Science Virtual Learning

MPI Physics 210

Rotational Dynamics 13

Angular Momentum – The Spinning Skater

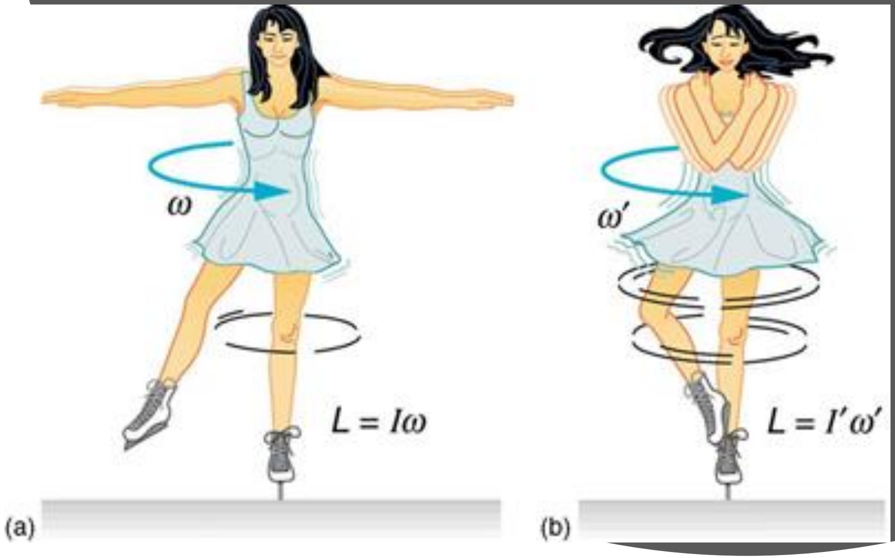
May 6, 2020

Lesson: MPI Angular Momentum – The Spinning Skater
May 6, 2020

Objective: To learn how to apply angular momentum conservation to problems in which the moment of inertia changes

This video discusses angular momentum problems where the moment of inertia changes, the so-called "spinning skater" problem.

https://youtu.be/Qr8ZGuPVh6U



Video: Spinning Skater Problems

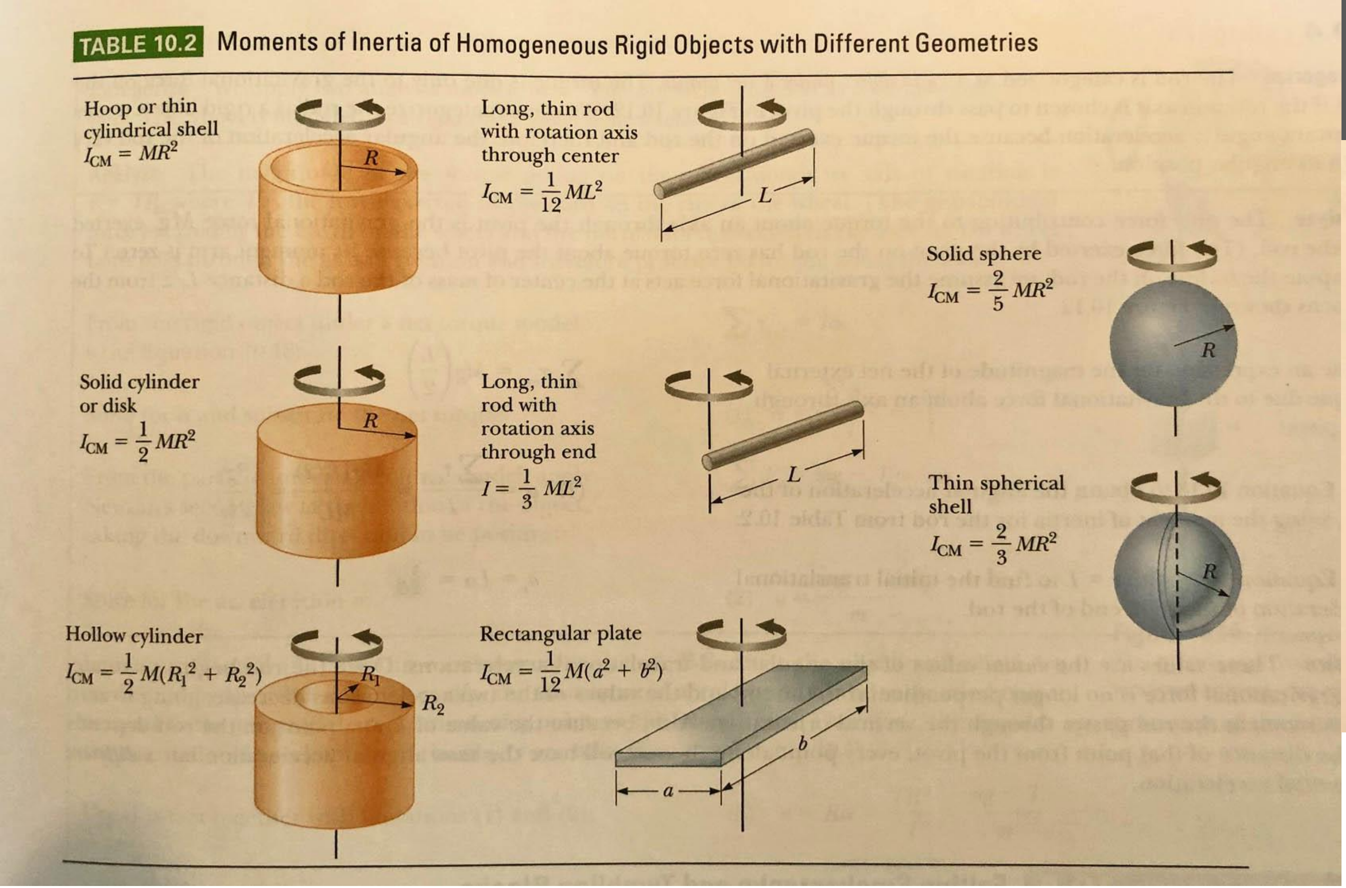


TABLE 10.2 Moments of Inertia of Homogeneous Rigid Objects with Different Geometries

Hoop or thin cylindrical shell
$I_{CM} = MR^2$

Long, thin rod with rotation axis through center
$I_{CM} = \frac{1}{12}ML^2$

Solid sphere
$I_{CM} = \frac{2}{5}MR^2$

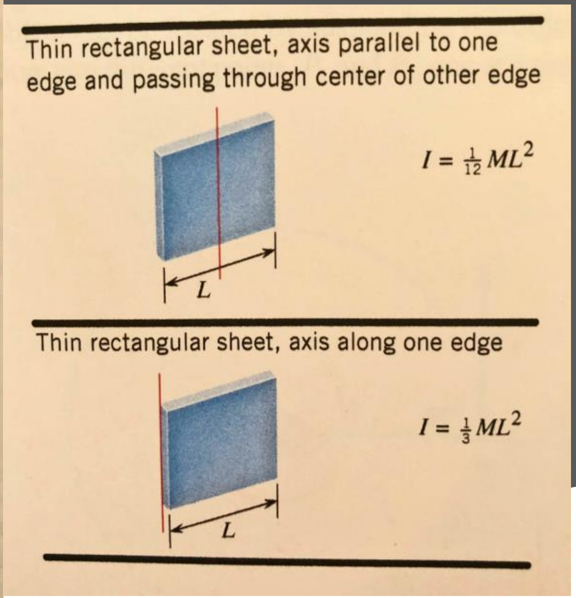
Solid cylinder or disk
$I_{CM} = \frac{1}{2}MR^2$

Long, thin rod with rotation axis through end
$I = \frac{1}{3}ML^2$

Thin spherical shell
$I_{CM} = \frac{2}{3}MR^2$

Hollow cylinder
$I_{CM} = \frac{1}{2}M(R_1^2 + R_2^2)$

Rectangular plate
$I_{CM} = \frac{1}{12}M(a^2 + b^2)$



Thin rectangular sheet, axis parallel to one edge and passing through center of other edge

$I = \frac{1}{12}ML^2$

Thin rectangular sheet, axis along one edge

$I = \frac{1}{3}ML^2$

Moments of Inertia for Different Shapes

Equation	Missing
1. $\omega_f = \omega_i + \alpha t$	$\Delta\theta$
2. $\Delta\theta = \frac{1}{2}(\omega_f + \omega_i)t$	α
3. $\Delta\theta = \omega_i t + \frac{1}{2}\alpha t^2$	ω_f
4. $\omega_f^2 = \omega_i^2 + 2\alpha\Delta\theta$	t
5. $\Delta\theta = \omega_f t - \frac{1}{2}\alpha t^2$	ω_i

Rotational Motion Equations

1. A 200-kg merry-go-round of radius 1.85 m is spinning at 0.884 rad/s. A 42.0-kg kid initially at rest jumps on the edge of the merry-go-round. What is the new angular velocity?
2. A 0.500-kg tetherball is spinning around the pole in a circle of radius 1.33 m at a speed of 2.44 m/s. As the rope winds around the pole, the radius of the circle gets shorter and shorter. What is the speed of the ball when the radius reaches 0.400 m?

Examples from Video

Homework 1

A Lazy Susan is a rotating disk you use to pass items at a dinner table. Charley has a Lazy Susan with a mass of 5.52 kg and a radius of 0.250 m. It is rotating at 1.48 rad/s when Charley sets a two-liter of Coke (m = 2.15 kg) on it, 0.175 m from the center.

a) What is the initial angular momentum of the Lazy Susan before the Coke is set on it?

b) What is the rotational speed of the Lazy Susan after she drops the Coke on it?

- Try to solve the problem yourself, then watch the first part of the solution video:
- https://youtu.be/xWuSr-tzwHs

Homework 2

A neutron star is the core of a dead star that has collapsed due to its own gravity. It has a mass of $8.00 \cdot 10^{30}$ kg. Before collapsing, it had a radius of $1.50 \cdot 10^{8}$ m, and rotated once every 22.5 days. After collapsing, it has a radius of 10,000 m.

a) How much angular momentum did the core have before collapsing?

b) How much moment of inertia does the core have after collapsing?

c) What is the angular velocity of the core after collapse?

- Try to solve the problem yourself, then watch the first part of the solution video:
- https://youtu.be/nYMBAFfITcE

That’s it!