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Pendulums on the Moon

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Grade Level	6-12
Subject Area	physical science
Curriculum Focus	physics, space science
Duration	two class periods

Objective

Students will 

1. discuss and understand the importance of the scientific method and experimental controls and then put those ideas into practice;
2. conduct experiments in the classroom to determine whether length, mass, or starting angle has any effect on the rate of a pendulum's swing;
3. conduct an experiment using an [online Moon Pendulum](#) to determine whether gravitational force has any effect on the rate of a pendulum's swing;
4. create graphs to illustrate the results of their experiments; and
5. draw conclusions from the graphs they have created.

Materials

★ Related Materials

Historical and Modern Uses of Mathematics DVD

Product Type: DVD
Price: 49.95

Introduce middle school students to more advanced concepts about the general nature and uses of mathematics.



- ◆ one pendulum apparatus for each lab group ◆ each apparatus should include strings of 40, 60, 80, and 100 centimeters and bobs with masses of approximately 25, 50, and 75 grams
- ◆ copies of the [Pendulums on the Moon worksheet](#) and the [Pendulums on the Moon worksheet answers](#)
- ◆ copies of the [Pendulums on the Moon data sheet](#)
- ◆ graph paper
- ◆ computers with Internet access

Procedure

This activity consists of two phases. In phase 1, students will recreate Galileo's famous pendulum experiments in the classroom. In phase 2, students will take Galileo one step further ◆ into outer space ◆ by using an [online Moon Pendulum!](#)

1. To introduce this activity, begin by leading a class discussion about the scientific method. Review with your students the concepts of observation and collecting and recording data. You might also want to review the terms *dependent variable*, *independent variable*, and *constant variable* with your students, as these will be crucial for an understanding of this activity. In addition, your students will need to be familiar with G , the gravitational constant (9.8 m/s²). This will be important for phase 2 of the activity, in which students will use the [online Moon Pendulum](#).
2. Ask your students the following question: What variables affect the rate of a pendulum's swing? Students may come up with a variety of answers, but the four that they will be testing in the following experiment are the length of the pendulum, the starting angle of the pendulum, the mass of the bob at the end of the pendulum, and the force of gravity. As you make a list of students' answers to the question, make sure that those four are included. Give them a chance to debate and discuss their answers before continuing.
3. Distribute copies of the [Pendulums on the Moon worksheet](#); then explain to your students that they will need to conduct experiments to determine whether each of the four variables has an effect on the rate of a pendulum's swing. Before they conduct their experiments, however, they will need to determine the dependent, independent, and constant variables for each one. Divide your class into lab groups and ask each group to work together to fill out the chart on the worksheet as best it can. Then bring the class back together and discuss the groups' answers. Make sure that students explain the reasoning behind their decisions. When the discussion is complete, distribute copies of the [Pendulums on the Moon worksheet answers](#) and discuss the various variables with the class.
4. Your students are now ready to begin phase 1 of their experiments, in which they will use the pendulum apparatus you have provided to test the effects of length, starting angle, and mass on the pendulum's rate of swing. Make sure that the groups understand that by changing the value of only one of these variables at a time, they can determine the effect that it has on the rate of the pendulum's swing. For instance, to determine the effect of length on the pendulum's rate of swing, they will need to use the same mass, the same starting angle, and the same gravitational force (obviously) as they test different lengths.
5. Distribute copies of the [Pendulums on the Moon data sheet](#) to your students. Make sure that students understand how to use the data sheet. Explain that before each experiment, the group needs to state a hypothesis: What effect, if any, will the independent variable have on the rate of the pendulum's swing? Encourage them to make careful measurements and record their data neatly and

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clearly.

6. When phase 1 is complete, ask the groups to use the data they have collected to create three graphs, one for each experiment. On each graph, the independent variable should be placed on the x-axis, and the dependent variable should be placed on the y-axis.
7. Next, your students are ready to begin phase 2 of their experiments, in which they will use the [online Moon Pendulum](#). Explain to students that this online pendulum is designed to simulate the swinging of a pendulum on the moon. Make sure they understand that the moon's gravitational force is 1/6 that of the Earth.
8. Explain to students that in phase 2, they are going to repeat experiment 3 from phase 1 this time, using the online pendulum. Make sure that, as before, groups state a hypothesis about the effect of the independent variable (gravitational force) on the rate of the pendulum's swing before conducting the experiment.
9. When phase 2 is complete, ask students to use the data they have collected to create three small bar graphs of their results—one for each of the three masses they used in the experiment. The independent variable (gravitational force) should be placed on the x-axis as before, and the dependent variable should be placed on the y-axis.

Closure

When their final graphs are complete, bring the class together to discuss the groups' results. What did their experiments reveal? (In phase 1, students should have observed that length has the greatest effect on the rate of the pendulum's swing. The starting angle also has some effect, but it is often not observable. If the experiments were done carefully, the mass should have no effect at all. In phase 2, students should have observed that gravitational force does indeed have an effect on the rate of the pendulum's swing.) If students did not observe the expected results, what explanations can they offer for why that may have occurred? Conclude with a discussion on the significance of isolating variables. Why is this an essential feature of a useful scientific experiment?

Extension

1. One way to extend this activity is to have your students research the significance of pendulums as they are used in various technological efforts. Students should begin to understand where pendulums are commonly utilized and the practical functions they serve. Each student can choose a machine in which a pendulum is used, research it, then give a brief presentation to the class.

Related Links

Galileo's Pendulum Experiments

http://es.rice.edu/ES/humsoc/Galileo/Student_Work/Experiment95/galileo_pendulum.html

The Simple Pendulum

<http://theory.uwinnipeg.ca/physics/shm/node5.html>

The Foucault Pendulum

<http://www.calacademy.org/products/pendulum.html>

Credits

Ray Ann De Prisco Havasy, professor of education at the New York Institute Of Technology, and Eric Patysiak, research fellow at the New York Institute of Technology and high school science teacher.

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