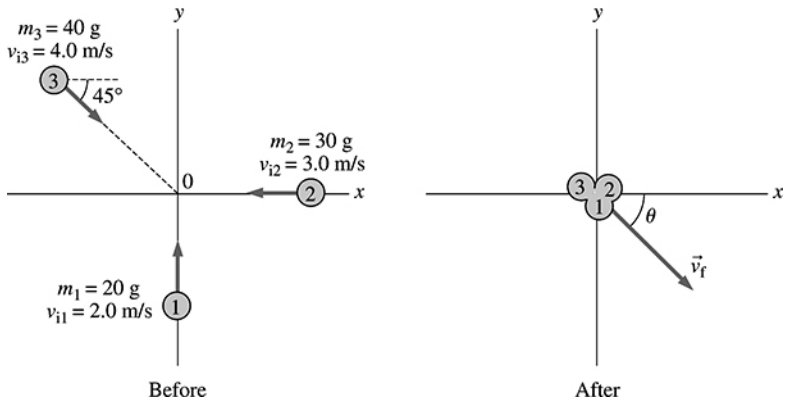
9.59. Model: Model the three balls of clay as particle 1 (moving north), particle 2 (moving west), and particle 3 (moving southeast). The three stick together during their collision, which is perfectly inelastic. The momentum of the system is conserved.

Visualize:

Pictorial representation



Solve: The three initial momenta are

$$\vec{p}_{i1} = m_1\vec{v}_{i1} = (0.020\text{ kg})(2.0\text{ m/s})\,\hat{j} = 0.040\hat{j}\ \text{kg m/s}$$

$$\vec{p}_{i2} = m_2\vec{v}_{i2} = (0.030\text{ kg})(-3.0\text{ m/s}\,\hat{i}) = -0.090\hat{i}\ \text{kg m/s}$$

$$\vec{p}_{i3} = m_3\vec{v}_{i3} = (0.040\text{ kg})\left[(4.0\text{ m/s})\cos 45°\hat{i} - (4.0\text{ m/s})\sin 45°\,\hat{j}\right] = \left(0.113\hat{i} - 0.113\hat{j}\right)\ \text{kg m/s}$$

Since $\vec{p}_f = \vec{p}_i = \vec{p}_{i1} + \vec{p}_{i2} + \vec{p}_{i3}$, we have

$$(m_1 + m_2 + m_3)\vec{v}_f = \left(0.023\hat{i} - 0.073\hat{j}\right)\ \text{kg m/s} \ \Rightarrow \vec{v}_f = \left(0.256\hat{i} - 0.811\hat{j}\right)\ \text{m/s}$$

$$\Rightarrow v_f = \sqrt{(0.256\text{ m/s})^2 + (-0.811\text{ m/s})^2} = 0.85\text{ m/s}$$

$$\theta = \tan^{-1}\frac{|v_{fy}|}{v_{fx}} = \tan^{-1}\frac{0.811}{0.256} = 72°\ \text{ below } +x$$