611-1215 (40-320) Ring and Disc

Warranty and Parts:

We replace all defective or missing parts free of charge. Additional parts may be ordered using the list above. We accept Master Card and Visa, School P.O's. All products warranted to be free from defect for 90 days. Does not apply to accident, misuse, or normal wear and tear.

Introduction:

Bodies resist change in motion; in other words, they have inertia. Rotational inertial of a body is its property which makes it resist any change in rotational motion. Greater rotational inertia means that it is harder to rotate the body if it is standing, and harder to stop it if it is rolling.

This simple device demonstrates how this property is related not only to the mass of the body but the way in which the mass distributes itself in the body.

PVC ring and wood disc have the same mass and diameter.

Note: Due to the variability of wood, your wood disc may be slightly heavier than the ring. If this is the case, sand one edge of the disc to remove excess weight.

Theory:

Inertia is the property by which a stationary object resists moving and a moving object resists stopping. When the change in motion is in a straight line, it is referred to as **linear** inertial. **Rotational** inertia, also called Moment of Inertia, is the body's resistance to a change in its rotational motion. When a body rotates or spins about an axis, the angle made by its rotating mass with the axis in the plane of rotation is changing with time; that is, there is an **angular velocity.** This is zero when the body is not spinning. On the other hand, if the angular velocity increases (or decreases), there is an angular acceleration (or deceleration.) Changing the rotational motion of a body changes its angular velocity or giving it an angular acceleration/deceleration.

Just as linear force F = ma (where **m** is the mass and **a** is the linear acceleration) causes the change in linear motion, in the case of rotational motion, a torque (T) causes the change, and it is equal to I α, where I is the moment of inertia of the body and α is its angular acceleration. Therefore, the greater the moment of inertia of a body, the greater the torque needed to give it an angular acceleration. But when is the moment of inertia of a body is greater (or smaller)? On what does it depend?

Experiment:

1. Place a flat surface (like a wide book or board) on the table top and support one of its edges on a block (or similar solid object) such that you have an **inclined plane.**
You can also use 40-250 Inclined Plane manufactured by **Science First**

2. Place the ring and the disc vertically side by side at the top of the incline and let them roll simultaneously down. Note the relative speed with which they come down by watching them from the side. (Time their motion with the help of another person.)

Which comes down faster - the ring or the disc? Why?

Discussion:

The two objects have the same mass. Therefore the ring (which is mostly hollow) is heavier along the edge than at the center, its mass almost entirely concentrated at the rim, away from the axis of rotation. The disc, on the other hand, is solid and its mass is uniformly distributed about the axis of rotation, such tat at the rim it has less mass concentration than in the case of the ring.

The moment of inertia (I) of a body depends on two factors - its mass and the square of its distance from the axis of rotation . In the case of a ring, it equals $\mathbf{mr}^{2,}$ where **m** is the mass and **r** the radial distance of the mass from the axis of rotation. (Note: For differently shaped bodies, the moment of inertia is calculated differently.

If you consider the spinning masses in the case of the ring and disc, the ring has almost its entire mass spinning at its rim mass instead of its center about the axis.

Although the distance of the spinning mass at the rim is the same for both the ring and disc (since both have the same radii,) the difference in the mass makes the I greater in the case of the ring than in the case of the disc.

In other words, the ring resists the rotation more than the disc. It rolls more slowly down the incline. Its acceleration is less than in the case of the disc. Recall that the torque is qual to I. For a given torque, the greater the I, the smaller the acceleration and vice versa.

The dependence of the moment of inertia of a body on the mass distribution about the axis of rotation has many applications in every day life. Bicycle wheels, for example, should

have more weight at their hubs than at their rims. The moment of inertia for a ring equal to **mr** is greatly influenced by the squared distance factor in the equation. If the major mass were at the rim and if the wheel diameter doubled, its moment of inertias would increase by a factor of 4!

Reference: Cunningham, James and Herr, Norman. Hands-On Physics Activities, West Nyack Center for Applied Research in Education, N.Y. 1994.

How to Teach with Ring and Disc

Concepts Taught: Inertia - linear vs rotational Moment of Inertia of rotating bodies. Relation to mass, distance from axis of rotation as well as to mass distribution. Center of mass, center of gravity. Torque. Translational and rotational equilibrium. Angular displacement. Angular velocity. Angular acceleration. Angular momentum.

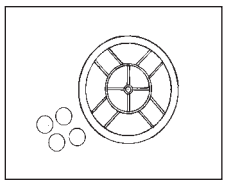
Curriculum Fit: Physics Sequence/ Force and Motion. Unit: Causes of Motion (Newton's Laws, friction/equilibrium.) Grades 6-8.

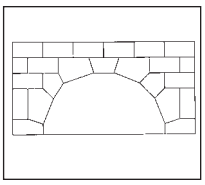
Related Products:

The following products, designed and manufactured by **Science First**, *are available from most science education distributors. Call us for more information.*

611-0035 Inclined Plane - Solid aluminum plane & accessories. Investigate acceleration, friction, gravity, Galileo's free-fall experiments. Folds for storage, clamps to 45°, features protractor and pulley.

611-1300 Mini-Dynamics - Colorful system to experiment with elastic and inelastic collisions. Plastic cars have bumpers, deep wells, low friction wheels. *Includes* 2 cars, 2 bumpers & hardware, 2 rubber stoppers, instructions.





611-1220 Variable Inertia - Instantly change distribution of mass with 8 balls that can be inserted into your choice of compartments. Which is faster, with the mass toward the center or toward the rim? Why? *Includes:* 8 3/4" steel balls, two plastic discs with hardware, instructions.

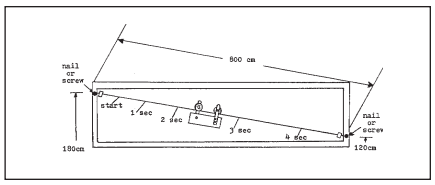
611-0350 Roman Arch - Try building it without the template first - a geometric puzzle. 23 precision cut hardwood blocks in 6 unique shapes, predrilled buttress in 3 sections, hardware, instructions and full-scale template. For science, math - even art classes!

611-1400 the horizontal component of a force is independent of the vertical component. Push car forward; eject a ball. Ball returns to moving car. Features all-metal car with spring-loaded barrel with 2 settings; ball bearing wheels. *Includes:* 2.5 cm ball; lock pin with cord; instructions.

611-1700 Collision in One Dimension - (Newton's Cradle) Propel a steel ball down track, hit balls further down. Observe how far and how many balls move. With 24" aluminum trough, 5 steel balls (3/4" dia), 2 plastic supports, instructions. A good hands-on lab for middle school science.

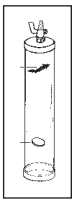
611-1230 Acceleration Tape Timer - Determine velocity, acceleration, friction with the precision of an electric clock. Timer places a carbon dot on moving paper every 1/60th sec. Attractive, sturdy hardwood body is substantial enough to needs no ring stand. *Includes:* 500-ft ticker tape, 24 carbon circles, 1 m cord with on/off switch, instructions.

40-300 Inertia Apparatus - You may have seen this as a magic trick. What happens when a tablecloth is whisked from beneath a load of dishes? When the spring hits, the card shoots forward but the ball drops back to the post. Contains glass ball, card, plastic base, post, hardware, instructions.



611-1340 Acceleration Trolley - Show how the rate of acceleration of an object depends upon the angle of incline. Features 2 low friction pulleys with 3 holes for easy attachment of weights, protected by brackets which let you place trolley at any point along the wire. *Includes:* trolley with pulley; 1.5 m wire cable; attachment kit with hardware; instructions.

611-1050 Build-A Pulley - Low friction modular pulleys snap together with interlocking brackets. Connect up to 6 for an exciting lab in simple machines. Why use flimsy wheels to teach a crucial concept? Tough ABS plastic brackets, 2" dia. plastic sheaves.



030-0500 Free-Fall Tube- Show how heavy, light items fall at same rate in a vacuum. 81 cm butyrate tube; hose cock & rubber hose; weights, instructions. *Operation requires vacuum pump.* **70 g.**

611-1985 19 mm Ball Kit - 6 different 1" dia. balls, drilled (Aluminum, cork, steel, wood), solid (glass, steel).

611-1990 2 mm Ball Set 5 different balls, all 25 mm in dia - glass, steel (solid); wood, cork, aluminum (drilled)

652-1010 Anemometer - This colorful working model is sensitive to breezes as slight as 2 mph. Determine wind speed by counting the rotations, multiplying by 6. Four molded plastic cups; cone bearing hub; low friction axle; plastic base; instructions.

P/N 24-4320