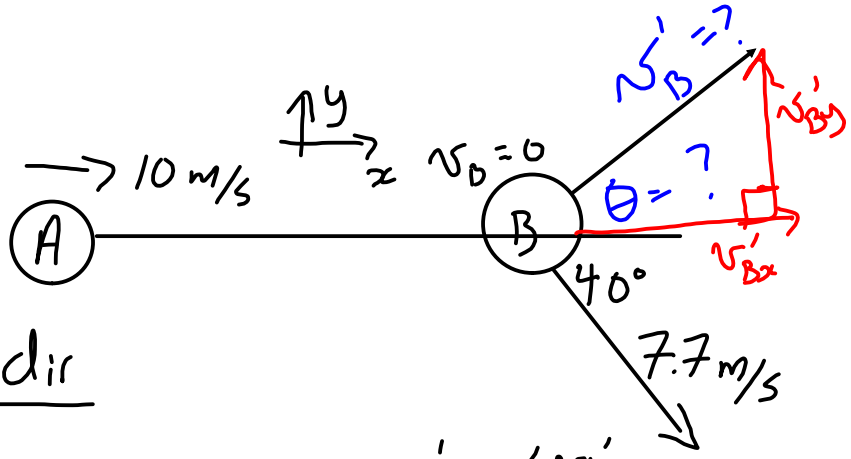
#35)



x-dir

$$m_A v_{Ax} + m_B v_{Bx} = m_A v_{Ax}' + m_B v_{Bx}'$$

$$10 + 0 = 7.7\cos 40 + v_{Bx}'$$

$$10 = 5.9 + v_{Bx}'$$

$$4.1 \text{ m/s} = v_{Bx}'$$

y-dir

$$m_A v_{Ay} + m_B v_{By} = m_A v_{Ay}' + m_B v_{By}'$$

$$0 = -7.7\sin 40 + v_{By}'$$

$$4.9 \text{ m/s} = v_{By}'$$

$$v_B' = \sqrt{(v_{Bx}')^2 + (v_{By}')^2}$$

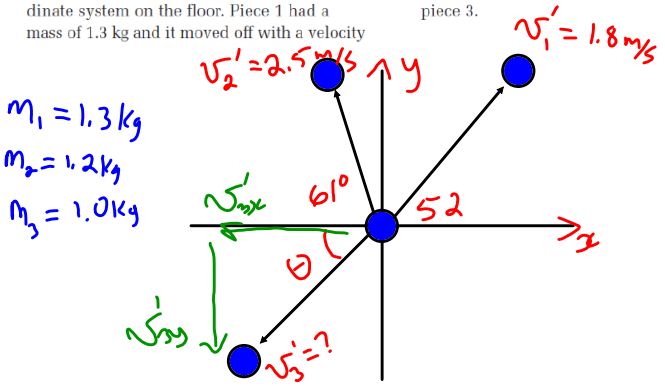
$$= \sqrt{40.8} = 6.4 \text{ m/s}$$

$$\theta = \tan^{-1}\left|\frac{v_{By}'}{v_{Bx}'}\right| = 50°$$

$v_B' = 6.4$ m/s 50° clockwise

counter

38. You accidentally dropped a 3.5 kg glass platter. Before it hit the floor, the motion was entirely in the vertical direction. When it hit the floor, it broke into three pieces and they all moved out in the plane of the floor. Imagine a coordinate system on the floor. Piece 1 had a mass of 1.3 kg and it moved off with a velocity of 1.8 m/s at an angle of 52° counterclockwise from the positive *x* axis. Piece 2 with a mass of 1.2 kg moved off with a velocity of 2.5 m/s at an angle of 61° clockwise from the negative *x* axis. Find the mass and the velocity of piece 3.



x-dir

$$0 = m_1 v_{1x}' + m_2 v_{2x}' + m_3 v_{3x}'$$

$v_{1x}' = 1.8\cos 52 = 1.11\ m/s$ $\quad v_{1y}' = 1.8\sin 52 = 1.42$

$v_{2x}' = -2.5\cos 61 = -1.21\ m/s$ $\quad v_{2y}' = 2.5\sin 61 = 2.19$

$$0 = (1.3)(1.11) + (1.2)(-1.21) + (1)(v_{3x}')$$

$$0 = 1.443 - 1.452 + v_{3x}'$$

$$0.009 = v_{3x}'$$

y-dir

$$0 = m_1 v_{1y}' + m_2 v_{2y}' + m_3 v_{3y}'$$

$$0 = (1.3)(1.42) + (1.2)(2.19) + (1) v_{3y}'$$

$$0 = 1.846 + 2.628 + v_{3y}'$$

$$-4.47\ m/s = v_{3y}'$$

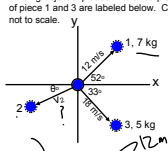
$$v_3' = \sqrt{(v_{3x}')^2 + (v_{3y}')^2}$$

$$v_3' = \sqrt{(0.009)^2 + (4.47)^2} = 4.47\ m/s$$

$$\theta = \tan^{-1}\left|\frac{4.47}{0.009}\right| = 90^\circ$$

$v_3' = 4.47\ m/s$ down y-axis

A 15 kg object explodes in to three pieces numbered 1, 2, and 3. The velocities of piece 1 and 3 are labeled below. Calculate the velocity of piece 2. Diagram is not to scale.



$P_i = 0 = P_f$

$m_2 = 3kg$

1) 12 m/s, 15°

P_{y1}

P_{x1}

$V_{x1} = 12\cos 52 = 7.39$

$V_{y1} = 12\sin 52 = 9.46$

2) = ??

3) 33°, 18 m/s

$V_{x3} = 18\cos 33 = 15.1$

$V_{y3} = -18\sin 33 = -9.8$

$P_{tot} = 0$ $\quad P_1 + P_2 + P_3 = 0$

$P_{x1} + P_{x2} + P_{x3} = 0$

$m_1 = 7$ $V_1 = 7.39$ $P = 51.73$

$m_3 = 5$ $V_{3x} = 15.1$ 75.5

$P_{x1} + P_{x2} + P_{x3} = 0$

$P_{x1} + P_{x3} = -P_{x2}$

$= -P_{x2}$

$-mv$

$-127.73 / 3$

$V_{x2} = -42.41$ $m_2 = 3kg$

$P_y \Rightarrow$ $V_{1y} = 9.46 m/s$ $m_1 = 7$

$V_{3y} = -9.8 m/s$ $m_3 = 5$

$P_{1y} + P_{2y} + P_{3y} = 0$

$(7)(9.46) + P_{2y} + (-9.8)(5)$

$66.22 \quad -49$

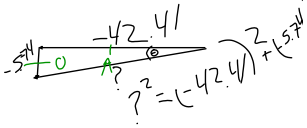
$-17.22 = P_{y2} = m_2 V_{2y}$

3

$V_{y2} = +5.74 m/s$

$V_{x2} = -42.41 m/s$

$V_{y2} = -5.74$



$?^2 = (-42.41)^2 + (-5.74)^2$

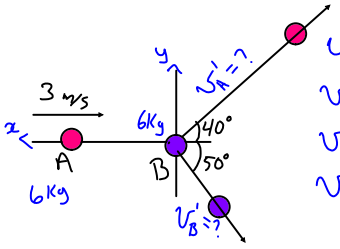
$? = \sqrt{1832}$

$= 42.8 m/s$

$\theta = \tan^{-1}\left|\frac{5.74}{42.41}\right|$

$\theta = 7.7^\circ$

Example: A 6.0 kg object, A, moving at a velocity of 3.0 m/s east collides with a 6.0 kg object, B, at rest. After the collision, A moves off in a direction 40.0° to the left of its original direction. B moves off in a direction 50.0° to the right of A's original direction. What is the magnitude of the velocity of each object after the collision? ($v_A' = 2.3$ m/s, $v_B' = 1.9$ m/s)



$v_{Ax} = 3$ m/s
$v_{Ay} = 0$ m/s
$v_{Bx} = 0$ m/s
$v_{By} = 0$ m/s

*all masses the same

x-dir

$m_A v_{Ax} + m_B v_{Bx} = m_A v_{Ax}' + m_B v_{Bx}'$

$3 + 0 = v_{Ax}' + v_{Bx}'$

y-dir

$0 + 0 = v_{Ay}' + v_{By}'$

$v_{Ax}' = v_A' \cos 40°$ $\quad v_{Bx}' = v_B' \cos 50$

$v_{Ay}' = v_A' \sin 40$ $\quad v_{By}' = -v_B' \sin 50$

x-dir

$3 = 0.766 v_A' + 0.643 v_B'$ (Eqn 1)

y-dir

$0 = 0.643 v_A' - 0.766 v_B'$ (Eqn 2)

Rearrange eqn 2 for v_A' or v_B'; we'll do v_B'

$0.766 v_B' = 0.643 v_A'$

$v_B' = \frac{0.643 v_A'}{0.766}$

$v_B' = 0.839 v_A'$ Sub into eqn 1

From above eqn 1 is:

$3 = 0.766 v_A' + 0.643 v_B'$

but $v_B' = 0.839 v_A'$

Eqn 1 becomes: $3 = 0.766 v_A' + 0.643(0.839 v_A')$

Solve for v_A':

$3 = 0.766 v_A' + 0.5397 v_A'$

$3 = 1.306 v_A'$

$2.3 \text{ m/s} = v_A'$ ← use to get v_B' as $v_B' = 0.839 v_A'$ ← worked out above

$v_B' = 0.839(2.3)$

$v_B' = 1.9$ m/s

Finally !! $v_A' = 2.3$ m/s

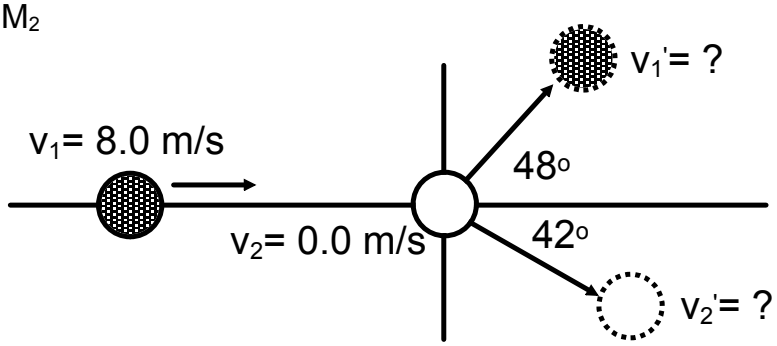
$v_B' = 1.9$ m/s

Practice Worksheet

Conservation of Momentum in 2D - Practice

Physics 122

1) $M_1 = M_2$

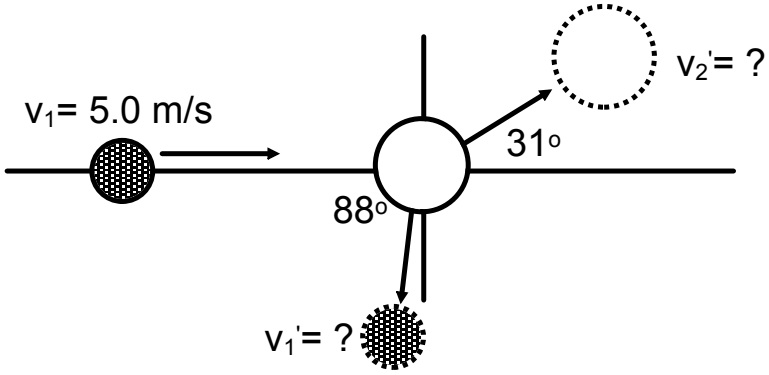


Answers

$v_1' = 5.3$ m/s

$v_2' = 6.0$ m/s

2) $M_1 = 1.5$ kg; $M_2 = 3.0$ kg

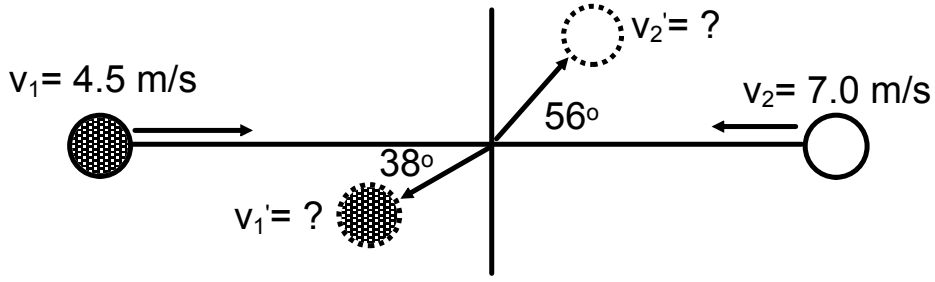


Answers

$v_1' = 2.9$ m/s

$v_2' = 2.9$ m/s

3) $M_1 = M_2$

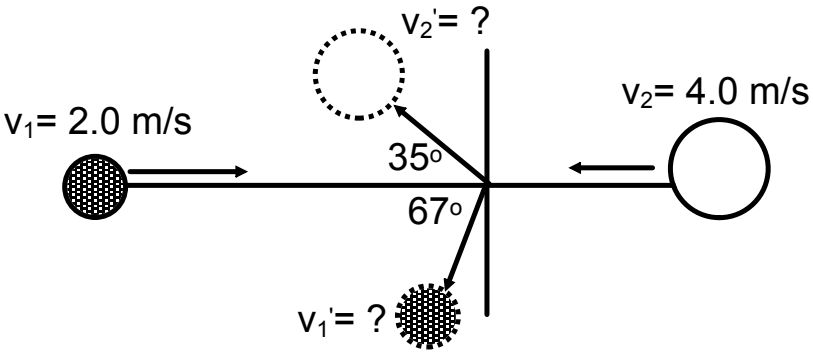


Answers

$v_1' = 6.7$ m/s

$v_2' = 5.0$ m/s

4) $M_1 = 2.0$ kg; $M_2 = 5.0$ kg



Answers

$v_1' = 4.6$ m/s

$v_2' = 3.0$ m/s