1 = \vec{p}_{\text{before}} = 35.25 \text{ kg} \cdot \text{m/s}$$
$$\vec{v}_1 = \frac{\vec{p}_1}{m_1}$$
$$= \frac{35.25 \text{ kg} \cdot \text{m/s}}{0.050 \text{ kg}}$$
$$= 705 \text{ m/s}$$

