Name: Solutions

Collaborator(s): ______

This tutorial will walk you through solving a physics problem involving collisions in 2-D. Following these steps will enable you to solve a wide variety of similar problems.

After class last time, I played with the air pucks a little. I pushed a puck in the +y direction at a velocity of 1 m/sec. It collided with a second puck that was initially at rest. After the collision, the first puck's velocity was reduced to 0.5 m/sec, and it was moving at a 45° angle (between the +x and +y axes). The two pucks had the same mass. What was the velocity of the second puck after the collision? What fraction of the initial kinetic energy was lost?

Identify the missing and relevant information

1. List all the relevant variables for which you know a value. List the variable(s) you will be solving for.

$v_{1xi}=0$ $\quad v_{1xf}=0.5\cos 45^\circ$

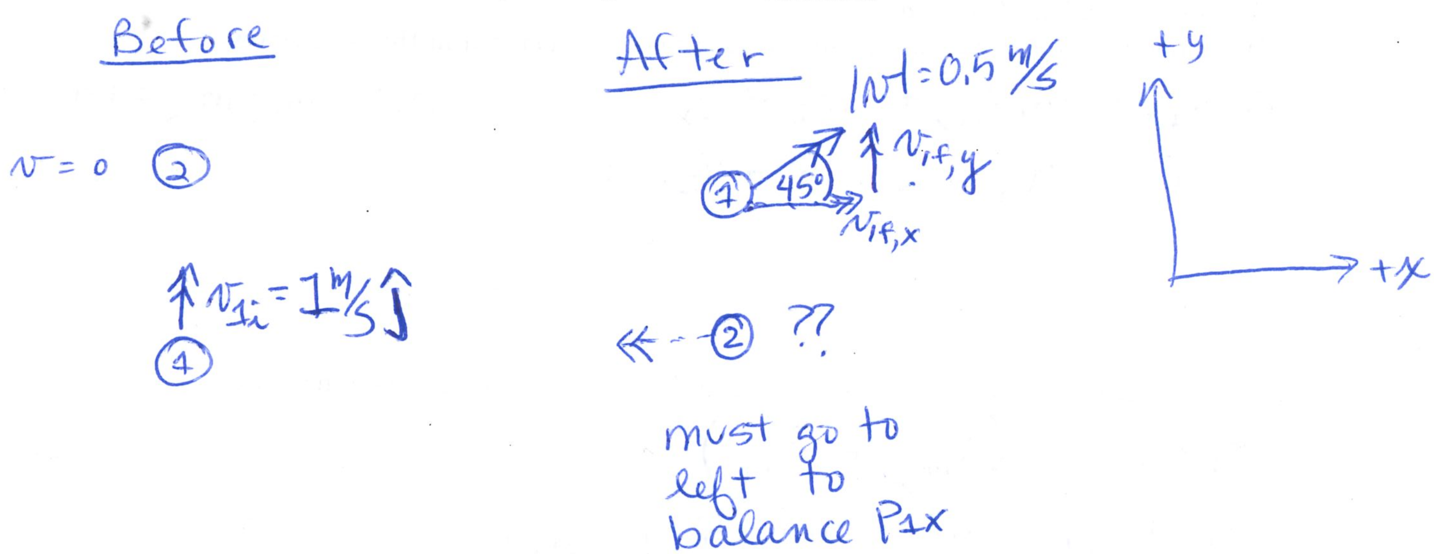
$v_{2xi}=0$ $\quad v_{1yf}=0.5\sin 45^\circ$

$v_{2yi}=0$ $\quad v_{2xf}=?$

$m_1=m_2=m$ $\quad v_{2yf}=?$

Draw a diagram

2. Draw a diagram of the system, labeling all known variables.



Determine what equations/principals will be useful in solving the problem

3. Can we assume conservation of linear momentum applies? Why or why not?

Yes, no external forces.

4. Can we assume conservation of kinetic energy applies? Why or why not?

No, not enough info.

Divide the the problem into x and y components.

5. Write expressions for the x and y components of velocity for both pucks and the initial and final times.

x

$v_{1ix} = 0$

$v_{2ix} = 0$

$v_{1fx} = \frac{1}{2}\cos 45^\circ$

$v_{2fx} = v_2 \cos\theta = -v_{1fx}$

y

$v_{1iy} = 1\ m/s$

$v_{2iy} = 0$

$v_{1fy} = \frac{1}{2}\sin 45^\circ$

$v_{2fy} = v_2 \sin\theta$

Write down the relevant equations

6. Write down your equation for conservation of linear momentum in the x-direction.

$m_1 V_{1x} = m_1 V_{1fx} + m_2 V_{2fx}$

$0 = m\left(\frac{1}{2}\cos 45^\circ - V_{2fx}\right)$

note $m_1 = m_2 = m$

7. Write down your equation for conservation of linear momentum in the y-direction.

$m_1 V_{1y} = m\left(\vec{v}_{1fy} + \vec{v}_{2fy}\right)$

$m\,(1\ m/s) = m\left(\frac{1}{2}\sin 45^\circ + V_{2fy}\right)$

Solve for the desired information

7. Solve the system of equations to find the velocity of the second puck after the collision.

$$\frac{1}{2}\cos 45^\circ = -V_{2xf}$$

$$V_{2fx} = -\frac{1}{2}\cos 45^\circ = -\frac{1}{2}\left(\frac{1}{\sqrt{2}}\right)$$

$$V_{2fx} = -0.35 \text{ m/s}$$

$$1 - \frac{1}{2}\sin 45^\circ = V_{2fy}$$

$$1 - \frac{1}{2}\left(\frac{1}{\sqrt{2}}\right) = 0.65 \text{ m/s} = V_{2fy}$$

$$|V_2| = \sqrt{(-.35)^2 + (0.65)^2} = 0.74 \text{ m/s}$$

$$\boxed{\vec{V}_{2f} = -0.35\,\hat{i} + 0.65\,\hat{j}}$$

$$\theta = \tan^{-1}\left(\frac{.65}{.35}\right) \approx 62^\circ \text{ N of W}$$

8. Determine the initial and final kinetic energy of the system and determine what fraction of the initial kinetic energy was lost.

$$\frac{1}{2}mv_{1i}^2 \stackrel{?}{=} \frac{1}{2}mV_{1f}^2 + \frac{1}{2}mV_{2f}^2$$

$$\frac{1}{2}m\left(1\frac{m}{s}\right)^2 \; ? \; \frac{1}{2}m\left(0.5\frac{m}{s}\right)^2 + \frac{1}{2}m\left(0.74\text{ m/s}\right)^2$$

$$1 \neq .25 + .55$$

$$\text{Lost: } 1 - \frac{K_{Ef}}{K_{Ei}} = 1 - \frac{.8}{1} = 20\% \text{ lost}$$

Check the reasonableness of your answer

9. Have you witnessed a similar situation in the real-world? Does your answer seem reasonable?

Yes