Locate the centre of mass coordinates for each of the following planar objects having uniform mass density:

A -

B -

A ball with mass \( m = 0.210 \) kg and kinetic energy \( K_1 = 2.97 \) J collides elastically with a second ball of the same mass that is initially at rest. After the collision, the first ball moves away at an angle of \( \theta_1 = 30.6^\circ \) with respect to the horizontal, as shown in the figure. What is the kinetic energy of the first ball after the collision?
Two balls of equal mass collide and stick together as shown in the figure. The initial velocity of ball B is twice that of ball A.

a) Calculate the angle above the horizontal of the motion of mass $A + B$ after the collision.

b) What is the ratio of the final velocity of the mass $A + B$ to the initial velocity of ball A, $v_f/v_A$?

c) What is the ratio of the final energy of the system to the initial energy of the system, $E_f/E_i$? Is the collision elastic or inelastic?

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A ball falls straight down onto a wedge that is sitting on frictionless ice. The ball has a mass of 3.00 kg, and the wedge has a mass of 5.00 kg. The ball is moving a speed of 4.50 m/s when it strikes the wedge, which is initially at rest (see the figure). Assuming that the collision is instantaneous and perfectly elastic, what are the velocities of the ball and the wedge after the collision?

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A particle ($M_1 = 1.00$ kg) moving at $30^\circ$ downward from the horizontal with $v_1 = 2.50$ m/s hits a second particle ($M_2 = 2.00$ kg), which was at rest momentarily. After the collision, the speed of $M_1$ was reduced to 0.50 m/s, and it was moving at an angle of $32^\circ$ downward with respect to the horizontal. Assume the collision is elastic.

a) What is the speed of $M_2$ after the collision?

b) What is the angle between the velocity vectors of $M_1$ and $M_2$ after the collision?
A block of mass \( m_b = 1.2 \text{ kg} \) slides to the right at a speed of 2.5 m/s on a frictionless horizontal surface, as shown in the figure. It "collides" with a wedge of mass \( m_w \), which moves to the left at a speed of 1.1 m/s. The wedge is shaped so that the block slides seamlessly up the Teflon (frictionless!) surface, as the two come together. Relative to the horizontal surface, block and wedge are moving with a common velocity \( v_{b+w} \) at the instant the block stops sliding up the wedge.

a) If the block's center of mass rises by a distance \( h = 0.37 \text{ m} \), what is the mass of the wedge?

b) What is \( v_{b+w} \)?

In Fig. 9-82, block 1 slides along an \( x \) axis on a frictionless floor with a speed of 0.75 m/s. When it reaches stationary block 2, the two blocks undergo an elastic collision. The following table gives the mass and length of the (uniform) blocks and also the locations of their centers at time \( t = 0 \). Where is the center of mass of the two-block system located (a) at \( t = 0 \), (b) when the two blocks first touch, and (c) at \( t = 4.0 \text{ s} \)?

<table>
<thead>
<tr>
<th>Block</th>
<th>Mass (kg)</th>
<th>Length (cm)</th>
<th>Center at ( t = 0 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.25</td>
<td>5.0</td>
<td>( x = -1.50 \text{ m} )</td>
</tr>
<tr>
<td>2</td>
<td>0.50</td>
<td>6.0</td>
<td>( x = 0 )</td>
</tr>
</tbody>
</table>
**Speed amplifier.** In Fig. 9-73, block 1 of mass $m_1$ slides along an $x$ axis on a frictionless floor with a speed of $v_{1i} = 4.00$ m/s. Then it undergoes a one-dimensional elastic collision with stationary block 2 of mass $m_2 = 0.500m_1$. Next, block 2 undergoes a one-dimensional elastic collision with stationary block 3 of mass $m_3 = 0.500m_2$. (a) What then is the speed of block 3? Are (b) the speed, (c) the kinetic energy, and (d) the momentum of block 3 greater than, less than, or the same as the initial values for block 1?

**Speed deamplifier.** In Fig. 9-74, block 1 of mass $m_1$ slides along an $x$ axis on a frictionless floor at speed 4.00 m/s. Then it undergoes a one-dimensional elastic collision with stationary block 2 of mass $m_2 = 2.00m_1$. Next, block 2 undergoes a one-dimensional elastic collision with stationary block 3 of mass $m_3 = 2.00m_2$. (a) What then is the speed of block 3? Are (b) the speed, (c) the kinetic energy, and (d) the momentum of block 3 greater than, less than, or the same as the initial values for block 1?

In the inelastic collision described in the figure find the angle $\theta$. 