PSI: PHYSICAL SCIENCE INVESTIGATION

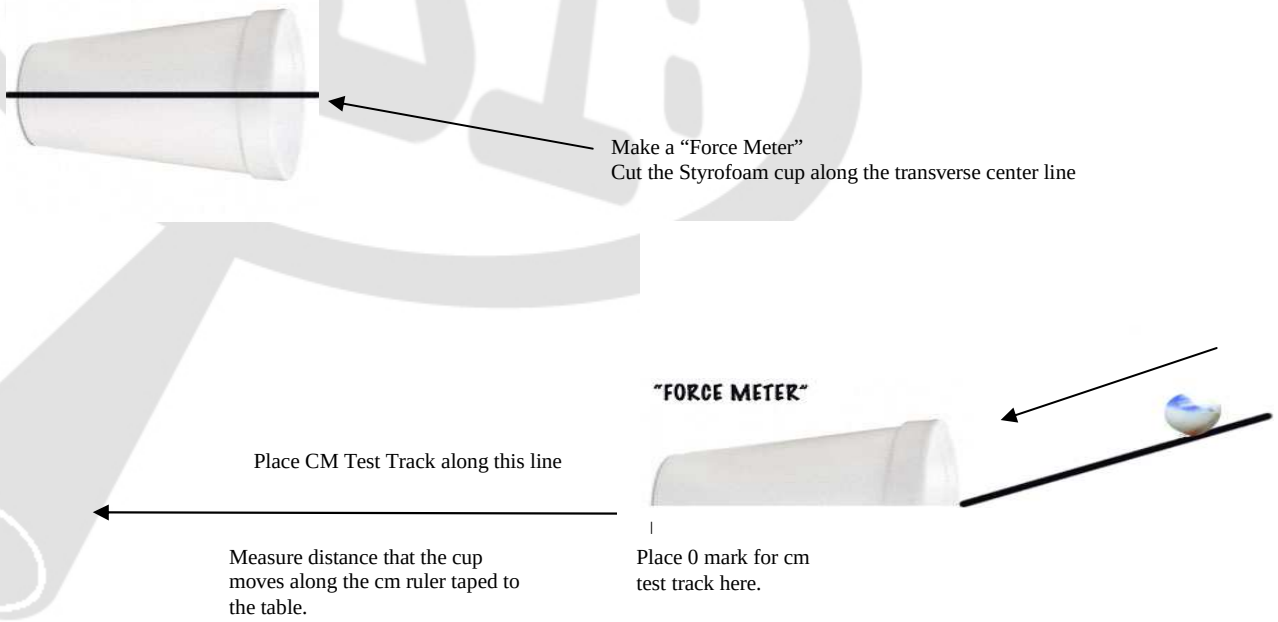
wviz ideastream℠

GREAT LAKES Science Center

Teacher's Lesson Description

Title	**A Momentous Occasion**
Brief Description of the Videos	Dante demonstrates how gravitational potential energy can be converted to kinetic energy, and how the kinetic energy can be transferred through momentum.
Time Needed	3 class periods for all activities (1 day videos and discussion, 2 days for extension lesson)
Ohio Science Benchmarks Addressed in This Activity	Grades 6-8 Physical Science Benchmark B Grades 6-8 Scientific Inquiry Benchmarks A and B
Ohio Grade Level Indicators Addressed in This Activity	Grade 8 Forces and Motion Indicators 1, 2 , and 3 Grade 8 Scientific Inquiry Indicators 1 and 3
Concepts Developed	Gravitational potential energy can be converted to kinetic energy (energy of motion). When a rolling marble accelerates due to the effects of gravity, a force is created because of a relation between the marble's mass and the acceleration (F=ma). That force can be measured. Some part of the kinetic energy associated with a rolling mass can be transferred to other objects through collisions. The force will vary depending upon variables that students can investigate. The results of collisions are predictable unless an unanticipated or unobserved change in energy occurs.
Lesson Rationale	These activities provide students with the opportunity to make predictions, investigate Newton's Laws of Motion, gather and organize data, and make predictions based on those data.

Background Knowledge for Teachers	Review all of the teacher segments before conducting activities with students. The teacher segments contain additional physics content information, detailed explanations, and classroom suggestions for using the videos to encourage productive dialogue and inquiry-based questioning. An important part of Dante's demonstrations shows that the effects of collisions can be predicted based on such things as mass and acceleration due to gravity unless some additional forces are introduced to the system under investigation. Just as the magnetic bearing introduces magnetic forces that bring unanticipated results to the experiment, so can forces such as friction. Rolling masses with higher coefficients of friction will accelerate less rapidly than rolling masses with low coefficient of friction. The higher coefficient of friction produces a greater resistance to rolling, effectively slowing the acceleration (and the resulting force) relative to objects that produce less friction. This lesson also allows teachers to introduce, or further discuss, such concepts as inertia and momentum, and ways that different masses and different accelerations affect the outcomes of collisions between masses.
Classroom Procedures	After viewing and discussing the inquiry questions presented in the PSI video, student work teams can be given this challenge: After you have had 15 minutes to investigate and gather data about the force you can generate using your ramps and marbles, I will give you a target distance for your Styrofoam force meter. You will have three trials to move your force meter some distance between 5 and 30 cm. Using the data in your table, you should be able to predict the marble, height (slope) of the ramp, and the starting point necessary to move the force meter the required distance. Set-up: Place the CM Test track so that the 0 mark is at the back end of the force meter. The distance that the cup is moved, can be easily read off the cm ruler that is taped to the students' work tables. The students can read the "starting position" of each marble from the ruler used as the ramp. A tongue depressor or ice-pop stick makes a good "starting gate" and helps to provide a consistent starting point and release. Important independent variables – slope of ramp; height of starting point on the ramp; distance of starting point from end of ramp; mass of marble; distance from end of ramp to cup (rolling friction causes some energy conversion to heat & can affect force hitting the cup). Dependent variables: distance cup moves is a function of the force hitting it. Since F = ma, the mass of the marble and the gravitational potential energy of its starting point can be used to vary

	the force. Data can be uniformly collected through a table that includes mass of marble, height of ramp at marble release point, slope of ramp (rise v. run), and distance cup moved.
Materials Needed	Download the “Cm Test Track” PDF file from the PSI Web site and make enough copies for your student work groups. Each group will need a wooden ruler with a pencil trough down the center and a set of six dominos, or similar objects, that can be used to raise or lower that upper end of the ruler (ramp), and an assortment of marbles and ball bearings of different sizes and mass. Students should also have half of a Styrofoam cup, cut as shown in the diagram below, to use as a “force meter”. It is also preferable to have a beam balance, pan balance, or electronic scale capable of weighing to the nearest gram. 

<table>
<tr><td></td><td>Sample data collection sheet:

<table><tr><td>Description of Marble or Ball Bearing</td><td>Mass of Marble or Ball Bearing</td><td># Dominos Raising the Ramp (1 – 6)</td><td>Starting distance of marble up the ramp</td><td>Distance force meter moved</td></tr><tr><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>Science Connections</td><td>The relationship between gravitational potential energy and kinetic energy is evident in many daily situations, and it is the basis for many toys and pastimes. Any time a toy car or marble is rolled down a ramp, or a roller coaster is released down a hill, we make use of the force of gravity to create motion. Have students make a classroom list of all the connections they can make between recreational activities and the use of gravitational potential energy, kinetic energy, and other forces like friction. Some of the answers might be sledding or tobogganing, skiing, bungee jumping, parachuting, ski jumping, skateboarding ramps, Soap Box Derby, or the pendulum motion used to start a bowling throw, a golf shot, an underhand softball pitch. The important thing here is for students to realize how gravitational potential energy and kinetic energy are considerations in so many daily activities.</td></tr>
<tr><td>Additional Web Resources</td><td>The Physics Classroom Tutorial – Newton’s Laws.
http://www.glenbrook.k12.il.us/GBSSCI/PHYS/CLASS/newtlaws/u2l3a.html

Middle School Mechanics Lessons from the Illinois Institute of Technology
http://www.iit.edu/~smile/physinde.html

Middle school physical science lessons from the Ohio Resource Center
http://www.ohiorc.org/for/science/browse.aspx?topic=208&grade=8&resourcetype=1</td></tr>
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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