

Rotations Energy  
Student Practice

Rotational inertia formulas: Solid sphere  $I = \frac{2}{5}mr^2$  Hollow sphere  $I = \frac{2}{3}mr^2$

1. What are the factors affecting rotational inertia?

mass / shape / radius - distance mass is from point of rotation

2. The general formula for rotational inertia?  $I = mr^2$

3. The general formula for rotational energy?  $KE_R = \frac{1}{2}I\omega^2$

4. A kid places a 20Nm of torque of a 30cm beach ball perpendicular to the surface. Calculate the angular acceleration.

$F = ma$      $T = I\alpha$      $\frac{T_{net}}{I} = \frac{2.0}{.002} = 1000 \text{ rad/s}^2$

$I = 0.002 \text{ kg m}^2$

5. A solid ball (3kg) 12cm radius ball is spinning rate of 15rad/s while traveling at 6m/s horizontally.

a. What is its rotational inertia?

$I = \frac{2}{5}(3)(.12)^2 = 0.01728$

$KE_R = \frac{1}{2}I\omega^2$

$= \frac{1}{2}(.017)(15)^2 = 1.9 \text{ J}$

b. What is its rotational energy?

6. A 3kg solid ball (20cm radius) starts rolling from rest, at a point down an incline it is moving at 2.5m/s.

$I = 0.017$

a. What is the rotational energy?

$\frac{1}{2}(.017)(20)^2 = 3.6 \text{ J}$

b. What is the translational energy?

$KE = \frac{1}{2}mv^2 = \frac{1}{2}(3)(2.5)^2 = 9.3 \text{ J}$

c. How high was the ball at the start of the ramp?

Total Energy = PE = mgh

$12.9 \text{ J} = 3(10)h$   
 $h = .43 \text{ m (43cm)}$

$\frac{v}{r} = \omega$   
 $\frac{2.5}{.12} = 20.8 \text{ rad/sec}$

7. 3 balls are placed at the top of a ramp.

A: 5kg 5cm radius solid foam ball

B: 10kg 5cm radius solid foam ball

C: 10kg 5cm radius hollow copper ball (note: all the mass is located in this thinner shell)

List the order of who reaches the bottom of the ramp first to last... justify.

$I = \text{solid}$   
 $\frac{2}{5}mr^2$

Hollow  
 $\frac{2}{3}mr^2$   
Harder to Roll

Larger I = more energy to move.  
But... Larger masses have more energy in terms of PE  
only r + shape matter.

1st A+B    Last C