Gyroscope Bicycle Wheel

Physics Demonstration

Introduction

Why is a moving bicycle much more stable than one that is stopped? The answer lies in the momentum of the wheels. The following activities can be used to demonstrate the properties of a rotating bicycle wheel (or a gyroscope).

Science Concepts

- Gyroscopic motion
- Precession
- Momentum
- Conservation of angular momentum

Materials

Bicycle wheel with axle handles and eye screws

Hanging weights (Activity 3)

Rope, heavy-duty, cotton (Activity 3)

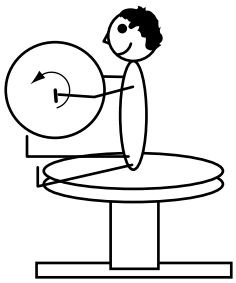
Turntable, or swivel chair or stool (Activities 1 and 2)

Safety Precautions

Care should be taken when spinning the bicycle wheel rapidly. Keep hands and other body parts clear of the spokes when the wheel is spinning. Hold the handles of the wheel firmly, with arms fully extended to prevent the wheel from rubbing against the body (and possibly injuring arms, legs and chest). Wear a lab coat or long-sleeved shirt when holding the spinning bicycle wheel. Wear safety glasses. When standing or sitting on a rotating stool, chair or table, be sure to keep your center of gravity low and over the center of the rotating apparatus in order to maintain optimal balance. Twist or tilt the bicycle wheel carefully. Do not use bare hands to slow down the spinning bicycle wheel. Stop the bicycle wheel by setting it on the floor.

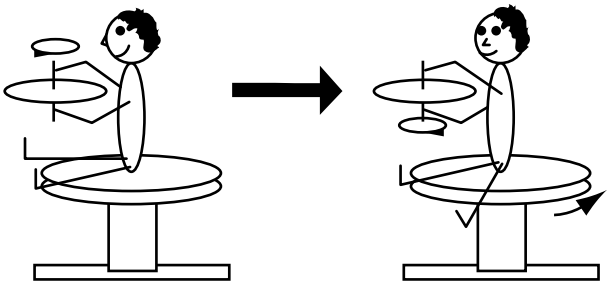
Procedure

Activity 1



1. Obtain a swiveling stool, chair or a rotational turntable (such as the Rotational Turntable, Flinn Catalog No. AP4609 or Labstool Rotational Turntable, Flinn Catalog No. AP6438). Make sure the stool or chair has a very sturdy base and legs.
2. Grip the handles of the bicycle wheel tightly, and carefully rotate the bicycle wheel rapidly in a vertical position (with the handles horizontal). Be sure to keep your center of gravity low and over the center of the rotating apparatus.
3. As the wheel spins, carefully, yet firmly, twist or tilt the handles. What happens? [Twisting the handles counterclockwise will cause the swiveling stool to rotate clockwise, and vice versa. When the handles are returned to their original position, the rotation stops.]
4. Discuss the observations with the students.

Activity 2



1. Repeat the steps in Activity 1, except hold the spinning wheel so that it is horizontal to the ground (with handles held vertical).
2. Make sure your center of gravity is low and over the center of the rotating apparatus.
3. While sitting on the rotating apparatus, carefully rotate the wheel 180° up-side-down (so your "bottom" hand is now the "top" hand).
4. Observe what happens. [The demonstrator will begin to rotate *very* rapidly on the rotating apparatus.]

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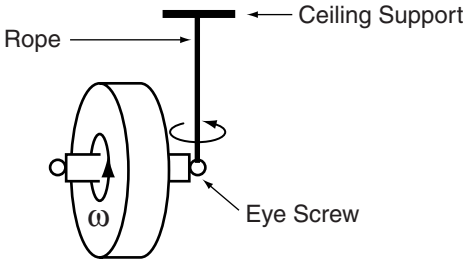
5. Rotate the wheel back to its original position.
6. Observe what happens. [The rotation stops.]
7. Discuss the observations with the students.

Activity 3

1. Obtain a heavy-duty rope. Tie or loop one end of the rope to the eye screw in one of the handles. (The other end of the rope can be tied to a support device, or it can be held in a hand for this demonstration.)
2. Hold the wheel by the handle, with the rope tied to it, with one hand.
3. Rapidly spin the bicycle wheel in the vertical position (refer to the figure).
4. Once the wheel is spinning quickly, grip the rope with your free hand while still holding the handle with your other hand.
5. Pull the rope so that it is vertical and taut. Then, release the handle quickly so the wheel is held up only by the rope.



6. Observe the gyroscope. [The wheel should remain suspended vertically and begin to spin around the support rope—it will precess. See Flinn Publication No. 10364 for a complete explanation.]
7. Discuss the observations with the students.

Discussion

Gyroscopic motion is generally a very complex topic. However, the basic idea is that the heavy, spinning wheel has a large amount of momentum and inertia. Applying a force to the spinning wheel results in a reacting twisting force on the force-applying body that conserves the momentum of the wheel. A complete explanation typically involves abstract (and not always well understood) concepts such as torque, angular momentum and vectors. The activities can be performed simply as interesting demonstrations, or they can be used to illustrate and explain complex physics principles. Please refer to Flinn Scientific Publication No. 10364 for a detailed explanation on gyroscopic motion and precession.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Systems, order, and organization
Evidence, models, and explanation
Content Standards: Grades 5–8
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, understanding of motions and forces
Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, structure of atoms, motions and forces, conservation of energy and increase in disorder

The *Gyroscope Bicycle Wheel* is available from Flinn Scientific, Inc.

Catalog No.	Description
AP4610	Gyroscope Bicycle Wheel
AP4609	Rotational Turntable
AP6438	Rotational Turntable, Labstool

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.

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