Perfectly inelastic collisions are easy to analyze in terms of momentum because the objects become essentially one object after the collision. The final mass is equal to the combined masses of the colliding objects. The combination moves with a predictable velocity after the collision.

Consider two cars of masses m_1 and m_2 moving with initial velocities of $\mathbf{v_{1,i}}$ and $\mathbf{v_{2,i}}$ along a straight line, as shown in **Figure 11.** The two cars stick together and move with some common velocity, $\mathbf{v_f}$, along the same line of motion after the collision. The total momentum of the two cars before the collision is equal to the total momentum of the two cars after the collision.

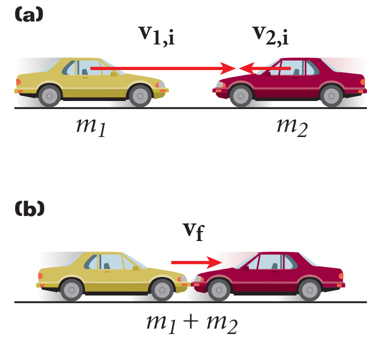

Figure 11
The total momentum of the two cars before the collision **(a)** is the same as the total momentum of the two cars after the inelastic collision **(b).**

PERFECTLY INELASTIC COLLISION

$$m_1\mathbf{v_{1,i}} + m_2\mathbf{v_{2,i}} = (m_1 + m_2)\,\mathbf{v_f}$$

This simplified version of the equation for conservation of momentum is useful in analyzing perfectly inelastic collisions. When using this equation, it is important to pay attention to signs that indicate direction. In **Figure 11,** $\mathbf{v_{1,i}}$ has a positive value (m_1 moving to the right), while $\mathbf{v_{2,i}}$ has a negative value (m_2 moving to the left).

SAMPLE PROBLEM E

Perfectly Inelastic Collisions

PROBLEM

A 1850 kg luxury sedan stopped at a traffic light is struck from the rear by a compact car with a mass of 975 kg. The two cars become entangled as a result of the collision. If the compact car was moving at a velocity of 22.0 m/s to the north before the collision, what is the velocity of the entangled mass after the collision?

SOLUTION

Given: $m_1 = 1850$ kg $\quad m_2 = 975$ kg $\quad \mathbf{v_{1,i}} = 0$ m/s

$\mathbf{v_{2,i}} = 22.0$ m/s to the north

Unknown: $\mathbf{v_f} = ?$

Use the equation for a perfectly inelastic collision.

$$m_1\mathbf{v_{1,i}} + m_2\mathbf{v_{2,i}} = (m_1 + m_2)\,\mathbf{v_f}$$

$$\mathbf{v_f} = \frac{m_1\mathbf{v_{1,i}} + m_2\mathbf{v_{2,i}}}{m_1 + m_2}$$

$$\mathbf{v_f} = \frac{(1850\text{ kg})(0\text{ m/s}) + (975\text{ kg})(22.0\text{ m/s north})}{1850\text{ kg} + 975\text{ kg}}$$

$$\boxed{\mathbf{v_f} = 7.59\text{ m/s to the north}}$$