Inspiring Greatness

INDEPENDENCE SCHOOL DISTRICT

Science Virtual Learning

MPI Physics 210

Rotational Dynamics 11

Rolling Motion

May 4, 2020

Lesson: MPI Rolling Motion
May 4, 2020

Objective: To understand how to solve problems involving rolling motion, including both linear and rotational kinetic energy

This video discusses rolling motion, where objects have both linear and rotational KE

https://youtu.be/h8WqTatY8WM

Video: Rolling Motion

1. A 7.25-kg bowling ball of radius 0.100 m is rolling down the lane at 8.24 m/s.

a) How much linear KE does it have?

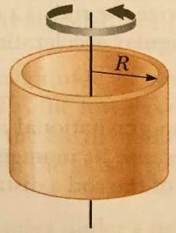
b) How much rotational KE does it have?

2. When Indiana Jones steps on the secret latch, a giant rock ball is released from rest, and rolls down a 12.0 m long ramp inclined at 15.0°. How fast is it rolling at the bottom of the ramp?

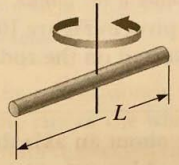
Rolling Motion Examples, from Video

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

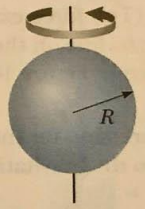
Hoop or thin cylindrical shell
$I_{CM} = MR^2$



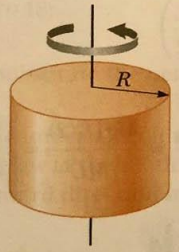
Long, thin rod with rotation axis through center
$I_{CM} = \frac{1}{12}ML^2$



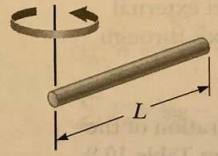
Solid sphere
$I_{CM} = \frac{2}{5}MR^2$



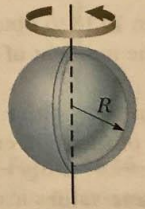
Solid cylinder or disk
$I_{CM} = \frac{1}{2}MR^2$



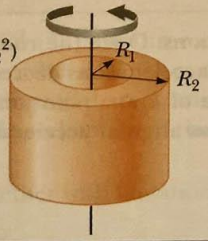
Long, thin rod with rotation axis through end
$I = \frac{1}{3}ML^2$



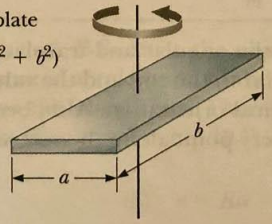
Thin spherical shell
$I_{CM} = \frac{2}{3}MR^2$



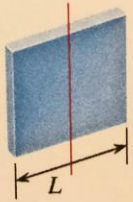
Hollow cylinder
$I_{CM} = \frac{1}{2}M(R_1^2 + R_2^2)$



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

Homework 1

1. In a barrel roll race, two people push an 82.0 kg barrel of radius 0.550 m from rest. Starting from rest, they speed up the barrel to 2.45 m/s.
   a) What is the moment of inertia of the barrel? Treat it as a hollow cylinder / ring / hoop.
   b) What is the linear KE of the barrel at the end?
   c) What is the angular velocity of the barrel at the end?
   d) What is the rotational KE of the barrel at the end?
   e) How much Work did they do on the barrel?

- Try to solve the problem yourself, then watch the first part of the solution video:
- https://youtu.be/KSF_aI4l0UY

Homework 2

2. When it was being unloaded, one of the barrels from the previous problem was released from rest at the top of a 1.40 m high ramp, to roll it off the back of a truck. What was its linear velocity “v” at the bottom of the ramp?

- Try to solve the problem yourself, then watch the first part of the solution video:
- https://youtu.be/I4brMT-QHvY

That’s it!