35 Rotational Derby

Purpose

To observe how round objects of various shapes and masses roll down an incline and how their rotational inertias affect their rate of rotation.

Required Equipment/Supplies

smooth, flat board, 1 m in length
ring stand or metal support with clamp and rod
balance
meterstick
3 solid steel balls of different diameter (3/4" minimum)
3 empty cans of different diameter, with both the top and the bottom removed
3 unopened cans of different diameter, filled with nonsloshing contents (such as chili or ravioli)
2 unopened soup cans filled with different kinds of soup, one liquid (sloshing) and one solid (nonsloshing)

Activity

Discussion

Why is most of the mass of a flywheel, a gyroscope, or a Frisbee concentrated at its outer edge? Does this mass configuration give these objects a greater tendency to resist changes in rotation? How does their "rotational inertia" differ from the inertia you studied when you investigated linear motion? Keep these questions in mind as you do this activity.

The *rotational speed* of a rotating object is a measure of how fast the rotation is taking place. It is the angle turned per unit of time and may be measured in degrees per second or in radians per second. (A radian is a unit similar to a degree, only bigger; it is slightly larger than 57 degrees.) The *rotational acceleration*, on the other hand, is a measure of how quickly the rotational speed changes. (It is measured in degrees per second squared or in radians per second squared.) The rotational speed and the rotational acceleration are to rotational motion what speed and acceleration are to linear motion.

Procedure

Step 1: Make a ramp with the board and support. Place the board at an angle of about 10°.

Set up ramp.

Roll balls down ramp.

Step 2: Select two balls. Predict which ball will reach the bottom of the ramp in the shorter time.

predicted winner: _____

Place a meterstick across the ramp near the top, and rest the balls on the stick. Quickly remove the stick to allow the balls to roll down the ramp. Record your results.

actual winner: _____

Repeat the race for the other pair of balls.

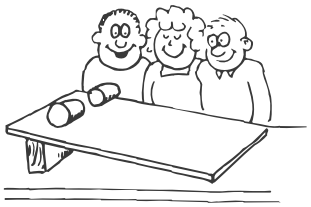
1. What do you conclude about the time it takes for two solid steel balls of different diameter to roll down the same incline?

_____

_____

_____

Roll hollow cylinders.



Step 3: Repeat the race for two hollow cylinders (empty cans). Record your predictions and results.

predicted winner: _____

actual winner: _____

Repeat the race for the other pairs of hollow cylinders.

2. What do you conclude about the time it takes for two hollow cylinders of different diameter to roll down the same incline?

_____

_____

_____

Roll solid cylinders.

Step 4: Repeat the race for two solid cylinders (filled cans with non-sloshing contents). Record your predictions and results.

predicted winner: _____

actual winner: _____

Repeat the race for the other pairs of solid cylinders.

3. What do you conclude about the time it takes for two solid cylinders of different diameter to roll down the same incline?

_____

_____

_____

Roll hollow and solid cylinders.

Step 5: Repeat the race for a hollow cylinder and a solid one. Before trying it, predict which cylinder will reach the bottom of the ramp first.

predicted winner: _____

Now try it, and record your results.

actual winner: _____

Repeat for other pairs of hollow vs. solid cylinders.

4. What can you conclude about the time it takes for a hollow and a solid cylinder to roll down the same incline?

_____

_____

_____

_____

5. How do you explain the results you observed for the hollow and solid cylinders?

_____

_____

_____

_____

_____

Roll balls and solid cylinders.

Step 6: Repeat the race for a solid ball and a solid cylinder. Record your prediction and result.

predicted winner: _____

actual winner: _____

6. What do you conclude about the time it takes for a solid ball and a solid cylinder to roll down the same incline?

_____

_____

Roll balls and hollow cylinders.

Step 7: Repeat the race for a solid ball and a hollow cylinder. Record your prediction and result.

predicted winner: _____

actual winner: _____

7. What can you conclude about the time it takes for a solid ball and a hollow cylinder to roll down the same incline?

_____

_____

_____

_____

Roll cans of different kinds of soup.

Step 8: Repeat the race for two soup cans, one with liquid (sloshing) contents and the other with solid (nonsloshing) contents. Record your prediction and results.

predicted winner: _____

actual winner: _____

8. How can you explain the results you observed for the sloshing vs. nonsloshing kinds of soup?

_____

_____

_____

_____

_____

_____

Analysis

9. Of all the objects you tested, which took the least time to roll down the incline?

_____

_____

_____

10. Gravity caused the objects to turn faster and faster—that is, they had rotational acceleration. Of the objects you tested, what shape of objects had the greatest rotational inertia—that is, the greatest *resistance* to rotational acceleration?

_____

_____

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