Science Virtual Learning

MPI Physics 210

Rotational Dynamics 10

Newton's 2nd Law for Rotation - Practice

April 30, 2020

Lesson: MPI Newton's 2nd Law for Rotation – Practice
April 30, 2020

Objective: To practice calculating the torques, inertias, and resulting motion of rotating objects

An old timey helicopter toy has a wooden propeller of mass 0.120 kg and length 0.150 m attached to a thin stick; see picture. A kid holds the stick between their hands, then slides their hands across each other, making the stick spin rapidly, causing the helicopter to take off. The stick starts at rest, and the kid makes it rotate 10.0 times in 0.525 s before taking off.

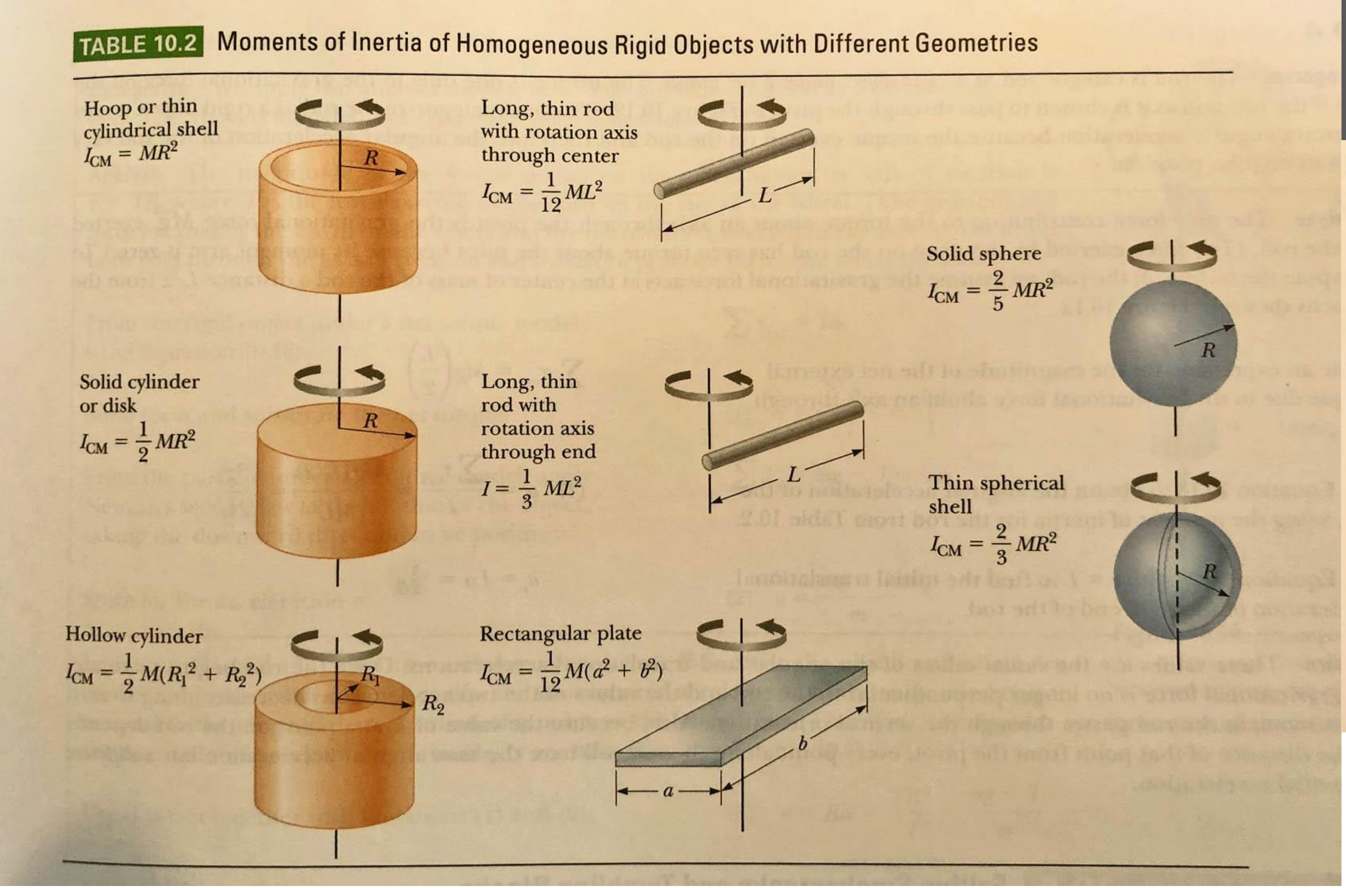
a) Calculate the moment of inertia of the propellers, ignoring the stick.

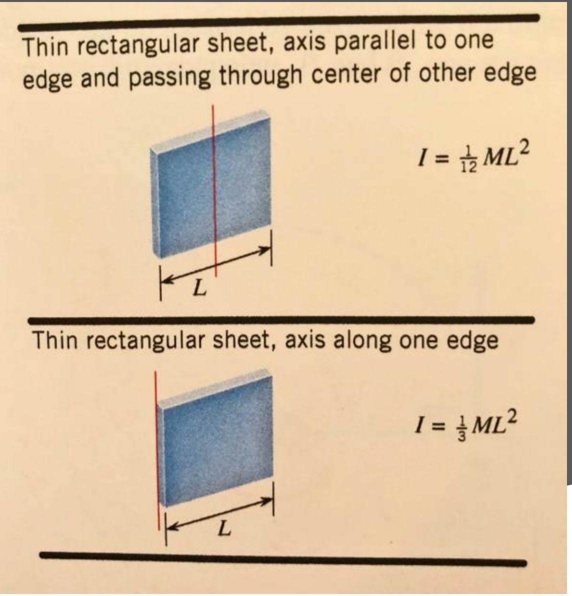
b) Calculate the angular acceleration.

c) How much torque did the kid exert on the toy?

https://youtu.be/HIrt6r5lm8U

Newton's 2nd Law Example





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

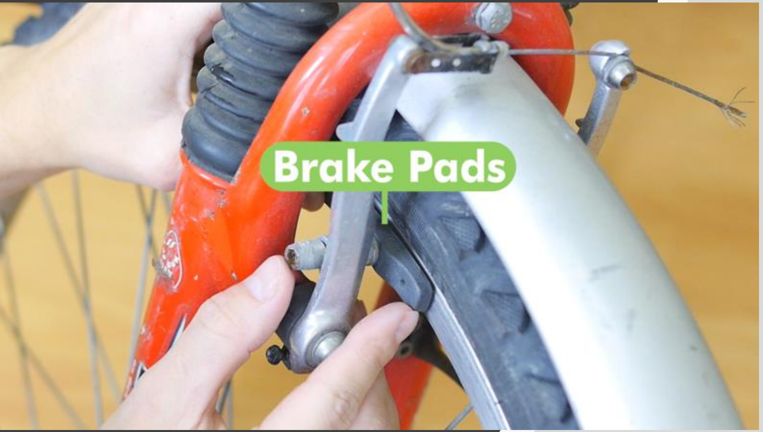
Rotational Motion Equations

Homework 1

A playground merry-go-round is a metal disk of radius 1.52 m (5’) and weight 448 kg (990 lb). Two 30.0 kg kids are sitting on the edge. To set it in motion, an adult pushes a bar on the outer rim with a 90.5 N force that makes a 75.0° angle to the radius. The adult pushes for two full rotations, then lets go. What is the final angular velocity of the merry-go-round? What is the linear velocity of the kids?

- Try to solve the problem yourself, then watch the first part of the solution video:
- https://youtu.be/OyJsUD0qu5U

Homework 2



A bike wheel has a radius of 0.350 m and mass 0.980 kg. It is spinning at 15.5 rad/s when the driver applies the brake. The brake pushes in on the wheel, creating a frictional force of 2.55 N on the rim, 0.320 m from the axis. How much time does it take to bring the wheel to a stop?

- Try to solve the problem yourself, then watch the first part of the solution video:
- https://youtu.be/5JF8vX8WZMo

Homework 3

A washing machine uses a drum with a moment of inertia of 1.21 kg•m^2, and is driven by a belt that fits around a ring of radius 0.0900 m; see picture. When the button is pushed, the drum speeds up from rest to 3.00 rot/s in 8.00 s.

a) What is the angular acceleration?

b) How much torque is being applied to the drum?

c) The torque is due to the force being applied to the ring by the belt. How much force does it exert?

- Try to solve the problem yourself, then watch the first part of the solution video:
- https://youtu.be/F0_2psAWzzc

That’s it!