#29 Angular Momentum Pre-class

Due: 11:00am on Wednesday, October 31, 2012

Note: You will receive no credit for late submissions. To learn more, read your instructor's Grading Policy

Spinning Situations

Suppose you are standing on the center of a merry-go-round that is at rest. You are holding a spinning bicycle wheel over your head so that its rotation axis is pointing upward. The wheel is rotating counterclockwise when observed from above.

For this problem, neglect any air resistance or friction between the merry-go-round and its foundation.

Part A

Suppose you now grab the edge of the wheel with your hand, stopping it from spinning.

What happens to the merry-go-round?

Hint 1. Change in angular momentum

Consider yourself, the merry-go-round, and the bicycle wheel to be a single system. When you stop the wheel from spinning, what happens to the angular momentum of the system about the vertical axis?

ANSWER:

- It increases.
- It decreases.
- It remains unchanged.

ANSWER:

- It remains at rest.
- It begins to rotate counterclockwise (as observed from above).
- It begins to rotate clockwise (as observed from above).

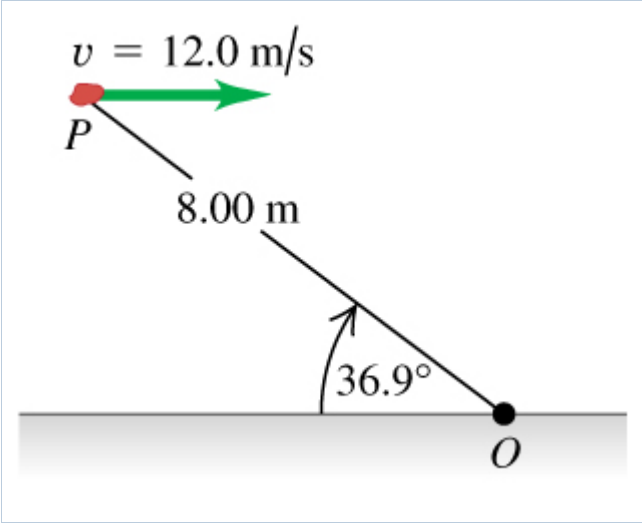
Correct

It may seem incredible, but as long as there are no external torques acting on the system (which includes yourself, the merry-go-round, and the bicycle wheel) the angular momentum originally stored in the bicycle wheel is conserved.
What really happens?

To stop the wheel from spinning (counterclockwise), you must exert a clockwise torque on it. By extending Newton's third law, this means that the wheel exerts a counterclockwise torque on you. If there is no friction between you and the merry-go-round, i.e., if the floor of the latter is completely smooth, this torque from the wheel will make *you* spin counterclockwise. However, if there is friction between your shoe soles and the floor, to prevent relative motion, this time, the floor exerts a clockwise torque on you, and you exert a counterclockwise torque on the floor of the merry-go-round. If the axle is completely smooth, then this torque will now make the merry-go-round spin counterclockwise. Of course, the ride will spin *much* slower than the wheel, because its moment of inertia is much larger.

Exercise 10.35

A 3.00kg rock has a horizontal velocity of magnitude 12.0 $\mathrm{m/s}$ when it is at point P in the figure .



Part A

At this instant, what is the magnitude of its angular momentum relative to point O?

ANSWER:

L = 173 $\text{kg} \cdot \text{m}^2/\text{s}$

Correct

Part B

What is the direction of the angular momentum in part (A)?

ANSWER:

- (•) into the page
- ( ) out of the page

Correct

Part C

If the only force acting on the rock is its weight, what is the magnitude of the rate of change of its angular momentum at this instant?

ANSWER:

$\left|\frac{d\vec{\mathbf{L}}}{dt}\right|$ = 188 $\text{kg} \cdot \text{m}^2/\text{s}^2$

Correct

Part D

What is the direction of the rate in part (C)?

ANSWER:

- into the page
- out of the page

Correct

Exercise 10.44

A solid wood door 1.00 m wide and 2.00 m high is hinged along one side and has a total mass of 43.0 kg . Initially open and at rest, the door is struck at its center by a handful of sticky mud with mass 0.700 kg , traveling perpendicular to the door at 12.0 $\mathrm{m/s}$ just before impact.

Part A

Find the final angular speed of the door.

ANSWER:

ω = 0.289 $\mathrm{rad/s}$

Correct

Part B

Does the mud make a significant contribution to the moment of inertia?

ANSWER:

- yes
- no

Correct

Exercise 10.46: Asteroid Collision!

Suppose that an asteroid traveling straight toward the center of the earth were to collide with our planet at the equator and bury itself just below the surface.

Part A

What would have to be the mass of this asteroid, in terms of the earth's mass $\{\rm M\}$, for the day to become 26.0% longer than it presently is as a result of the collision? Assume that the asteroid is very small compared to the earth and that the earth is uniform throughout.

ANSWER:

m = 0.104 M

Correct

Score Summary:

Your score on this assignment is 98.3%.
You received 19.65 out of a possible total of 20 points.