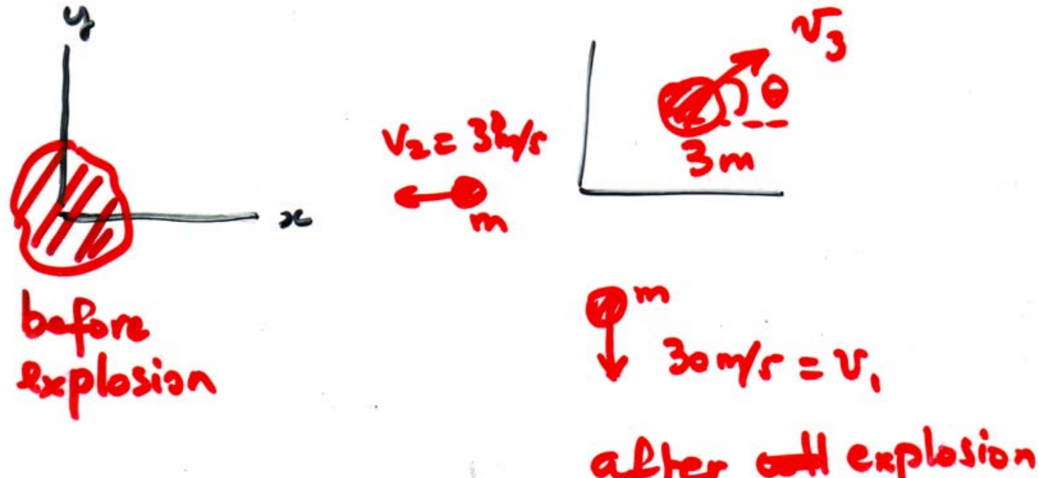
41. A vessel at rest at the origin of an xy coordinate system explodes into three pieces. Just after the explosion, one piece, of mass m, moves with velocity $(-30\text{ m/s})\hat{i}$ and a second piece, also of mass m, moves with velocity $(-30\text{ m/s})\hat{j}$. The third piece has mass $3m$. Just after the explosion, what are the (a) magnitude and (b) direction of the velocity of the third piece?



No net external forces

$\vec{P}$ = Constant

$\vec{P_i} = \vec{P_f}$ < $P_{x,i} = P_{x,f}$; $P_{y,i} = P_{y,f}$

$0 = -30\times m + v_3\cos\theta \times 3m$ — (1)

$0 = -30\times m + v_3\sin\theta \times 3m$ — (2)

(2) $\Rightarrow$ $v_3\sin\theta = 10$ $\quad \tan\theta = 1 \Rightarrow \theta = 45°$

(1) $\Rightarrow$ $v_3\cos\theta = 10$ $\quad v_3 = 14.4$ m/s

45. A 5.20 g bullet moving at 672 m/s strikes a 700 g wooden block at rest on a frictionless surface. The bullet emerges, travling at the same direction with its speed reduced to 428 m/s. a) What is the resulting speed of the block? (b) What is the speed of the bullet–block center of mass?

Conservation of linear momentum

$$m_1 v_{1i} + 0 = m_1 v_{1f} + m_2 v_{2f}$$

$$v_{2f} = \frac{m_1 v_{1i} - m_1 v_{1f}}{m_2} = 1.8 \text{ m/s.}$$

$$V_{cm} = \frac{m_1 v_{1i} + 0}{m_1 + m_2} = 4.9 \text{ m/s}$$

$$V_{cm} = \frac{m_1 v_{1f} + m_2 v_{2f}}{m_1 + m_2} = 4.9 \text{ m/s.}$$

$$V_{cm\,before} = V_{cm\,after} \;!!!$$

••50 In Fig. 9-60, a 10 g bullet moving directly upward at 1000 m/s strikes and passes through the center of mass of a 5.0 kg block initially at rest. The bullet emerges from the block moving directly upward at 400 m/s. To what maximum height does the block then rise above its initial position?

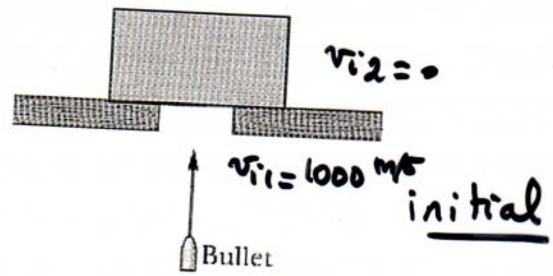


Fig. 9-60 Problem 50.

Conservation of linear momentum

$$m_1 v_{1i} + 0 = m_1 v_{1f} + m_2 v_{2f}$$

$$v_{2f} = \frac{m_1 v_{1i} - m_1 v_{1f}}{m_2} = 1.2 \text{ m/s.}$$

block alone

Chapter 8: $\Delta K + \Delta U_g = 0$

$$0 - \frac{1}{2} m_2 v^2 + m_2 g h = 0$$

$$h = \frac{v^2}{2g} = \frac{(1.2)^2}{2 \times 9.8} = 0.073 \text{ m}$$

36 The blocks in Fig. 10-37 slide without friction. (a) What is the velocity $\vec{v}$ of the 1.6 kg block after the collision? (b) Is the collision elastic? (c) Suppose the initial velocity of the 2.4 kg block is the reverse of what is shown. Can the velocity $\vec{v}$ of the 1.6 kg block after the collision be in the direction shown? **ssm**

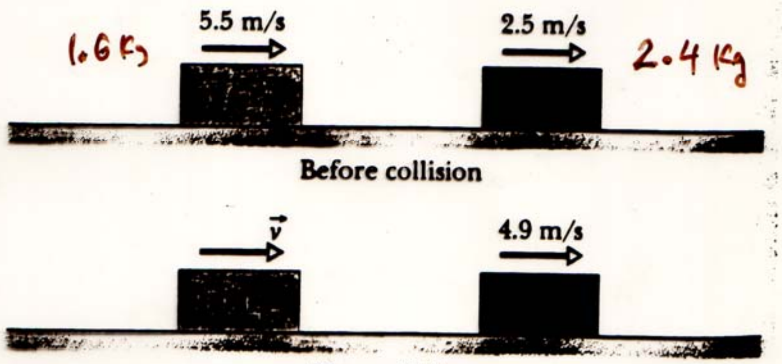


Fig. 10-37 Exercise 35.

a) Conservation of momentum

$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$$

$$v_{1f} = \frac{1.6 \times 5.5 + 2.5 \times 2.4 - 2.4 \times 4.9}{1.6} = \boxed{1.9 \text{ m/s}}$$

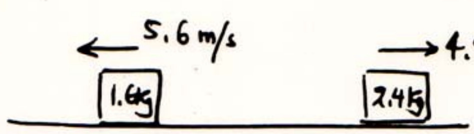
b) $K_i = \frac{1}{2} m_1 v_{1i}^2 + \frac{1}{2} m_2 v_{2i}^2 = 31.7 \text{ J}$

$K_f = \frac{1}{2} m_1 v_{1f}^2 + \frac{1}{2} m_2 v_{2f}^2 = 31.7 \text{ J}$

Since $K_i = K_f \Rightarrow$ the collision is elastic.

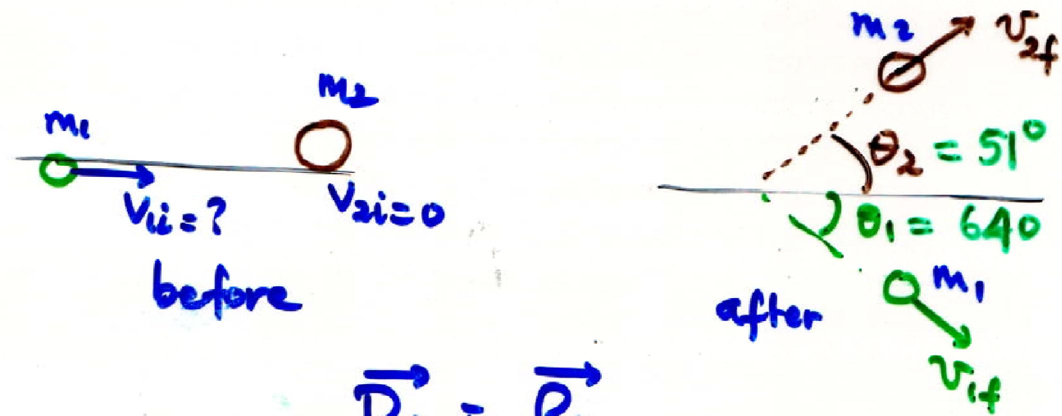
c) $v_{2i} = -2.5$ m/s

$$v_{1f} = \frac{1.6 \times 5.5 + (2.4)(-2.5) - 2.4 \times 4.9}{1.6} = -5.6 \text{ m/s}$$



after collision

65 In Fig. 9-22, projectile particle 1 is an alpha particle and target particle 2 is an oxygen nucleus. The alpha particle is scattered at angle $\theta_1 = 64.0°$ and the oxygen nucleus recoils with speed 1.20×10^5 m/s and at angle $\theta_2 = 51.0°$. In atomic mass units, the mass of the alpha particle is 4.00 u and the mass of the oxygen nucleus is 16.0 u. What are the (a) final and (b) initial speeds of the alpha particle? ILW



$$\vec{P_i} = \vec{P_f}$$

x-axis:

$$m_1 V_{1i} = + m_1 v_{1f} \cos\theta_1 + m_2 v_{2f} \cos\theta_2$$

y-axis

$$0 = - m_1 v_{1f} \sin\theta_1 + m_2 v_{2f} \sin\theta_2$$

$$v_{1f} = \frac{m_2 v_{2f} \sin\theta_2}{m_1 \sin\theta_1} = 4.2 \times 10^5 \frac{m}{s}$$

$$V_{1i} = \frac{m_1 v_{1f} \cos\theta_1 + m_2 v_{2f} \cos\theta_2}{m_1}$$

$$= 4.8 \times 10^5 \text{ m/s}.$$

66. Two 2.0 kg bodies, A and B, collide. The velocities before the collision are $\vec{v}_A = (15\hat{i} + 30\hat{j})$ m/s and $\vec{v}_B = (-10\hat{i} + 5.0\hat{j})$ m/s. After the collision, $\vec{v}'_A = (-5.0\hat{i} + 20\hat{j})$ m/s. What are (a) the final velocity of B and (b) the change in the total kinetic energy (including sign)?

a) $$m_A \vec{V_A} + m_B \vec{V_B} = m_A \vec{V_A}' + m_B \vec{V_B}'$$

$$\vec{V_B}' = \vec{V_A} + \vec{V_B} - \vec{V_A}'$$

$$= (15\hat{i} + 30\hat{j}) + (-10\hat{i} + 5\hat{j}) - (-5\hat{i} + 20\hat{j})$$

$$= 10\hat{i} + 15\hat{j} \text{ m/s}$$

b) $$K_i = \frac{1}{2} m_A V_A^2 + \frac{1}{2} m_B V_B^2$$

$$= 1.3 \times 10^3 \text{ J}$$

$$K_f = \frac{1}{2} m_A V_A'^2 + \frac{1}{2} m_B V_B'^2$$

$$= 8.0 \times 10^2 \text{ J}$$

$$\Delta K = K_f - K_i = -5 \times 10^2 \text{ J}$$

↑ lost