Make Your Own Pendulum

Primary Audience: Kindergarten – 5th Grade

Description: Guests build a pendulum using a ball and string.

Keywords: Pendulum, Gravity, Momentum

Materials:

- For Demonstration:
  - Tennis Ball on a String
  - Silver Ball (Optional)

Instructions:
Go to the pendulum and find some guests waiting for the next ball to fall. Check to see that you have a few minutes before the next collision. If not, have guests watch and talk about what's happening. Use good questioning techniques to lead guests to the answer. When you're ready for the demonstration, get a guest to loan you her nose. Swing the model pendulum (tennis ball on a string or a guest's pendant necklace) toward her nose. Begin turning in a circle. The pendulum will keep going to her nose. Hold up a knuckle or the silver ball so that it moves into the path of the pendulum and is struck.

Now ask why the pendulum doesn't turn. Hold the model pendulum at two points instead of one and turn again. Now the pendulum will turn with you.

Finally, demonstrate why the pendulum wouldn't work on the equator. Hold the string against your waist, with the ball held out perpendicular to you. Swing the ball back and forth with your hand as you turn in a circle, showing that the pendulum won't change in relation to the circle of balls if it is on the equator.

Possible Interactive Questions:

- What do you notice about the pendulum? Can you make a hypothesis about what will happen after you provide motion to the pendulum?
- Is there an observable pattern to the movement of the pendulum?

What's Going On?
Hi, folks. Is it getting close? Oh, it looks like we have a few minutes before the next ball gets knocked over. While we're waiting, can anyone tell me what's happening here?

Why do the balls get knocked over? Yes, it has something to do with the Earth turning. Let's find out how it works. I have here a model of our pendulum. Can I borrow your nose? Great. I'm going to swing the pendulum to your nose. Now I'm the Earth. What does the Earth do every day? That's right, it rotates.

As I rotate, is the pendulum changing direction? No, it's still going right to your nose. As the Earth turns, the silver balls on the surface of the Earth turn with the Earth, and get in the way, and then . . . whack, they get hit by the pendulum. That's what is happening in here. Each time you see one of those silver balls get knocked off, it means you've just seen the Earth turning. This was the way scientists actually proved that the Earth turns every day.

That's the easy part. Here's the hard part. Why doesn't the pendulum turn with the Earth? You're turning, and I'm turning, and the building is turning, and everything is turning with the Earth, except this pendulum. What makes it so special.

Let's try our experiment again. May I borrow your nose again? Great. This time, I'll hang the pendulum from two points. Let's see if that makes a difference.

What happens? Yes, now the pendulum turns with the Earth. There's a force on these two points, causing the pendulum to turn as the Earth turns. But when there's just one point, there's no force there, nothing to make the pendulum turn, and so it stays in the same plane all day long.

Now, if our pendulum were built on the North Pole or the South Pole, that would be exactly right. It would take exactly one day, or 24 hours, for the balls to turn all the way around the pendulum. But we're not on the North Pole or the South Pole. Here in Columbus we're off on the side of the Earth, and so it doesn't take one day (or 24 hours) for the balls to turn all the way around, but about a day and a half (37 hours).

Now here's my question. If it takes one day (24 hours) on the North Pole and a day and a half (37 hours) here in Columbus, how long would it take for these balls to go all the way around on the equator? The answer is, it would take forever. Think about why. On the equator, the pendulum swings like this, straight out from my belt. As the Earth turns, the pendulum turns with it. Nothing ever changes on the equator, and so the balls never get knocked over.

So if we built this exhibit on the equator, it wouldn't work. It would just keep swinging back and forth and never knock over any balls.

Relevant Ohio Science Content Standards:

- Physical Sciences K-2 B: Recognize that light, sound and objects move in different ways.
    - 1.5: Explore the effects some objects have on others even when the two objects might not touch (e.g., magnets).
- Physical Sciences 3-5 C: Describe the forces that directly affect objects and their motion.
    - 3.3: Identify contact/noncontact forces that affect motion of an object (e.g., gravity, magnetism and collision).

Mechanics: