PSI:
PHYSICAL SCIENCE INVESTIGATION

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GREAT LAKES Science Center

Teacher's Lesson Description

Title	**Give it a Whirl**
Brief Description of the Segment	In this segment Dante will demonstrate that the movement of an object in a circular path will create a force that allows water to stay in the bucket and a glass of water to stay on the table. This force is centripetal force.
Time Needed	Two class periods.
Ohio Science Benchmarks Addressed	• Grade 6-8 SI Benchmark A and B • Grade 6-8 SW Benchmark A • Grade 6-8 PS Benchmark B • Grade 6-8 ES Benchmark A •
Ohio Grade Level Indicators Addressed	• Grade 6 SI Indicator 1 & 2 • Grade 7 SI Indicator 1, 2, 3, & 4 • Grade 8 SI Indicator 3 & 4 • Grade 8 SW Indicator 1 • Grade 8 PS Indicator 1 • Grade 8 PS Indicator 2 • Grade 8 PS Indicator 3 • Grade 8 ES Indicator 1 • Grade 8 ES Indicator 2

Concepts Developed	• Forces are balanced or unbalanced. • Unbalanced forces can move things or cause things to stay in position. • Centripetal force is the force that causes objects to move in a circular path. • Gravity between two objects provides the centripetal force that pulls the planets toward the center of the Sun AND the Moon toward the center of Earth. • Centripetal force is perpendicular to the circular movement of an object. • Scientific investigations involve variables that should be identified and controlled.
Lesson Rationale	Students should be provided with multiple to engage in the scientific inquiry process. This particular investigation deals with forces that students encounter everyday, but might not think about. Newton's second law explains that the relationship between the unbalanced forces acting on an object, the mass of the object, and the acceleration (the measure of how quickly the speed or direction of an object is changing) of the object results. Newton used the equation F = m X a to explain how these three factors are related.
Background Knowledge for Teachers	Newton's laws of motion form a system that can be used to determine an object's future motion. Objects interacting with each other also follow these laws. If you know the forces acting between objects, you can determine the changes in the objects' future motion. For these lessons, we will primarily deal with Newton's second law but it is important to understand that all three laws are involved in an object's motion. • Newton's first law states that objects in motion tend to stay in motion and objects at rest tend to stay at rest unless acted upon by a net force. A **force** is a push or a pull and a **net force** is the combination of all the forces acting on an object. **Friction** is a force that resists motion between surfaces that are touching each other.

	• Newton's second law states that an object acted upon by a net force will accelerate in the direction of the force. The acceleration due to a net force is given by the equation a = Fnet / m. The force of gravity between two objects depends on their mass and the distance between them. In circular motion, a force pointing toward the center of the circle acts on an object. This force is **centripetal force.** • Newton's third law states that the forces two objects exert on each other are always equal but in opposite directions. These forces do not cancel each other because they are acting on different objects. A **spring scale** will measure the force applied to an object in Newtons.
Classroom Procedures	This lesson demonstrates several of the principles of Newton's laws of motion. Begin by asking the following questions or writing them on the board as a pre-assessment: • Why do you feel pressure on your seat belt in the car when it turns a corner at a high rate of speed? • Why do you slid to the outside edge of the seat in an amusement car ride as it whips around a corner? Have students discuss what they know about inertia and Newton's laws. They should watch the videos and make the predictions in their laboratory journals. Laboratory Activity: CENTRIPETAL FORCE GOAL: Students will be able to determine the relationship of mass to the movement of an object in a circular path. Students will make a centripetal force measurement device by doing the following: 1. Measure 1.5 m of medium weight string.

	2. Tie it to a 2-hole stopper at one end. 3. Put the other end through the center of a thread spool and tie it to a paper clip. 4. Place a pinch clip between the paper clip and the spool so that 1-meter of string is left between the stopper and the top of the spool. Once the device is made, students use the device to measure the time it takes to make one revolution based on different masses. 5. Place washers equal to 50 grams on the paper clip. 6. Move the stopper in a circular motion over the head until it raises the mass from the table and the pinch clip is just about touching the bottom of the spool. 7. Time the amount of seconds it takes for the stopper to complete 10 revolutions. 8. Replace the 50-gram mass with 100 grams and then 150 grams. Each time repeat steps 6 and 7. 9. Replace the gram masses with a spring scale. 10. Hold the spring scale as you partner turns the stopper. When it measures 50 grams, record the Newtons of force measured. Once students have collected this data they should: 1. Draw a picture of the string, rubber stopper, and the weights. Label the different forces acting on these objects and their direction. 2. Draw a picture of the string, rubber stopper, and the weights. Label them with the words Moon, Earth, and centripetal force.

	3. Draw a picture of the string, rubber stopper, and the weights. Label them with the words Sun, Earth, and centripetal force. 4. Explain how this demonstration helps you understand the movement of the bodies in the universe 5. How could knowing the mass of an object and its
Materials Needed	2-hole rubber stopper (the larger the better) medium weight string pinch clamp (hair clips can work) thread spools (glass tubing about 8-10 centimeters will work) metal washers or weights of 50, 100, and 150 grams Spring scales
Science Connections	Centripetal force is the force that causes objects to move in a circular path. This relationship is seen in the moon's revolving around the Earth. It is also seen in the orbital paths of the planets around the Sun.
Additional Web Resources from the Ohio Resource Center	Tennis ball on a string http://teachingtoday.glencoe.com/lessonplans/exploring-the-circular-motion-of-a-tennis-ball Roller Coaster Loops http://www.teachersdomain.org/resources/phy03/sci/phys/mfw/roller/index.html Centripetal Force Demo http://www.teachersdomain.org/resources/phy03/sci/phys/mfw/zcentrip/index.html Roller Coaster Design Simulation http://www.funderstanding.com/k12/coaster/index.html Phun Physics Demos

	http://phun.physics.virginia.edu/topics/centrifugal.html The "Gravitron" Ride – YouTube Video http://www.youtube.com/watch?v=W3K7SDzfF2U&feature=related

Ohio Science Standards Abbreviations:

ES – Earth/Space Science
LS – Life Sciences
PS – Physical Sciences
SI – Scientific Inquiry
ST – Science and Technology
SW – Scientific Ways of Knowing