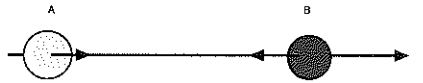


Your Name: _____

PHY203
Exam #3
Chapters 8-10, 14
Mon., 4/30/18

Solutions

Exam3S18



1. Two disks traveling on a one-dimensional track (x-direction) collide into each other. The masses and speeds before the collision of disk A are 5.50 kg and 4.00 m/s and of disk B are 3.00 kg and 3.50 m/s.

a. Assuming the disks stick to each other, which of the following are conserved in the collision? (Circle all that apply.)

momentum

kinetic energy

total energy

6

b. Find the momenta of each disks, p_A and p_B , before the collision in vector notation.

$$\vec{p}_A = (5.50)(4.00) = +22.0 \hat{x} \text{ kg m/s}$$

$$\vec{p}_B = (3.00)(-3.50) = -10.5 \hat{x} \text{ kg m/s}$$

5

5

c. Assuming the disks stick to each other after the collision, find the final velocity of the disks after the collision in vector notation.

$$p_{tot} = 11.5 = (5.50 + 3.00) v_f$$

$$\vec{v}_f = 1.35 \hat{x} \text{ m/s}$$

7

d. Instead, assuming the disks collide elastically, which of the following are conserved in the collision? (Circle all that apply.)

momentum

kinetic energy

total energy

6

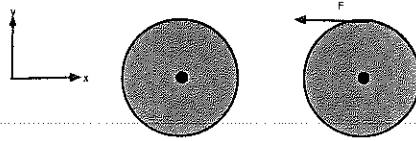
e. For the elastic case, explain briefly how you would find the velocities of the pucks after the collision.

$$\text{Set } \vec{p}_{tot i} = \vec{p}_{tot f}$$

$$K_{tot i} = K_{tot f}$$

Substitute and solve for the 2 velocities.

6



2. A thin spherical shell has a mass of 4.50 kg and a radius of 0.750 m. It is rotating about an axis through its center with angular speed of 5.50 rad/s in a clockwise direction as seen from above.

a. Find the moment of inertia of the shell.

$$I = \frac{2}{3} (4.50) (0.750)^2 = 1.69 \text{ kg m}^2 \quad 5$$

b. Find the angular momentum of the shell in vector notation. Assume out of the page is the +z-direction.

$$\begin{aligned} L &= I\omega = (1.69) (-5.50) \\ &= -9.28 \hat{k} \text{ kg m}^2/\text{s} \end{aligned} \quad 5$$

c. Find how long it takes the shell to rotate through 900°.

$$\begin{aligned} \theta &= \frac{900^\circ}{360} \cdot 2\pi = 15.7 \text{ rad} \\ 15.7 &= 0 + (5.50)t \\ t &= 2.86 \text{ s} \end{aligned} \quad 10$$

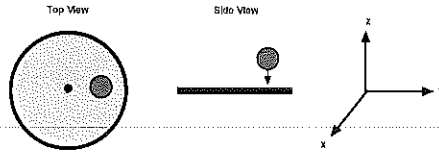
A force of 25.0 N is applied to the edge of the shell in a direction tangent to the shell as shown above.

d. Find the torque on the shell in vector notation.

$$\begin{aligned} \vec{\tau} &= \vec{r} \times \vec{F} = (0.750)(25.0) \\ &= 18.8 \hat{k} \text{ N}\cdot\text{m} \end{aligned} \quad 5$$

e. Find the new angular speed of the shell after the force has been applied for 2.00 s.

$$\begin{aligned} \alpha &= \frac{\tau}{I} = \frac{18.8}{1.69} = 11.1 \frac{\text{rad}}{\text{s}^2} \\ \omega &= -5.50 + 11.1(2.00) = 16.7 \frac{\text{rad}}{\text{s}} \end{aligned} \quad 10$$



3. a. A solid disk of mass 3.50 kg and radius 0.750 m is rotating clockwise as viewed from above with an angular speed of 4.50 rad/s .

a. Find the moment of inertia and the angular momentum of the disk and express the angular momentum in vector notation. Take the z-axis in the positive direction as out of the paper (for the figure on the left) ("up" in the figure to the right).

$$I = \frac{1}{2} (3.50) (0.750)^2 = 0.984 \text{ kg m}^2 \quad 5$$

$$L = I\omega = (0.984) (-4.50) = -4.43 \hat{k} \text{ kg m}^2/\text{s} \quad 5$$

b. A blob of clay of mass 1.45 kg is dropped onto the moving disk at a distance of 0.500 m from the center of the disk and sticks to it. Assume the clay is traveling at a speed of 4.00 m/s in the vertical direction just before it hits the disk. Find the linear momentum of the clay and express it in vector notation.

$$\vec{p} = (1.45) (-4) = -5.80 \hat{k} \text{ kg m/s} \quad 5$$

c. Find the angular momentum of the ball/clay system with respect to an axis through the center of the disk just after the collision in vector notation.

$$\text{Same} = -4.43 \hat{k} \text{ kg m}^2/\text{s} \quad 5$$

d. Find the magnitude of the angular velocity of the ball/clay system just after the collision.

$$I_f = (0.984) + (1.45) (0.5)^2 = 1.35 \text{ kg m}^2$$

$$4.43 = (1.35) \omega_f \quad 10$$

$$\omega_f = 3.29 \text{ rad/s}$$

Exam3S18alt



1. Two disks traveling on a one-dimensional track (x-direction) collide into each other. The masses and speeds before the collision of disk A are 6.00 kg and 4.50 m/s and of disk B are 3.50 kg and 5.50 m/s.

a. Assuming the disks stick to each other, which of the following are conserved in the collision? (Circle all that apply.)

momentum

kinetic energy

total energy

6

b. Find the momenta of each disks, p_A and p_B , before the collision in vector notation.

$$\vec{p}_A = (6.00)(4.50) = 27.0 \hat{x} \text{ kg m/s}$$

$$\vec{p}_B = (3.50)(-5.50) = -19.2 \hat{x} \text{ kg m/s}$$

5

5

c. Assuming the disks stick to each other after the collision, find the final velocity of the disks after the collision in vector notation.

$$p_{\text{tot}} = 7.75 = (6.00 + 3.50) v_f$$

$$\vec{v}_f = 0.816 \hat{x} \text{ m/s}$$

7

d. Instead, assuming the disks collide elastically, which of the following are conserved in the collision? (Circle all that apply.)

momentum

kinetic energy

total energy

6

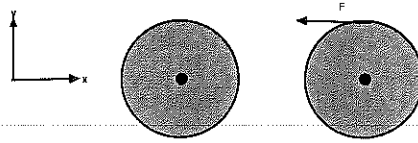
e. For the elastic case, explain briefly how you would find the velocities of the pucks after the collision.

$$\text{Set } \vec{p}_{\text{tot } i} = \vec{p}_{\text{tot } f}$$

$$K_{\text{tot } i} = K_{\text{tot } f}$$

6

Substitute and solve for the 2 velocities.



2. A thin spherical shell has a mass of 5.50 kg and a radius of 0.850 m. It is rotating about an axis through its center with angular speed of 4.50 rad/s in a clockwise direction as seen from above.

a. Find the moment of inertia of the shell.

$$I = \frac{2}{3} (5.50) (0.850)^2 = 2.65 \text{ kg m}^2 \quad 5$$

b. Find the angular momentum of the shell in vector notation. Assume out of the page is the +z-direction.

$$L = I\omega = (2.65) (-4.50) = -11.9 \hat{k} \text{ kg m}^2/\text{s} \quad 5$$

c. Find how long it takes the shell to rotate through 800° .

$$\theta = \frac{800}{360} (2\pi) = 14.0 \text{ rad}, \quad 10$$

$$14.0 = 0 + 4.50 t$$

$$t = 3.10 \text{ s}$$

A force of 22.5 N is applied to the edge of the shell in a direction tangent to the shell as shown above.

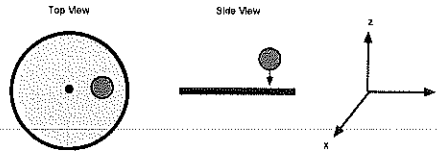
d. Find the torque on the shell in vector notation.

$$\begin{aligned} \vec{\tau} &= \vec{r} \times \vec{F} = (0.850) (22.5) \\ &= 19.1 \hat{k} \text{ N}\cdot\text{m} \quad 5 \end{aligned}$$

e. Find the new angular speed of the shell after the force has been applied for 2.00 s.

$$\alpha = \frac{\tau}{I} = \frac{19.1}{2.65} = 7.21 \frac{\text{rad}}{\text{s}^2} \quad 10$$

$$\omega = -4.50 + 7.21 (2.00) = 9.92 \frac{\text{rad}}{\text{s}}$$



3. a. A solid disk of mass 4.00 kg and radius 0.950 m is rotating clockwise as viewed from above with an angular speed of 5.50 rad/s .
- a. Find the moment of inertia and the angular momentum of the disk and express the angular momentum in vector notation. Take the z-axis in the positive direction as out of the paper (for the figure on the left) ("up" in the figure to the right).

$$I = \frac{1}{2} (4.00) (0.950)^2 = 1.80 \text{ kg m}^2 \quad 5$$

$$L = I\omega = (1.80) (-5.50) = -9.93 \hat{k} \text{ kg m}^2/\text{s} \quad 5$$

- b. A blob of clay of mass 1.85 kg is dropped onto the moving disk at a distance of 0.700 m from the center of the disk and sticks to it. Assume the clay is traveling at a speed of 5.00 m/s in the vertical direction just before it hits the disk. Find the linear momentum of the clay and express it in vector notation.

$$\vec{p} = (1.85) (-5.00) = -9.25 \hat{k} \text{ kg m/s} \quad 5$$

- c. Find the angular momentum of the ball/clay system with respect to an axis through the center of the disk just after the collision in vector notation.

$$\text{same} = -9.93 \hat{k} \text{ kg m}^2/\text{s} \quad 5$$

- d. Find the magnitude of the angular velocity of the ball/clay system just after the collision.

$$I_f = (1.80) + (1.85) (0.700)^2 = 2.71 \text{ kg m}^2$$

$$9.93 = (2.71) \omega_f \quad 10$$

$$\omega_f = 3.67 \text{ rad/s}$$