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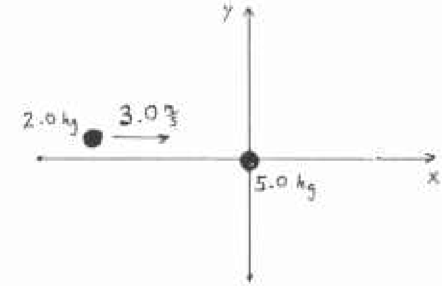
Phys 221 (Section 6)

Quiz #4

1. A 2.0 kg mass moves in the $+x$ direction with a speed of $3.0\,\frac{m}{s}$. It makes a glancing collision with a stationary 5.0 kg mass; after the collision the 2.0 kg mass has a speed of $1.0\,\frac{m}{s}$ and moves in a direction 115° from the x axis.



a) Find the x and y velocity components of the 5.0 kg mass after the collision.

Total x-momentum is conserved:

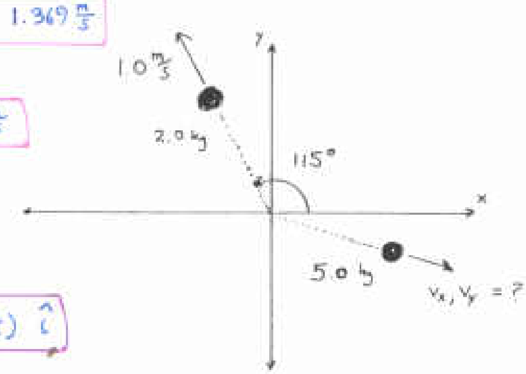
$(2.0\,kg)(3.0\,\frac{m}{s}) = (2.0\,kg)(1.0\,\frac{m}{s})\cos(115°) + (5.0\,kg)\,V_{2x}$

Solve for V_{2x}: $6.0\,\frac{kg\,m}{s} = -.845\,\frac{kg\,m}{s} + (5.0\,kg)\,V_{2x}$ $\quad$ $V_{2x} = 1.369\,\frac{m}{s}$

Total y-momentum is conserved:

$0 = (2.0\,kg)(1.0\,\frac{m}{s})\sin(115°) + (5.0\,kg)\,V_{2y}$

$0 = 1.813\,\frac{kg\,m}{s} + (5.0\,kg)\,V_{2y}$ $\rightarrow$ $V_{2y} = -0.362\,\frac{m}{s}$



b) Find the velocity of the center of mass.

The velocity of the cm is the same before & after the collision. Using the velocity values before the collision,

$V_{x\,cm} = \frac{m_1 V_{1x} + m_2 V_{2x}}{m_1 + m_2} = \frac{(2.0\,kg)(3.0\,\frac{m}{s})}{7\,kg} = 0.857\,\frac{m}{s}$

$V_{y\,cm} = \frac{m_1 V_{1y} + m_2 V_{2y}}{m_1 + m_2} = 0$ $\rightarrow$ $\vec{V}_{cm} = (0.857\,\frac{m}{s})\,\hat{i}$

c) How much kinetic energy was lost in the collision?

Initial KE:

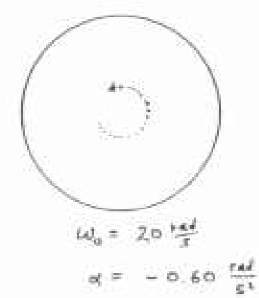
$E_i = \frac{1}{2}(2.0\,kg)(3.0\,\frac{m}{s})^2 = 9\,J$

Final KE:

$E_f = \frac{1}{2}(2.0\,kg)(1\,\frac{m}{s})^2 + \frac{1}{2}(5.0\,kg)\left[(1.369)^2 + (.362)^2\right]\frac{m^2}{s^2} = 6.014\,J$

So $9\,J - 6.014\,J = 2.986\,J$ of KE was lost.

2. A wheel with an initial angular velocity of $20\,\frac{rad}{s}$ slows to a halt with a constant angular acceleration of $-0.60\,\frac{rad}{s^2}$.



a) How long does it take to stop?

$\omega = \omega_0 + \alpha t$, $\omega = 0$ when wheel has stopped.

Solve for t:

$t = \frac{\omega - \omega_0}{\alpha} = \frac{0 - (20\,\frac{rad}{s})}{-.60\,rad/s^2} = 33.3\,s$

b) How many revolutions does it make in stopping?

Use $\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$:

$(\theta - \theta_0) = \frac{\omega^2 - \omega_0^2}{2\alpha} = \frac{0 - (20\,\frac{rad}{s})^2}{2(-.60\,\frac{rad}{s^2})} = 333\,rad$

This is the angular displacement of the wheel in stopping. The number of revolutions is:

$\#\,rev's = (333\,rad)\left(\frac{1\,rev}{2\pi\,rad}\right) = 53.1\,revs$

$$\mathbf{p} = m\mathbf{v} \qquad \mathbf{P} = M\mathbf{v}_{cm} \qquad \mathbf{F}_{ext} = \frac{d\mathbf{P}}{dt}$$