**Chapter 9 Problem 48** [†]

**Given**
$m_1 = 1250\ kg$
$\vec{v}_1 = \{36.2\hat{i} + 12.7\hat{j}\}\ m/s$
$m_2 = 448\ kg$
$\vec{v}_2 = \{13.8\hat{i} + 10.2\hat{j}\}\ m/s$

**Solution**
If the car and wagon stick together, find their velocity after the collision.

By conservation of momentum, the momentum of the car-wagon system before and after the collision is the same.

$$\vec{p}_{before} = \vec{p}_{after}$$

$$\vec{p}_1 + \vec{p}_2 = \vec{p}_T$$

$$m_1\vec{v}_1 + m_2\vec{v}_2 = (m_1 + m_2)\vec{v}_T$$

$$\vec{v}_T = \frac{m_1\vec{v}_1 + m_2\vec{v}_2}{(m_1 + m_2)}$$

$$\vec{v}_T = \frac{(1250\ kg)\{36.2\hat{i} + 12.7\hat{j}\}\ m/s + (448\ kg)\{13.8\hat{i} + 10.2\hat{j}\}\ m/s}{(1250\ kg + 448\ kg)}$$

$$\vec{v}_T = \frac{\{45,250\hat{i} + 15,875\hat{j}\}\ kg \cdot m/s + \{6,182\hat{i} + 4,570\hat{j}\}\ kg \cdot m/s}{(1698\ kg)}$$

$$\vec{v}_T = \frac{\{51,432\hat{i} + 20,445\hat{j}\}\ kg \cdot m/s}{(1698\ kg)}$$

$$\vec{v}_T = \{30.3\hat{i} + 12.0\hat{j}\}\ m/s$$

In polar coordinates this velocity is

$$v = \sqrt{(30.3\ m/s)^2 + (12.0\ m/s)^2} = 32.6\ m/s$$

$$\theta = \tan^{-1}\left(\frac{12.0\ m/s}{30.3\ m/s}\right) = 21.6^\circ$$

[†]Problem from Essential University Physics, Wolfson