Student ID: [ ][ ][ ][ ] - [ ][ ][ ][ ]

PHYS121 2005F
Test #2
17:00-19:00 Saturday 2005-11-12

Surname: O'Donnell

Given Name: ____________

5. Two identical pucks of mass m and radius r are in contact and at rest on a frictionless horizontal surface. A third identical puck is sliding along the surface with a velocity $\vec{v}_{1i}$ such that it will strike the two stationary pucks simultaneously in a perfectly elastic two dimensional collision.

(1) (a) Below the diagram to the right draw the system at the moment of contact of the three pucks. Add vectors representing the directions of final velocities, $\vec{v}_{2f}$ & $\vec{v}_{3f}$, of the two initially stationary pucks.

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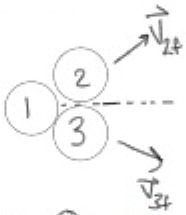


(3) (b) What will be the directions, θ_1, θ_2 & θ_3, of the velocities of the three pucks with respect to the direction of $\hat{\imath}$ unit vector after the collision?

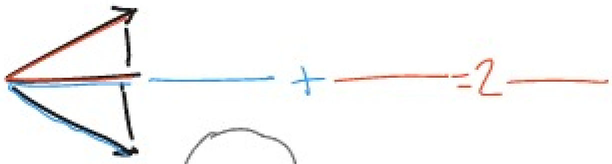
$\sin\theta = \frac{1}{2}$

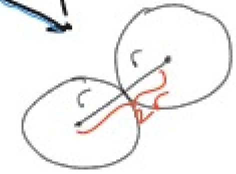
$\cos\theta = \frac{\sqrt{3}}{2}$

$\Rightarrow \theta_1 = 0, \pi$

$\theta_2 = +\pi/6$

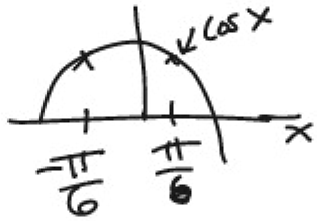
$\theta_3 = -\pi/6$





(1) (c) What is the ratio of the final speeds of the two initially stationary pucks, v_{2f}/v_{3f}?

$$\frac{V_{2f}}{V_{3f}} = 1$$



(5) (d) What will be the final speed of the initially moving puck, v_{1f}?

$$P_i = P_f$$

$$\cancel{m}V_{1i} = \cancel{m}V_{1f} + \cancel{m}V_{2f}\cos\theta_2 + \cancel{m}V_{3f}\cos\theta_3$$

$$V_{1i} = V_{1f} + V_{2f}\frac{\sqrt{3}}{2} + V_{3f}\frac{\sqrt{3}}{2}$$

$$\boxed{V_{1i} = V_{1f} + \cancel{2}V_{2f}\frac{\sqrt{3}}{\cancel{2}}} \rightarrow \boxed{V_{1i} - V_{1f} = V_{2f}\sqrt{3}}$$

$$E_i = E_f$$

$$\cancel{\tfrac{1}{2}m}V_{1i}^2 = \cancel{\tfrac{1}{2}m}V_{1f}^2 + \cancel{\tfrac{1}{2}m}V_{2f}^2 + \cancel{\tfrac{1}{2}m}V_{3f}^2$$

$$V_{1i}^2 = V_{1f}^2 + V_{2f}^2 + V_{3f}^2$$

$$\boxed{V_{1i}^2 = V_{1f}^2 + 2V_{2f}^2} \rightarrow \boxed{V_{1i}^2 - V_{1f}^2 = 2V_{2f}^2}$$

$$\underbrace{(V_{1i} - V_{1f})}(V_{1i} + V_{1f}) = 2V_{2f}^2$$

$$\cancel{V_{2f}}\sqrt{3}\,(V_{1i} + V_{1f}) = 2V_{2f}^{\cancel{2}}$$

$$V_{1i} + V_{1f} = \frac{2}{\sqrt{3}}\left(\frac{V_{1i} - V_{1f}}{\sqrt{3}}\right)$$

$$3(V_{1i} + V_{1f}) = \frac{2}{\cancel{3}}(V_{1i} - V_{1f})$$

$$3V_{1f} + 2V_{1f} = 2V_{1i} - 3V_{1i}$$

$$\boxed{V_{1f} = -\frac{1}{5}V_{1i}}$$