Answer on Question #42082, Physics, Other

Two masses, m and 2m, approach each other along a path at right angles to each other. After collision, they stick together and move off at 2m/s at an angle 37 degree to the original direction of the mass m. What were the initial speeds of the two particles?

Solution:

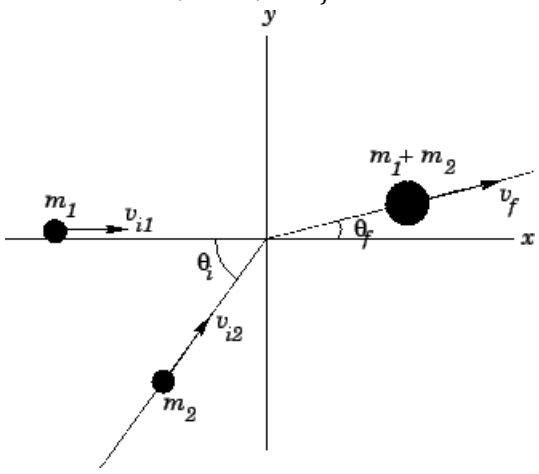
Given:
$m_1 = m,$
$m_2 = 2m,$
$v_f = 2\ \mathrm{m/s},$
$\theta_i = 90°$
$\theta_f = 37°,$
$v_{i1} = ?,$
$v_{i2} = ?$

When two bodies collide, the impulse between them determines the directions in which they then travel. In particular, when the collision is not head-on, the bodies do not end up traveling along their initial axis. For such two-dimensional collisions in a closed, isolated system, the total linear momentum must still be conserved:

$$\vec{P}_{1i} + \vec{P}_{2i} = \vec{P}_{1f} + \vec{P}_{2f}$$

In our case of inelastic collision:

$$\vec{P}_{1i} + \vec{P}_{2i} = \vec{P}_f$$



Momentum conservation along the x-axis yields

$$m_1 v_{i1} + m_2 v_{i2} \cos\theta_i = (m_1 + m_2) v_f \cos\theta_f = 3m v_f \cos\theta_f \qquad (1)$$

Likewise, momentum conservation along the y-axis gives

$$m_2 v_{i2} \sin\theta_i = (m_1 + m_2) v_f \sin\theta_f = 3m v_f \cos\theta_f \qquad (2)$$

Given the initial conditions, we have a system of two equations and two unknowns (i.e., v_{i2} and v_{i1}). Clearly, we should be able to find a unique solution for such a system.

From first equation

$$mv_{i1} + 2mv_{i2}\cos 90° = 3mv_f \cos\theta_f$$
$$v_{i1} = 3v_f \cos\theta_f$$
$$v_{i1} = 3 \cdot 2 \cdot \cos 37° = 4.792 \approx 4.8 \text{ m/s}$$

From second equation

$$2mv_{i2}\sin 90° = 3mv_f \cos\theta_f$$
$$v_{i2} = \frac{3}{2} v_f \cos\theta_f$$

$$v_{i2} = \frac{3}{2} \cdot 2 \cdot \cos 37° = 2.396 \approx 2.4 \text{ m/s}$$

Answer. $v_{i1} = 4.8$ m/s, $v_{i2} = 2.4$ m/s.