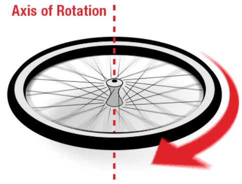
Announcements

PRACTICE	LABS	TESTS
Unit 12 Problems (1-9)	Paper Car Crash Lab (Due Today)	Unit 12 Test Tuesday (3/26/19)

Rolling Motion and the Moment of Inertia

Learning Target | **12.2** | I can describe, interpret, and solve problems involving rolling motion and the moment of inertia.



UNIT 12 REVIEW

Key Concepts

- Angular position and its changes are measured in radians. One complete revolution is 2π rad.
- Angular velocity is given by the following equation.

$$\omega = \frac{\Delta\theta}{\Delta t}$$

- Angular acceleration is given by the following equation.

$$\alpha = \frac{\Delta\omega}{\Delta t}$$

- For a rotating, rigid object, the angular displacement, velocity, and acceleration can be related to the linear displacement, velocity, and acceleration for any point on the object.

$$d = r\theta \qquad v = r\omega \qquad a = r\alpha$$

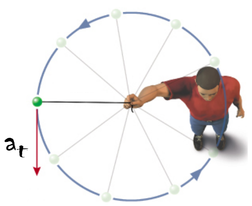
UNIT 12 REVIEW

Key Concepts

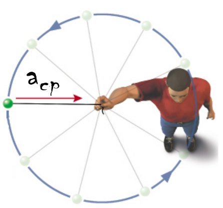
Linear Equation (a = constant)	Angular Equation (α = constant)
$v = v_0 + at$	$\omega = \omega_0 + \alpha t$
$x = x_0 + v_0 t + \frac{1}{2}at^2$	$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$
$v^2 = v_0^2 + 2a(x - x_0)$	$\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$

Acceleration of a Rotating Object

Tangential Acceleration

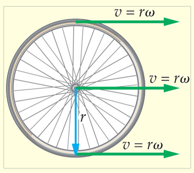


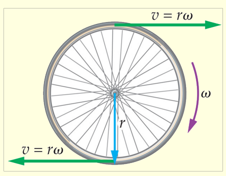
Centripetal Acceleration



Rolling Motion

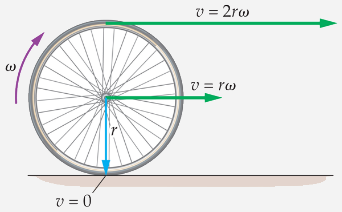
In pure translational motion, each point on the wheel moves with the same speed in the same direction.





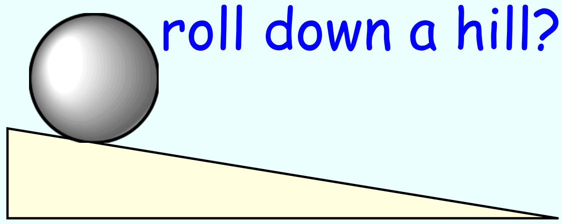
In pure rotational motion, the velocities at the top and bottom of the wheel are in opposite directions.

Velocities in Rolling Motion



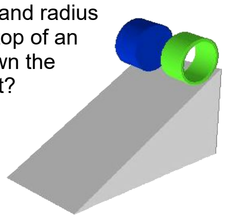
In a wheel that rolls without slipping, the point in contact with the ground is instantaneously at rest. The center of the wheel moves forward with the speed $v = r\omega$, and the top of the wheel moves forward with twice that speed, $v = 2r\omega$.

Why does a ball roll down a hill?



UNIT 12 IN CLASS PROBLEMS

A disk and a hoop of the same mass and radius are released at the same time at the top of an inclined plane. If both objects roll down the ramp, which will reach the bottom first?

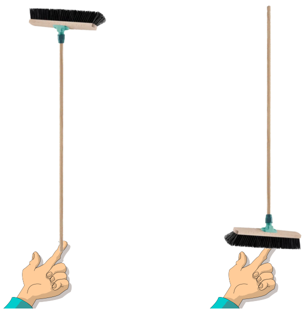


9. Write a sentence or two that explains your answer.

D H S

8 5 7

Which would be easier?



SAME

Balancing Act

Moment Of Inertia

The resistance to rotation is called the **moment of inertia**.

I

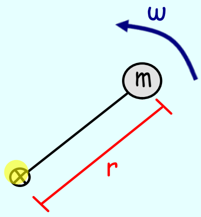
PULL

Units
$kg \cdot m^2$

Moment Of Inertia

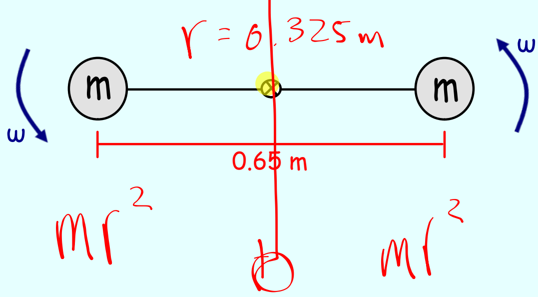
The moment of inertia of a point mass, m, at a distance, r, from the axis of rotation is given by the following equation.

$$I = m r^2$$



Moment Of Inertia

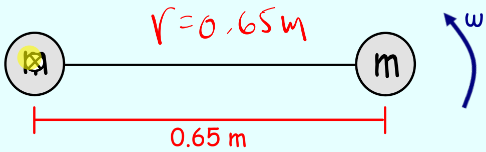
What is the moment of inertia for the rotating dumbbell if m = 0.30 kg?



I = 0.063 kg·m²

How About Now?

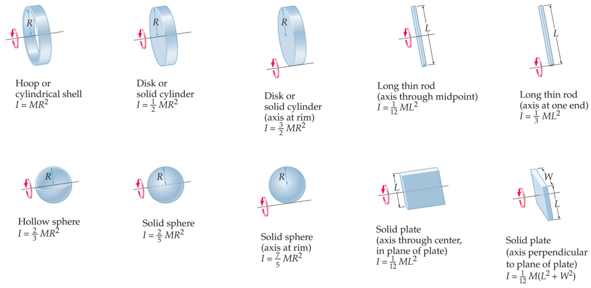
What is the moment of inertia, in kg•m², for the rotating dumbbell if m = 0.30 kg?



I = mr²

I = 0.13 kg·m²

Moments Of Inertia



UNIT 12 IN CLASS PROBLEMS

10. A car with tires of radius 32 cm drives on the highway at 55 mph. **(a)** What is the angular speed of the tires? **(b)** What is the linear speed of the top of the tires?

11. The hoop and disc are at rest at the top of an inclined plane. Both are then released at the same time and allowed to roll down the inclined plane. Both the hoop and disc have a mass, m = 0.50 kg, and radius, r = 15.2 cm. What are the moments of inertia for the hoop and disc?

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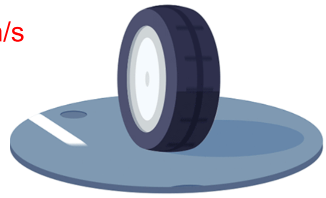
(a) $v = r\,\omega$ $\qquad \omega = \dfrac{v}{r} = 78$ rad/s

(b) $v_{top} = 2\,v = 50$ m/s



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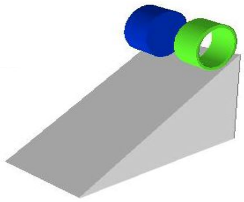

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$I_{hoop} = mr^2 = 0.012$ kg.m^2

$I_{disk} = \tfrac{1}{2}mr^2 = 0.0058$ kg.m^2