2. (40 pts.) A 3.0 kg ball is moving with a velocity 4.0 m/s along the *x* axis. It strikes a 5.0 kg ball that was initially at rest. After the collision, the 5.0 kg ball moves with a velocity of 2.2 m/s at an angle of 35° away from the *x* axis. The collision takes place on a horizontal frictionless *xy* plane.

a. (10 pts.) *Before* doing any calculations, can you assume that the total mechanical energy of the system (kinetic + potential) is conserved during the collision? **Carefully** justify your answer.

b. (10 pts.) *Before* doing any calculations, can you assume that the total momentum of the system is conserved during the collision? **Carefully** justify your answer.

c. (20 pts.) Find the velocity *vector* of the $3.0 kg$ ball after the collison.

Big Hint: It is easiest to simply solve for the *x* and *y* components of the velocity of the 3.0 kg ball, rather than solving for the magnitude and direction.

3. (40 pts.) A 3.0 kg ball is moving with a velocity 4.0 m/s along the x axis. It strikes a 5.0 kg ball that was initially at rest. After the collision, the 5.0 kg ball moves with a velocity of 2.2 m/s at an angle of 35° away from the x axis. The collision takes place on a horizontal frictionless xy plane.

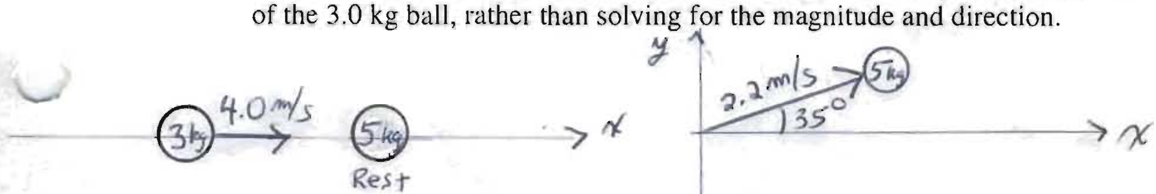
a. (10 pts.) *Before* doing any calculations, can you assume that the total mechanical energy of the system (kinetic + potential) is conserved during the collision? **Carefully** justify your answer. NO. You do not know the nature of the interaction forces. They might be non-conservative. [Remember the lab with sticky tape.]

b. (10 pts.) *Before* doing any calculations, can you assume that the total momentum of the system is conserved during the collision? **Carefully** justify your answer.

Yes. Since the net external force is zero, $\vec{P}_i = \vec{P}_f$.

c. (20 pts.) Find the velocity *vector* of the $3.0 kg$ ball after the collison.

Big Hint: It is easiest to simply solve for the x and y components of the velocity of the 3.0 kg ball, rather than solving for the magnitude and direction.



$\vec{P}_i = \vec{P}_f$

$m_1 = 3$
$m_2 = 5$
$\vec{v}_{1i} = 4\hat{i}$
$v_{2i} = 0$

$\vec{v}_{1f} = ?$
$\vec{v}_{2f} = 2.2 @ 35°$

$m_1\vec{v}_{1i} + m_2\vec{v}_{2i} = m_1\vec{v}_{1f} + m_2\vec{v}_{2f}$

$v_{2f,x} = 2.2 \cos 35° = 1.80$ m/s
$v_{2f,y} = 2.2 \sin 35° = 1.26$ m/s

x-components:

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

$\frac{(m_1 v_{1i,x} - m_2 v_{2f,x})}{m_1} = v_{1f,x}$

$\boxed{0.996 \text{ m/s} = v_{1f,x}}$

y-components:

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

$v_{1f,y} = \frac{-m_2}{m_1} v_{2f,y}$

$\boxed{v_{1f,y} = -2.10 \text{ m/s}}$

Alternate approach using magnitude and direction:

<u>x - components</u>:

$$m_1 v_{1ix} + 0 = m_1 v_{1f} \cos\theta_{1f} + m_2 v_{2f} \cos\theta_{2f}$$

$$v_{1f} \cos\theta_{1f} = \frac{(m_1 v_{1ix} + 0 - m_2 v_{2f} \cos\theta_{2f})}{m_1}$$

$$= \frac{(3\text{ kg})(4.0\text{ m/s}) - (5\text{ kg})(2.2\text{ m/s})\cos 35^\circ}{3\text{ kg}}$$

$$\boxed{v_{1f} \cos\theta_{1f} = 0.996\text{ m/s}}$$

<u>y - components</u>:

$$0 + 0 = m_1 v_{1f} \sin\theta_{1f} + m_2 v_{2f} \sin\theta_{2f}$$

$$v_{1f} \sin\theta_{1f} = \frac{-m_2 v_{2f} \sin\theta_{2f}}{m_1} = \frac{-(5\text{ kg})(2.2\text{ m/s})\sin 35^\circ}{3\text{ kg}}$$

$$\boxed{v_{1f} \sin\theta_{1f} = -2.10\text{ m/s}}$$

How do we combine these two to solve for v_{1f} and θ_{1f}?

Use 2 trig tricks: $\sin^2\theta + \cos^2\theta = 1$, and $\sin\theta / \cos\theta = \tan\theta$.

First: square and add

$$v_{1f}^2 \cos^2\theta_{1f} + v_{1f}^2 \sin^2\theta_{1f} = (0.996\text{ m/s})^2 + (-2.10\text{ m/s})^2$$

$$v_{1f}^2 (1) = 5.416\text{ m}^2/\text{s}^2$$

$$\boxed{v_{1f} = 2.33\text{ m/s}}$$

Second: take ratio:

$$\frac{v_{1f} \sin\theta_{1f}}{v_{1f} \cos\theta_{1f}} = \frac{-2.10\text{ m/s}}{0.996\text{ m/s}}$$

$$\tan\theta_{1f} = -2.108$$

$$\boxed{\theta_{1f} = -64.6^\circ}$$