ARBOR SCIENTIFIC

Deluxe Bicycle Wheel Gyroscope

P3-3507

INSTRUCTIONAL GUIDE

Contents

- Bike Wheel (24", 61 cm diameter)
- 2 Handles
- Rip Cord

Recommended for activity:

- Rotating Platform (P3-3510)

Background

The bicycle wheel is a classic demonstration of angular momentum. A spinning bicycle wheel's angular momentum depends on the radius of the wheel, its mass, and angular velocity. Angular momentum has both a size and a direction, and is conserved in a closed system. The bicycle wheel can also be used to demonstrate gyroscopic precession.

Set-Up

Attach the two handles by screwing them onto the axle. Tighten the handles firmly. Make sure that the wheel spins freely and that the handles are secure before experimenting. Keep the tightening nut to the center of the wheel.

Activities

1. **Angular momentum and torque:** Hold the handles with both hands while another person starts the wheel spinning (using the enclosed starter or their hand). Try to tilt the wheel from side to side. Describe what you feel.

   A change in the speed or direction of linear motion requires a force. Likewise, a change in the speed or direction of rotational motion requires a torque. When you twist the wheel, you are changing the direction of the angular momentum. The twisting motion you apply is a torque, and a higher angular momentum of the wheel needs a larger torque to change direction.

2. **Conservation of angular momentum:** Stand on a rotating platform (or sit on a rotating stool) with the spinning wheel. (The wheel should be spinning as fast as possible.) Hold the handles vertically so that the wheel is spinning in a horizontal plane. Turn the wheel all the way over so that your hands trade positions. The platform should rotate. (It may be a small rotation, depending on your size, the friction in the platform, and the speed of the wheel.)

If the wheel is rotating clockwise in front of you (in a horizontal plane), the angular momentum is said to be pointing toward the floor. When you invert the wheel, you apply a torque that changes the direction of angular momentum so that it is pointing toward the ceiling (and the wheel is turning counter-clockwise). Angular momentum will be conserved in the "wheel-you" system, and you gain angular momentum to compensate for the change. According to Newton's 3rd law, when you apply a torque to the wheel, it will apply an equal but opposite torque to you. Your resulting angular momentum is toward the floor, and you rotate clockwise.

3. **Gyroscopic Precession:** Hold a loop of rope or hang it from a sturdy anchor. Bring the Bicycle Wheel Gyroscope up to speed and place one of the handles in the loop of rope. Let go of the other handle and the rotational inertia will keep the wheel spinning vertically, and gyroscopic precession will cause the wheel to revolve around the rope.

   This resulting motion is related to both the rotation of the wheel and the distance to the support point. If you are interested in a detailed explanation of gyroscopic precession, you might want to consult a physics text or the Internet.

Related Products

Extreme Gyroscope (P3-3500) Now you can demonstrate the nature of spin. Capture young imaginations when you make the Extreme Gyro stand on end. The Extreme Gyro starts with the included toothy T-handle.

Perpetual Top (P3-3503) Just an easy clockwise twist will set this top spinning for an unbelievable length of time. A tiny battery powered off-center motor maintains the rotational inertia of the top making it appear to continue spinning on its own. While spinning alternating red, green and blue LED lights are activated.

Euler's Disk (P2-9800) If you've ever watched a coin spinning on a tabletop, then you've got to see Euler's Disk. Constructed of heavy metal and a smooth concave surface, this device elegantly demonstrates conservation of energy.