

PSI:

PHYSICAL SCIENCE INVESTIGATION



Teacher's Lesson Description

Title	Bowled Over
Brief Description of Videos	Dante releases a bowling ball pendulum from chin height in order to show that the rule of conservation of energy will not allow the ball to hit him in the face.
Time Needed	For a full investigation, two class periods
Ohio Science Benchmarks Addressed	<ul style="list-style-type: none">• Grades 6-8, PS Benchmark B• Grades 6-8, SI Benchmark B• Grades 6-8, SW Benchmark A
Ohio Grade Level Indicators Addressed	<ul style="list-style-type: none">• Grade 7, PS, Indicator 2 - Describe how an object can have potential energy due to its position or chemical composition and can have kinetic energy due to its motion.•• Grade 7, SI, Indicator 1 - Explain that variables and controls can affect the results of an investigation and that ideally one variable should be tested at a time.• Grade 7, SI, Indicator 2 - Identify simple independent and dependent variables• Grade 8, PS, Indicator 1 - Describe how the change in the position (motion) of an object is always judged and described in comparison to a reference point.• Grade 8, PS, Indicator 2 - Explain that motion describes the change in the position of an object (characterized by a speed and direction) as time changes.• Grade 8, PS, Indicator 3 - Explain that an unbalanced force acting on an object changes

	<p>that object's speed and/or direction.</p> <ul style="list-style-type: none"> • Grade 8, SI, Indicator 3 - Read, construct and interpret data in various forms produced by self and others in both written and oral form, e.g., tables, charts, maps, graphs, diagrams and symbols (8). (SI) • Grade 8, SI, Indicator 4 - Apply appropriate math skills to interpret quantitative data.
Concepts Developed	Graphical analysis of data, kinetic and potential energy, behavior of falling objects, describing periodic motion, comparison of experimental results to theoretical outcomes.
Lesson Rationale	Students learn to evaluate the effects of a variable on the outcome of an experiment and to compare experimental outcomes with their predictions. Upon creating and analyzing their graphs, students will see a second order equation and how the curve of the graph describes the reality of the pendulum's behavior.
Background Knowledge for Teachers	Teachers will understand the concepts of acceleration due to gravity and adjusting variables in an experiment. They should be able to create graphs (by hand and/or using software) and use them to analyze experimental outcomes.

Classroom Procedures	<p>Using a pendulum with three masses (aluminum, balsa wood, and steel), each with a 100 cm. string, students will try to find the period while adjusting the length of the string, the mass of the bob, and the arc of the swing, with each set of trials done independently. They will use a stopwatch to time a given number of swings and divide to find the period. The number of swings should vary from one trial to the next within a reasonable range, perhaps as few as eight and as many as twenty.</p> <p>Teachers may wish to have students compare their experimental values with those obtained by Galileo's formula. Students can then graph the experimental results for each length of string with the theoretical figure obtained by the formula. Use the formula $T = 2\pi(\sqrt{l}/\sqrt{G})$, where T = period in seconds, l = length of the string in cm., and G = the gravitational constant, 980 cm./seconds²</p> <p>As you saw in the classroom video clip, students were assigned the task of designing a pendulum that can be used as a timing device. For example, the instructor might suggest that groups try to create a device that will accurately and repeatedly time a ten second interval.</p> <p>The video segment should be related to the classroom work. The distinction between potential and kinetic energy should be established both in class and from seeing the video. With reference to the video, the reason that the person dropping the bowling ball can not be struck should be developed in discussion of conservation of energy.</p>
Materials Needed	Pendulum (with several masses and length-adjustable strings), Stopwatch, Graph Paper, Excel (or comparable) software, measuring tapes and/or meter sticks.
Science Connections	Using mathematics to analyze and solve science problems; testing different variables to determine changes in outcomes; visual interpretation of data (developing graphing skills); understanding the concepts of periodic motion and acceleration due to gravity.
Additional Web Resources	<p>What is a Pendulum? http://www.calacademy.org/products/pendulum/page1.htm</p> <p>Pendulums and Amusement Parks http://www.learner.org/interactives/parkphysics/pendulum.html</p>

The Foucault Pendulum

<http://www.astro.louisville.edu/foucault/index.html>

Precession in Pendulums

http://www.physclips.unsw.edu.au/jw/foucault_pendulum.html

Science Net Links

<http://www.sciencenetlinks.com/lessons.cfm?Grade=6-8&BenchmarkID=4>

Periodic Motion Simulation

<http://www.school-for-champions.com/science/pendulum.htm>

Interactive Pendulum Simulator

http://www.physics.uoguelph.ca/applets/Intro_physics/kisalev/java/pend1/index.html

Another Interactive Pendulum Investigation

<http://www.myphysicslab.com/pendulum1.html>

Ohio Science Standards Abbreviations:

ES – Earth/Space Science

SI – Scientific Inquiry

LS – Life Sciences

ST – Science and Technology

PS – Physical Sciences

SW – Scientific Ways of Knowing