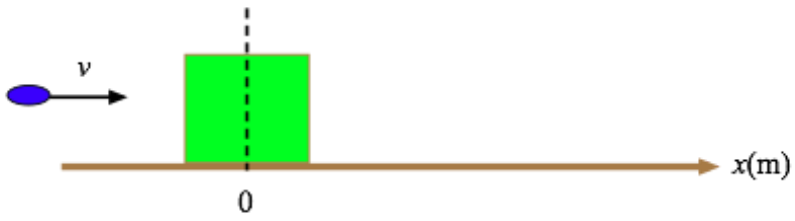
Your Name: _____ **PHY203**
Exam #3
Chapters 8-1
Fri., 4/15/11

Solutions

For problems1-3,
A bullet of mass 20.0 g is traveling in the positive x direction with a speed of v = 250 m/s when it strikes and embeds itself in a block of mass 0.500 kg that had been at rest on a frictionless table. The bullet/block system moves off in the positive x direction.



1. Find the momentum of the bullet before the collision with the block:

a. 3.0 kgm/s
b. 5.0 kgm/s
c. 10 kgm/s
d. 50 kgm/s
e. 5000 kgm/s

p = mv = (.02 kg)(250 m/s)

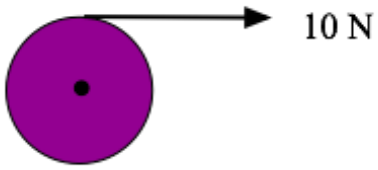
2. What can we say about the momentum of the bullet/block system after the collision?

a. It is the same as the momentum before the collision.
b. It is the greater than the momentum before the collision.
c. It is the less than the momentum before the collision.
d. None of the above.
e. Not enough information is given.

3. Find the distance the bullet+block travels in 2.0 seconds after the collision:

a. 0
b. 18 m
c. 19 m
d. 20 m
e. 22 m

x = vt = $\frac{p}{m_{tot}}t = \frac{5.0\,\text{kgm}\,2/\text{s}}{0.02\,\text{kg}+0.50\,\text{kg}}(2.0\text{s})$



For problems 4-7:
A solid sphere of mass 10 kg and radius 0.5 m is being held in place by a rod through its center and is initially at rest. A force of 10 N is applied at the edge of the sphere in a direction perpendicular to the radius, as shown.

4. Find the moment of inertia about the axis of the sphere:

a. 0.25 kgm^2
b. 0.5 kgm^2
c. 1.0 kgm^2
d. 1.25 kgm^2
e. 2.5 kgm^2

$I = \frac{2}{5}mr^2 = \frac{2}{5}(10\,\text{kg})(0.5\,\text{m})^2$

5. Find the magnitude of the torque on the sphere:

a. 0.50 Nm
b. 2.5 Nm
c. 5.0 Nm
d. 20 Nm
e. 50 Nm

t = rFsinq = (0.5 m)(10 N)sin(0) = 5 Nm

6. Find the angular speed of the sphere after the torque has been applied for 10 s:
a. 0.25 rad/s
b. 0.50 rad/s
c. 5.0 rad/s
d. 25 rad/s
e. 50 rad/s

$w = w_o + at = 0 + (t/I)(10\,s) = (5\text{Nm}/1\ \text{kgm}^2)(10\,s)$

7. Find the magnitude of the angular displacement of the sphere after the torque has been applied for 10 s:
a. 2.5 rad
b. 5.0 rad
c. 50 rad
d. 250 rad
e. 500 rad

$q = q_o + w_o t + 1/2at^2 = 0 + 0 + 1/2(t/I)(10\,s)^2$
$= 1/2(5\text{Nm}/1\ \text{kgm}^2)(10\,s)^2$

8. For which case below is the magnitude of the impulse imparted to the ball the greatest? (Assume all motion is along the *x* axis.)

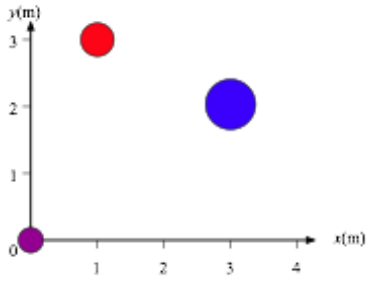
a. A ball of mass 0.25 kg hits a wall at a speed of 3.0 m/s and sticks to the wall.

b. A ball of mass 0.25 kg hits a wall at a speed of 2.5 m/s and bounces back at a speed of 1.5 m/s.
c. A ball of mass 0.50 kg hits a wall at a speed of 1.5 m/s and sticks to the wall.
d. A ball of mass 0.50 kg hits a wall at a speed of 1.0 m/s and bounces back at a speed of 0.50 m/s.
e. A ball of mass 1.00 kg hits a wall at a speed of 0.50 m/s and bounces back at a speed of 0.25 m/s.

answer = greatest value of $m(v_1 + v_2) =$ (0.25 kg) (2.5 m/s + 1.5 m/s) = 1.0 kg·m/s

9. Of momentum, kinetic energy, and total energy, which are conserved in an elastic collision?

a. momentum only
b. momentum and kinetic energy only
c. momentum and total energy only
d. kinetic energy and total energy only
e. all three

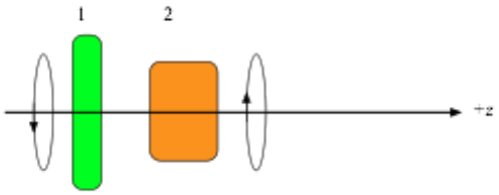


10. Point masses are placed as follows: 1kg at x=y=0; 2kg at x=1m y=3m; and 3kg at x=3m, y=2m, as shown above. Find the x and y positions of the center of mass:

	x_{cm}	y_{cm}
a.	**1.83m**	**2.0m**
b.	1.83m	2.17m
c.	2.0m	2.0m
d.	2.0m	2.17m
e.	2.17m	2.17m

x_{cm}=[(1kg)(0m) + (2kg)(1m) + (3kg)(3.0m)]/(6kg) =[11kgm]/(6kg)

y_{cm}=[(1kg)(0m) + (2kg)(3 m) + (3kg)(2.0m)]/(6kg) =[12kgm]/(6kg)



11. Two disks are rotating as shown above. Disk 1 is a solid disk with mass of 2.0 kg and radius of 1.0 m and initial angular speed of 20 rad/s. Disk 2 is a hollow disk (hollow cylinder) with mass of 8.0 kg and radius of 0.5 m and initial angular speed of 30 rad/s.
a. Calculate the moment of inertia of disk 1.

$I_1 = \frac{1}{2}MR^2 = \frac{1}{2}(2.0\,\text{kg})(1.0\,\text{m})^2 = 1.0\ \text{kgm}^2$

b. Calculate the moment of inertia of disk 2.

$I_2 = MR^2 = (8.0\,\text{kg})(0.5\,\text{m})^2 = 2.0\ \text{kgm}^2$

c. Calculate the initial angular moment of disk 1 about the z axis and express it in vector notation, using the coordinate system given above.

$L_1 = I_1\omega_1 = +(1.0\text{kgm}^2)(20\ \text{rad/s})\mathbf{k} = +(20\ \text{kgm}^2/\text{s})\mathbf{k}$

d. Calculate the initial angular moment of disk 2 about the z axis and express it in vector notation, using the coordinate system given above.

$L_2 = I_2\omega_2 = -(2.0\text{kgm}^2)(30\ \text{rad/s})\mathbf{k} = -(60\ \text{kgm}^2/\text{s})\mathbf{k}$

e. Calculate the total initial angular moment of the 2-disk system about the z axis and express it in vector notation, using the coordinate system given above.

$L_{tot} = L_1 + L_2 = +(20\ \text{kgm}^2/\text{s})\mathbf{k} - (60\ \text{kgm}^2/\text{s})\mathbf{k} = -(40\ \text{kgm}^2/\text{s})\mathbf{k}$

The disks are now brought into contact so that they stick together.
f. Find the final angular moment of the 2-disk system about the z axis and express it in vector notation, using the coordinate system given above.

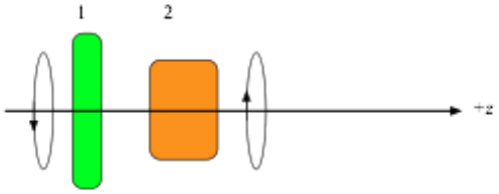
same as e. $-(40\ \text{kgm}^2/\text{s})\mathbf{k}$

g. Find the total moment of inertia of the 2-disk system.

$I_{tot} = I_1 + I_2 = 1.0\text{kgm}^2 + 2.0\text{kgm}^2 = 3.0\text{kgm}^2$

h. Find the final angular velocity of the 2-disk system about the z axis and express it in vector notation, using the coordinate system given above.

$\vec{\omega} = \frac{L}{I} = \frac{-(40\ \text{kgm}^2/\text{s})\mathbf{k}}{3.0\,\text{kgm}^2} = -(13.3\ \text{rad/s})\mathbf{k}$



11. Two disks are rotating as shown above. Disk 1 is a solid disk with mass of 1.0 kg and radius of 2.0 m and initial angular speed of 30 rad/s. Disk 2 is a hollow disk (hollow cylinder) with mass of 6.0 kg and radius of 1.0 m and initial angular speed of 20 rad/s.
a. Calculate the moment of inertia of disk 1.

$I_1 = \frac{1}{2}MR^2 = \frac{1}{2}(1.0\,\text{kg})(2.0\,\text{m})^2 = 2.0\ \text{kgm}^2$

b. Calculate the moment of inertia of disk 2.

$I_2 = MR^2 = (6.0\,\text{kg})(1.0\,\text{m})^2 = 6.0\ \text{kgm}^2$

c. Calculate the initial angular moment of disk 1 about the z axis and express it in vector notation, using the

coordinate system given above.

$L_1 = I_1 w_1 = +(2.0 \text{kgm}^2)(30 \text{ rad/s})\mathbf{k} = +(60 \text{ kgm}^2/\text{s})\mathbf{k}$

d. Calculate the initial angular moment of disk 2 about the z axis and express it in vector notation, using the coordinate system given above.

$L_2 = I_2 w_2 = -(6.0 \text{kgm}^2)(20 \text{ rad/s})\mathbf{k} = -(120 \text{ kgm}^2/\text{s})\mathbf{k}$

e. Calculate the total initial angular moment of the 2-disk system about the z axis and express it in vector notation, using the coordinate system given above.

$L_{tot} = L_1 + L_2 = +(60 \text{ kgm}^2/\text{s})\mathbf{k} - (120 \text{ kgm}^2/\text{s})\mathbf{k} = -(60 \text{ kgm}^2/\text{s})\mathbf{k}$

The disks are now brought into contact so that they stick together.
f. Find the final angular moment of the 2-disk system about the z axis and express it in vector notation, using the coordinate system given above.

same as e. $-(60 \text{ kgm}^2/\text{s})\mathbf{k}$

g. Find the total moment of inertia of the 2-disk system.

$I_{tot} = I_1 + I_2 = 2.0\text{kgm}^2 + 6.0\text{kgm}^2 = 8.0\text{kgm}^2$

h. Find the final angular velocity of the 2-disk system about the z axis and express it in vector notation, using the coordinate system given above.

$$\vec{\omega} = \frac{L}{I} = \frac{-(60\,\text{kgm}^2/\text{s})\text{k}}{8.0\,\text{kgm}^2} = -(7.5 \text{ rad/s})\mathbf{k}$$