WebAssign
CH11-HW04-SP12 (Homework)

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PHYS 172-SPRING 2012, Spring 2012
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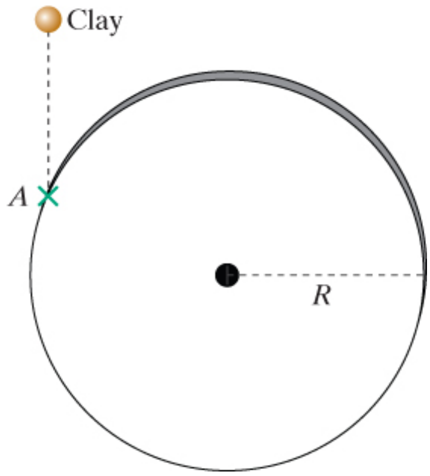
Current Score : 31 / 31 **Due :** Thursday, April 5 2012 11:59 PM EDT

1. 5/5 points | Previous Answers MI3 11.7.X.052

A rotating uniform-density disk of radius 0.6 m is mounted in the vertical plane. The axle is held up by supports that are not shown, and the disk is free to rotate on the nearly frictionless axle. The disk has mass 3 kg. A lump of clay with mass 0.3 kg falls and sticks to the outer edge of the wheel at location *A*, < -0.48, 0.360, 0 > m. (Let the origin of the coordinate system be the center of the disk.) Just before the impact the clay has a speed 8 m/s, and the disk is rotating clockwise with angular speed 0.64 radians/s.



(a) Just before the impact, what is the angular momentum of the combined system of wheel plus clay about the center *C*? (As usual, x is to the right, y is up, and z is out of the screen, toward you.)

$\vec{L}_{C,i}$ = kg · m^2/s

(b) Just after the impact, what is the angular momentum of the combined system of wheel plus clay about the center *C*?

$\vec{L}_{C,f}$ = kg · m^2/s

(c) Just after the impact, what is the angular velocity of the wheel?

$\vec{\omega}_f$ = radians/s

(d) Qualitatively, what happens to the linear momentum of the combined system? (Think about why this is.)

- ◯ Some of the linear momentum is changed into energy.
- ◯ Some of the linear momentum is changed into angular momentum.
- ◯ There is no change because linear momentum is always conserved.
- ◉ The downward linear momentum decreases because the axle exerts an upward force.

- *Read the eBook*
- Section 11.7

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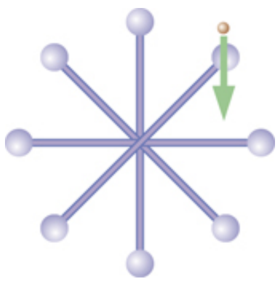
2. 8/8 points | Previous Answers MI3 11.7.X.053

A device consists of eight balls each of mass 0.5 kg attached to the ends of low-mass spokes of length 1.8 m, so the radius of rotation of the balls is 0.9 m. The device is mounted in the vertical plane. The axle is held up by supports that are not shown, and the wheel is free to rotate on the nearly frictionless axle. A lump of clay with mass 0.25 kg falls and sticks to one of the balls at the location shown, when the spoke attached to that ball is at 45 degrees to the horizontal. Just before the impact the clay has a speed 5 m/s, and the wheel is rotating counterclockwise with angular speed 0.19 radians/s.



(a) Which of the following statements are true about the device and the clay, for angular momentum relative to the axle of the device?

- ☑ The angular momentum of the device is the sum of the angular momenta of all eight balls.
- ☐ Just before the collision the angular momentum of the wheel is 0.
- ☐ The angular momentum of the device is the same before and after the collision.
- ☑ The angular momentum of the device + clay just after the collision is equal to the angular momentum of the device + clay just before the collision.
- ☐ The angular momentum of the falling clay is zero because the clay is moving in a straight line.

(b) Just before the impact, what is the angular momentum of the combined system of device plus clay about the center *C*? (As usual, x is to the right, y is up, and z is out of the screen, toward you.)

$\vec{L}_{C,i}$ = ✓ kg · m^2/s

(c) Just after the impact, what is the angular momentum of the combined system of device plus clay about the center *C*?

$\vec{L}_{C,f}$ = ✓ kg · m^2/s

(d) Just after the impact, what is the angular velocity of the device?

$\vec{\omega}_f$ = ✓ radians/s

(e) Qualitatively, what happens to the total linear momentum of the combined system? Why?

- ○ There is no change because linear momentum is always conserved.
- ● The downward linear momentum decreases because the axle exerts an upward force.
- ○ Some of the linear momentum is changed into angular momentum.
- ○ Some of the linear momentum is changed into energy.

✓

(f) Qualitatively, what happens to the total kinetic energy of the combined system? Why?

- ○ There is no change because kinetic energy is always conserved.
- ○ Some of the kinetic energy is changed into angular momentum.
- ● The total kinetic energy decreases because there is an increase of thermal energy in this inelastic collision.
- ○ Some of the kinetic energy is changed into linear momentum.

✓

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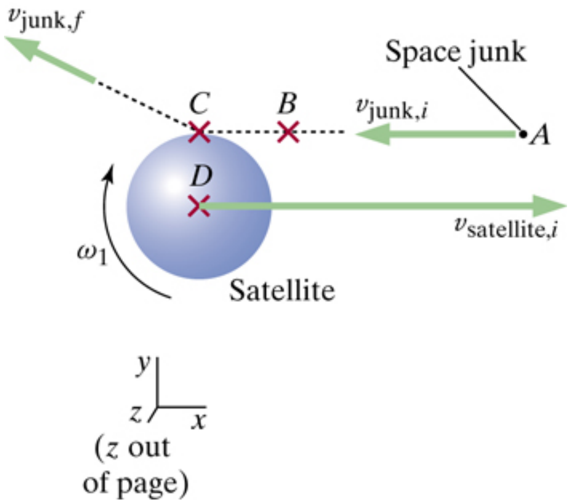
3. 18/18 points | Previous Answers MI3 11.7.P.065



A spherical satellite of radius 4.6 m and mass M = 195 kg is originally moving with velocity $\vec{v}_{\text{satellite},i}$ = < 2800, 0, 0 > m/s, and is originally rotating with an angular speed ω_1 = 2 radians/second, in the direction shown in the diagram. A small piece of space junk of mass m = 4 kg is initially moving toward the satellite with velocity $\vec{v}_{\text{junk},i}$ = < -2300, 0, 0 > m/s. The space junk hits the edge of the satellite at location C as shown in the diagram, and moves off with a new velocity $\vec{v}_{\text{junk},f}$ = < -1100, 500, 0 > m/s. Both before and after the collision, the rotation of the space junk is negligible.

MOMENTUM
After the collision, what is the final momentum of the satellite?

$\vec{p}_{\text{satellite},f}$ = kg·m/s

What is the final velocity of the satellite?

$\vec{v}_{\text{satellite},f}$ = m/s

ANGULAR MOMENTUM
Assuming the density of the satellite is uniform throughout, what is the moment of inertia of the satellite? (The moment of inertia of a uniform-density sphere is (2/5)MR^2.)

I = 1650.48 kg·m^2

What is the initial rotational angular momentum of the satellite, around location D (its center of mass)? (Be sure your signs are correct).

$\vec{L}_{\text{satellite},i}$ = kg·m^2/s

Which of the following statements about the translational angular momentum of the space junk, about location D, are true? Check all that apply:

- [x] $xp_y - yp_x$ is the same when the space junk is at locations *A*, *B*, and just before getting to *C*.
- [ ] Because the space junk is traveling in a straight line, its angular momentum is zero.
- [x] $r_\perp$ is the same when the space junk is at locations *A*, *B*, and just before getting to *C*.
- [ ] The translational angular momentum of the space junk is in the -z direction.
- [x] The translational angular momentum of the space junk is the same when the space junk is at locations *A*, *B*, and just before getting to *C*.

An instant before the collision, when the space junk is almost at location *C*, what is the translational angular momentum of the space junk about location *D*?

$\vec{L}_{\text{junk},i}$ = kg·m^2/s

An instant after the collision, when the space junk is just slightly beyond location *C*, what is the translational angular momentum of the space junk about location *D*?

$\vec{L}_{\text{junk},f}$ = kg·m^2/s

At the same instant after the collision, what is the rotational angular momentum of the satellite?

$\vec{L}_{\text{satellite},f}$ = kg·m^2/s

What is the new angular speed of the satellite?

ω_2 = 11.378 radians/s

In what direction is the satellite now rotating?

- (•) counterclockwise (opposite to original direction)
- ( ) clockwise (same as original direction)
- ( ) it is not rotating

ENERGY

Consider a system consisting of both objects (space junk and satellite).

Before the collision, what was the total kinetic energy (translational + rotational) of the system?

K_i = 7.7498e8 joules

After the collision, what is the total kinetic energy of the system?

K_f = 7.5395e8 joules

What was the rise in thermal energy for the space junk and satellite combined? (Your answer will be judged correct if it is consistent with earlier work, even if there were mistakes in the earlier work -- "propagation of errors".)

$\Delta E_{\text{thermal}}$ = 2.103e7 joules

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