Exploring Rotational Inertia Classroom Kit

96-1011

INSTRUCTIONAL GUIDE

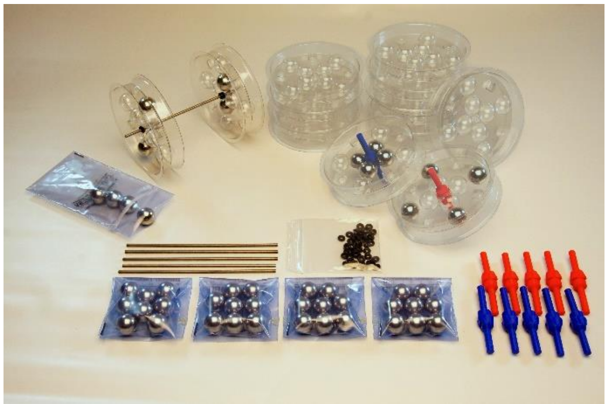
Contents

Exploring Rotational Inertia Kit:

- 12 Clear variable inertia disks (6 sets of 2)
- 48 Steel spheres (6 sets of 8)
- 6 Axles with O-rings
- String for rotational inertia "collisions"
- 6 red and 6 blue 3D printed fixed axles

Recommended for Activities:

- **Inclined Plane (P3-3541)**
- **Rotating Platform (P3-3510)**



Introduction

Only from Arbor Scientific, this classroom kit was designed with student inquiry and discovery in mind. The unique clear disks provide students the opportunity to visually conceptualize rotational inertia. Rearranging, adding, or removing the steel balls is easy. The disk halves are easily pulled apart and snapped together without using nuts and bolts. The simple and well-designed components offer open-ended versatility so teachers and students can come up with a wide variety of activities. Challenge students to derive their own understanding of rotational inertia.

The following activities will challenge students to design and conduct different tests to discover fundamentals of rotational motion, but they are by no means the extent of the possible activities! Here are some key ideas to encourage during the activity: compare disks separately or joined by the axle, hanging the disks from a support stand for rotational collisions, and rolling them on a flat or inclined surface. Note that if the inclined angle gets too large, the disks will roll *and slide* – which is much more difficult to analyze. Have fun!

Background

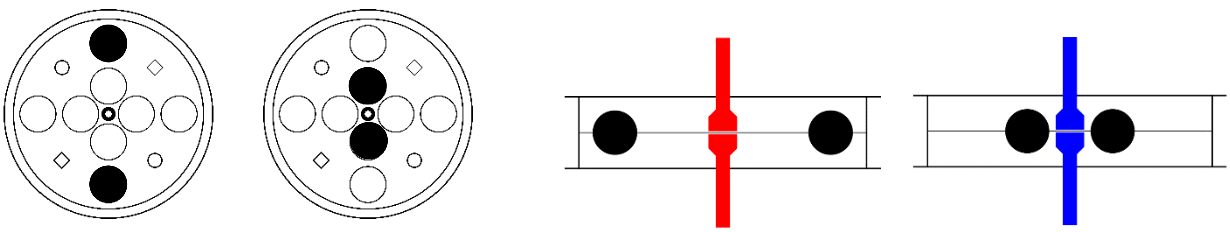
World class gymnasts are some of the most exciting athletes. They fly through the air in non-stop routines filled with various spins and rotations. The announcers call these complex moves "tricks" because they are so amazing. If you watch closely, you can notice some patterns. The athletes always seem to tuck into tighter positions for faster spins and rotations. Conversely, they always seem to "open up" or spread out their limbs when they wish to slow their spins and rotations. Ice skaters and divers use the same techniques to increase and decrease their spins and rotations.

Rotating Platform Demo
Your teacher should now engage the class in a memorable demo to show how a spinning person can increase or decrease their spinning motion. Use a spinning chair or our **Rotating Platform (P3-3510)** to demonstrate by comparing rotational speeds when one has their arms extended wide or tucked in tight.

Activities

Activity 1: Inertia and Rotational Inertia

Inertia is a measure of the resistance to a change in motion. If two objects have the same mass, then they will have the same resistance to change in motion.



Disk A *Disk B* *Disk A* *Disk B*

Place 2 steel balls into each disk as shown here. Insert a red axle into Disk A and a blue Axle into Disk B to help reference the different patterns.

Hold each disk by the top of the axle.
Now lift each disk straight up and down to verify that mass A equals mass B. Next, move each disk horizontally to feel that they have the motion when you apply the same sideways force.
Finally, twist the disks as shown in the sketch above. Describe what you feel.

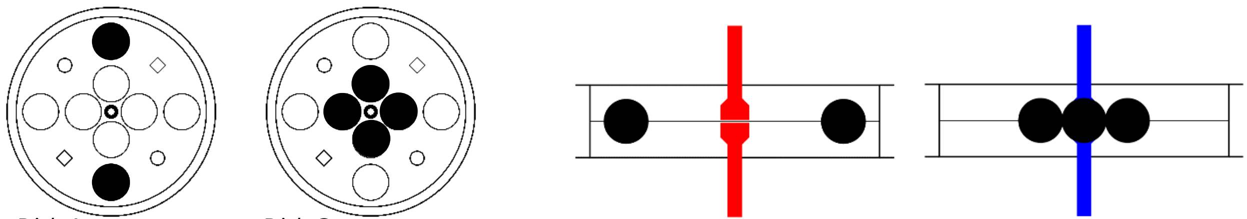
Rotational inertia is the "heaviness to **change** the rotational motion." Write a statement that describes how the rotational inertia depends on the position of the masses from the pivot point.

Activity 2: Race on the Ramp

Use a board or our **Inclined Plane (P3-3541)** to make a ramp. Now place disk A and disk B near the top of the ramp. Release the disks at the same time and watch closely. Then repeat the race.
Describe and explain the results:

Activity 3: How does rotational inertia depend on the mass and position?

Load the disks as shown below. Now notice that disk C has twice the mass, but the steel balls in disk A are twice as far from the center of the disk.



Disk A *Disk C* *Disk A* *Disk C*

Logically, it seems like the rotational inertia depends on both the amount of mass AND the distance of the mass from the pivot (center).

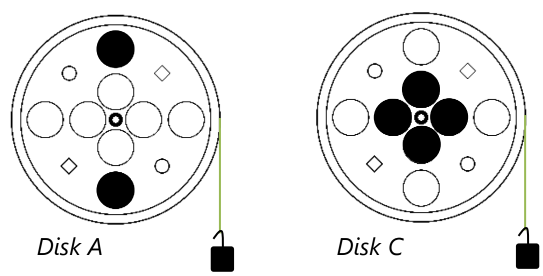
If the mass AND the distance factor are **equally important**, then the **rotational inertia of these two disks should be equal.**

Hold the disks by the axle and determine if they "feel" the same when you twist them back and forth. What do you feel? **Predict how the rotational inertia of disk A compares to disk C**.

Activity 4: How do the disks react to a torque (turning force)?

Forces that cause rotations are named torques. In this activity, we will use torques to create changes in the rotation of the disks. If the disks have the same amount of change in rotations, then we can conclude that the disks have the same rotational inertia.

Wrap strings around disk A and disk C. Insert a smooth axle through both disks and clamp one end of the axle to the lab bench with a C-clamp. It may help to use the included o-rings to space out the disks. Carefully hang the masses on the strings. When you release the masses (at the same instant) the falling weights will cause turning forces on the disks and they will experience rotational accelerations! Watch closely to see if the disks seem to have identical motions.



Disk A *Disk C*

Which disk seems to gain rotational speed slower? This disk will have MORE rotational inertia. Rewind the strings and re-do this experiment.

Write a statement to describe which disk has MORE rotational inertia.

Which factor (mass **or** distance from center) seems to have a greater effect on rotational inertia?

Related Products

Gyroscope Wheel (93-3501) The Gyroscope Wheel is an innovative tool for teaching rotational inertia and gyroscopic precession in a safe and engaging way. Its adjustable masses and large-scale demonstrations make it easy for students to experience these complex concepts.

Ring and disk apparatus (P3-3540) Two objects of equal mass and equal radius - one a solid disk and the other a ring - roll down an incline. Which reaches the end first?

Rotational Inertia Demonstrator (P3-3545) A Beautiful and engaging investigation of angular motion! Observe the angular acceleration of the apparatus and investigate the effects of changes in torque and inertia.

Visible Variable Inertia Set (96-1010) The Visible Variable Inertia Set is a wonderfully simple tool for students to explore the relationship between mass and radius in rotational dynamics. The set includes two identical clear disks, each with eight wells for inserting steel spheres. This allows students to easily change the rotational inertia of the disks by simply rearranging the spheres in the wells.

Acknowledgement

Special thanks to Mark Davids for developing these activities.