Rotational Inertia: Get Spinning!

- Objects resist changes in the speed or direction of their spin. This property is called **rotational inertia**
- Objects whose mass is farther away from the spinning axis have more rotational inertia (harder to change their spin).

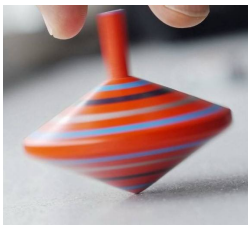
Part 1: Rotational Inertia

1. Get the fidget spinner spinning. Try turning your hand to make it spin vertically or horizontally. Compare to when the spinner is still

When do you feel more resistance to turning the spinner?

When it is still When it is spinning

2. Try balancing a wooden top on its point.



What does it do? Balance topple over

3. Now try spinning the top while balanced on its point.

What does it do? Stays mostly upright while spinning immediately falls over

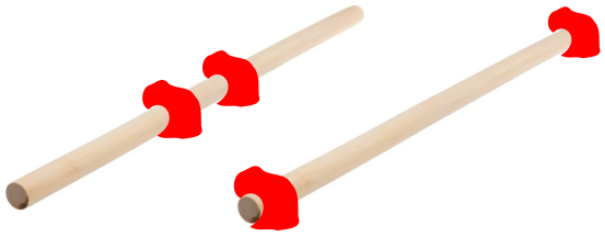
Discuss:

- Why does the top stay upright while spinning but not when it is still?
- Why is it easy to balance on a bike while it is moving, but hard to stay upright if you stop? Imagine the bike wheel as a fidget-spinner.

Recall that the **inertia** of an object tells how hard it resists changes in motion. Objects also have **rotational inertia**. They will keep spinning in their original direction unless external forces are applied.

4. Break your modeling clay into 4 equal pieces.

5. Take one wooden dowel and wrap two pieces of clay around it near the center, with about 1" separation between them.



6. Take another wooden dowel and wrap two pieces of clay around each end.

7. Try twirling the wooden dowels back and forth while holding the center between your finger. Have a race with a partner for who can most quickly do 20 twirls with their dowel.

Which dowel is easier to twirl? The one with…

clay near center or clay far out near ends

Which dowel has more **rotational inertia** (requires more force to rotate)?

clay near center or clay far out near ends

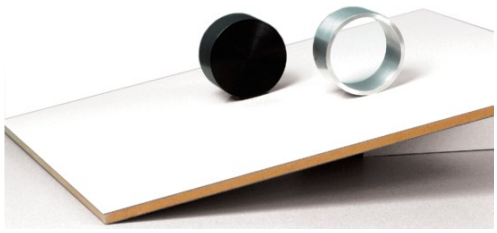
Discuss: Why do you think this is?

Rotational inertia depends not just on the mass of the object, but also where that mass is located. Mass further out from the center of rotation has more rotational inertia (harder to get spinning).

Discuss: Why do ice skaters pull in their arms to make themselves spin faster? Why do gymnasts and divers pull their legs up into a tuck when doing fast flips?

Part 2: Rolling Races

1. Tilt a desk by stacking some books under its feet. The desktop will be your ramp.



When an object rolls, some of its energy goes into spinning as well as moving forward. The more rotational inertia it has, the more energy is needed to make it spin, so it rolls more slowly.

2. Compare the following objects:

solid cylinder hollow tube roll of tape marble




Discuss: When they are rolling,
Which object has its mass distributed closer to the center axis?
Which has its mass furthest out from the center?

Make a prediction: rank the objects from 1 (will roll fastest) to 4 (will roll slowest)

___ solid cylinder ___ hollow tube ___ roll of tape ___ marble

3. Test your predictions by racing pairs of objects. **Use a ruler in front of each pair** to keep them in place at the top of the ramp. Pull the ruler upward quickly to make sure both start at the same time.

Which rolled faster?

Solid cylinder	vs	roll of tape
Roll of tape	vs	hollow tube
solid cylinder	vs	marble

Try other combinations too!

Based on your observations, rank objects from 1 (rolled fastest) to 4 (rolled slowest)

___ solid cylinder ___ hollow tube ___ roll of tape ___ marble