

Rotational motion: Energy Consideration

Purpose The aim of this lab is to investigate the rotational motion of a hollow ball, solid ball and hoop along an inclined plane. Assuming rolling without slipping and negligible friction, the conservation of energy leads to an experimental determination of the moment of inertia of this ball.

Equipment



CBL
Table
Motion Detector connected to calculator
Volley/Soccer/Basketball
Solid ball, Hoop or cylinder

Theory (prelab)

Show that (ignoring friction) if a ball rolls down an inclined plane from rest a height H without slipping, the velocity at the bottom is

$$v = \sqrt{\frac{2gH}{1 + \frac{I}{MR^2}}}$$

where I is the moment of inertia, M is the mass and R is the radius of the ball. Thus explain how you might find the moment of inertia of the ball by graphing $2gH$ versus v^2 for various heights of the plane of incline.

Experimental procedure

1. Measure the radius R and the mass M of the rolling object.
2. Measure the end velocity for 4 different heights along a plane of incline. Use multiple trials and average.
3. Repeat for each of the 3 objects.

Data analysis

1. Create a data table of $2gH$ and v^2 for various heights of the plane of incline.
2. Create a graph of $2gH$ versus v^2 for various heights of the plane of incline to determine the moment of inertia with uncertainty.
3. Repeat for each of the other objects and compare the results.
4. Calculate the moment of inertia for each object and compare with experimental findings.