Rotational Accelerometer Accessory

Contents
Aluminum bar with 4 thumbscrews and square mounting block
One 1000g mass
Two 1kg weights (bagged rice or sand)
Two Liquid Accelerometers

Also required
Rotating Lab Stool (P3-3610).

Instructions
1. Fill the liquid accelerometers half-full of water, so that the water reaches the “0” line. A few drops of food coloring will help make the water more visible.
2. Loosen the thumbscrews in the bar, place the accelerometers as in the photo, and tighten the screws.
3. Place the square mounting block in the stool seat.
4. Turn the stool to see the acceleration at two different points in the rotating radius.

Interpreting the Accelerometer
It is a good idea to do some linear demonstrations to show students how the accelerometer works.
1. From rest, accelerate the accelerometer to one side. Note the slope of the water as it accelerates forward. The lower end of the water points toward a positive acceleration. More slope indicates a higher acceleration.
2. Confirm this by watching the water as the accelerometer is stopped. The water slopes the other way, indicating negative acceleration.
3. Move the accelerometer until students can easily identify the direction and relative magnitude of acceleration by looking at the water’s slope.
4. For quantitative observations, the following equation describes the acceleration, where \( h \) is the height difference in the two ends of the water, \( b \) is the horizontal width of the water, \( g \) is the acceleration due to gravity, and \( a \) is the acceleration. Be sure to use consistent measurements (i.e. all in meters or all in centimeters).
\[
Slope = \frac{h}{b} = \frac{a}{g}
\]
5. If the water makes a straight line, the whole accelerometer is experiencing the same acceleration. If the water curves, that indicates differing acceleration at different points.
Experiments and Demonstrations

1. Use only one accelerometer, and secure it in the center of the stool. (Only one thumbscrew will be used.) You may need to attach another counterweight to the long end of the bar or add the other accelerometer, empty, in its outer position, to balance the system.
2. Spin the stool and observe the water. What is the direction of the acceleration:
   a. On the left side? (toward the center of rotation)
   b. On the right side? (also toward the center)
3. What is the acceleration in the center? (zero)
4. What parts of the accelerometer show the largest acceleration? (The outside edges, since the slope is highest there. Centripetal acceleration is greater at larger radii.)
5. Now attach two filled accelerometers as shown in the photo on page 1. Spin the stool and observe.
6. Which accelerometer shows the greatest average acceleration? (the outer one)
7. Which accelerometer has the greatest linear velocity? (the outer one)
8. Which accelerometer has the greatest angular velocity? (They are equal. They both complete the rotation in the same time.

Related Products

Bicycle Wheel (P3-3505). Classic demonstration of changing angular momentum.
Rotating Platform (P3-3510). This stable platform is large enough to stand on for rotational demonstrations.
Hydro-Gyro (P3-3550). This unique gyroscope uses colored water to produce rotational inertia.
Rotating Lab Stool

Contents
Turntable Stool Top
3-part unassembled Stool
2 Dowel Pins for step

Assembly
1. Mate the two large slotted pieces, pounding them with a soft mallet or the palm of the hand.
2. Secure them by inserting the prongs of the step.
3. Insert the two dowels to secure the step in place.
4. Place the turntable on top, so that the stool pieces fit in the slots.
5. The assembly can be made permanent by gluing the pieces and gluing the turntable top to the rest of the apparatus.

Instructions
The Turntable Top is designed to provide a low-friction rotating surface to demonstrate experiments involving the conservation of angular momentum and rotational kinetic energy. It is capable of supporting one student, when placed on the assembled stool. The load should be uniformly centered to prevent the bearing from binding. The bearing should be kept free from debris, and can be periodically cleaned with a vacuum or high pressure air hose.

Experiments with gyroscopic precession and torque can be investigated using a bicycle wheel gyroscope. Other experiments and demonstrations, such as an accelerometer, can be attached to the plug and placed on the stool top.

A student sitting on the turntable can have one kilogram mass in each hand to demonstrate how angular momentum is conserved with the arms extended and with the arms withdrawn. A 1kg “beanbag” can be caught or tossed by a properly balanced student.

Related Products
Bicycle Wheel (P3-3505). Classic demonstration of changing angular momentum.
Rotating Platform (P3-3510). This stable platform is large enough to stand on for rotational demonstrations.
Rotational Accelerometer Accessory (P3-3615). Allows students to see the magnitude and direction of acceleration at two points on the rotational radius.

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OPERATING INSTRUCTIONS

Contents

One (1) accelerometer puck, one (1) pivot post.

Accessories Required

Air table, syringe, food coloring, pulley, small mass.

Suggestions for Use

The accelerometer puck can be used to measure both linear and circular acceleration. When the accelerometer puck is at rest or moving with constant velocity the liquid surface will be horizontal. If the accelerometer is moving with a non-constant velocity, the liquid surface will be inclined. The slope of the surface is a measure of the magnitude of the acceleration.

Operation

Remove the threaded screws from the face of the accelerometer. Add a drop of food coloring to a small beaker of water. Fill the syringe with the colored water. Inject the water into the accelerometer until it is about half full. Replace the screws. Level the air table. Insert a threaded pivot post into the center of the air table. Place the puck over the post. Turn the air table on and slowly rotate the puck. Can you explain the shape of the water surface? Try rotating the puck at different speeds. How does the liquid surface change? Explain.

Remove the pivot post. Attach a pulley to the edge of the air table. Using a small mass apply a constant force to the puck. Turn on the air table. Allow the puck to move across the table. What happens to the liquid surface? Change the mass. Repeat the experiment. How does the liquid surface vary with the applied force?

Can you devise a method of calibrating the accelerometer puck so it reads directly in m/sec²?