



# Science Virtual Learning

## MPI Physics 210

### Rotational Dynamics 9 – Newton's 2<sup>nd</sup> Law for Rotation

April 29, 2020



Lesson: MPI Newton's 2<sup>nd</sup> Law for Rotation  
April 29, 2020

**Objective: To use torque and moment of inertia to predict the angular acceleration of a rotating object**

This video discusses Newton's 2<sup>nd</sup> Law for rotation, and how torques cause rotational motion. It also includes an example

[https://youtu.be/tiPuJA\\_jCkg](https://youtu.be/tiPuJA_jCkg)

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Video: Newton's 2<sup>nd</sup> Law for Rotation



The woman in the picture is pushing a 36.0 kg door 0.700 m from its hinges. She exerts a 65.0 N force perpendicular to the door.

- How much torque does she exert?
- What is the moment of inertia of the door?
- What is the resulting angular acceleration?
- If she pushes the door for  $1/8$  of a rotation, what is its angular velocity at the end?



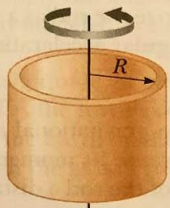
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## Newton's 2<sup>nd</sup> Law Example

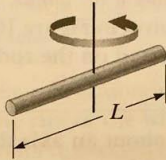


**TABLE 10.2** Moments of Inertia of Homogeneous Rigid Objects with Different Geometries

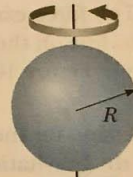
Hoop or thin cylindrical shell  
 $I_{CM} = MR^2$



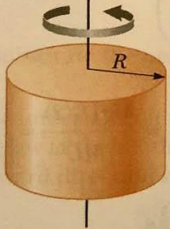
Long, thin rod with rotation axis through center  
 $I_{CM} = \frac{1}{12} ML^2$



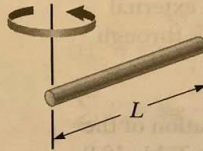
Solid sphere  
 $I_{CM} = \frac{2}{5} MR^2$



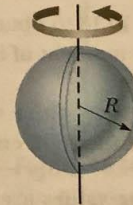
Solid cylinder or disk  
 $I_{CM} = \frac{1}{2} MR^2$



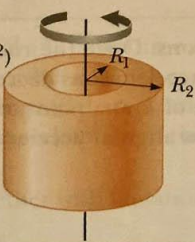
Long, thin rod with rotation axis through end  
 $I = \frac{1}{3} ML^2$



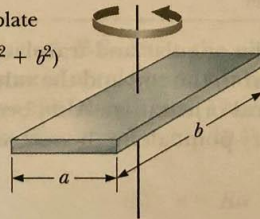
Thin spherical shell  
 $I_{CM} = \frac{2}{3} MR^2$



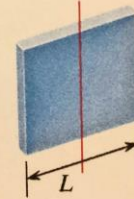
Hollow cylinder  
 $I_{CM} = \frac{1}{2} M(R_1^2 + R_2^2)$



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

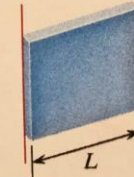


Thin rectangular sheet, axis parallel to one edge and passing through center of other edge



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

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.  $\Delta\theta = \frac{1}{2}(\omega_f + \omega_i)t$

$\alpha$

3.  $\Delta\theta = \omega_i t + \frac{1}{2}\alpha t^2$

$\omega_f$

4.  $\omega_f^2 = \omega_i^2 + 2\alpha\Delta\theta$

$t$

5.  $\Delta\theta = \omega_f t - \frac{1}{2}\alpha t^2$

$\omega_i$

Rotational Motion Equations



# Homework



A basketball is a hollow sphere of radius  $0.121\text{ m}$  and mass  $0.624\text{ kg}$ . A player starts the ball spinning on her finger by exerting a  $5.00\text{ N}$  force tangent to the basketball, for  $\frac{1}{4}$  of a turn. Find the angular acceleration, and final angular velocity.

- Try to solve the problem yourself, then watch the first part of the solution video:
- <https://youtu.be/ijYnXbZx7zA>



That's it!

