The Invisible Force: Teacher's Guide

Grade Level: 6-8 | **Curriculum Focus:** Physical Science | **Lesson Duration:** Two class periods

Program Description

Don't let gravity get your students down. *The Invisible Force* is an uplifting demonstration of this all-important presence. How does gravity work? How has it shaped our planet and the species living on it over millions of years? Do your students know why some scientists believe that gravity will eventually destroy the universe? This video gives them the scoop on the latest scientific research.

Onscreen Questions and Activities

Segment 1, The Invisible Force: Part One

- Pre-viewing questions:
    - What do you know about the force of gravity? What is it, and how does it affect your life on Earth?
    - Think of as many examples of gravity at work on Earth as you can.
    - Then, while you watch the program, keep track of the examples of gravitational influence on your life, your body, and your surroundings that you didn't consider.
- Post-viewing questions:
    - With almost every movement of your body, you defy the force of gravity. In what ways is your body specially designed to withstand the constant force?
    - How does your body's adaptation to the conditions on Earth differ from smaller creatures that walk on four or six legs?
- Activity: Choose an animal that lives in a 1 G setting. Then imagine how it would look and behave had it adapted to life under half that gravitational force. Draw a sketch or write a description of your specially adapted creature.

Segment 2, The Invisible Force: Part Two

- Pre-viewing questions:
    - What do you know about the structure of our universe? What role does gravity play in this structure?

  - While you watch the program, keep track of the various theories about the future of our rapidly expanding universe. How do these hypotheses connect to Newton's laws? How do they draw on Einstein's theories?

- Post-viewing questions:
  - Newton's revelations about gravity opened the door for a new understanding of mechanics. According to the program, this was the spark for the Industrial Revolution. What do you think? Consider objects that you use every day and show how an understanding of gravity was necessary for their production.
- Activity: Study gravity's effect on pendulums. Get or make a set of pendulums of different weights. Then let each one swing. Measure and record the weight differences, amplitude, and time it takes for each to become still.

Lesson Plan

Student Objectives

Students will understand:

- Without air resistance, all objects would fall with the same acceleration, regardless of mass.
- Gravity is the force that causes objects to fall.
- Air resistance, a type of friction, works against gravity to decrease the acceleration of a falling object.

Materials

- *The Invisible Force* video and VCR, or DVD and DVD player
- An encyclopedia or a computer with Internet access (to research Galileo's experiments with gravity)

For each group:

- A variety of object pairs, such as balls of different sizes and weights, or a book and a sheet of cardboard the same length and width as the book
- Objects, such as a feather or a sheet of paper, that encounter significant air resistance when dropped

Procedures

1. Ask your students if they predict that a heavier or larger object, if dropped from a height, will fall to Earth faster than a lighter or smaller object. Tell them that Galileo Galilei (1564-1642) performed a famous experiment that they are going to replicate in order to confirm or refute their predictions.

2. Have students use the Internet or an encyclopedia to find out about Galileo's experiment in which he dropped objects from the Leaning Tower of Pisa in Italy.
3. Divide the class into groups, giving each group a variety of objects to experiment with (see Materials).
4. Instruct groups to meet in order to design their own experiments. Remind them that a good experiment should have a control and introduce only one variable at a time. Each group's experimental design should include a chart on which to record the results of each test performed.
5. Have students experiment with the object pairs, dropping them, one at a time, while standing on a chair or desk. Other students in the group should observe closely to see whether one object reached the floor before another or both objects reached the floor at the same time. Students should carefully record their results on their charts. (Students should find that balls of different sizes and weights fall at the same rate of speed, as do a book and a sheet of cardboard the same length and width as the book.)
6. When students try dropping a feather or a sheet of paper from the same height from which they dropped the other objects, they will discover that the feather and the paper fall more slowly. Suggest that they bunch the sheet of paper up into a ball and drop it from the same height. They will find that the ball of paper reaches the floor in less time than the sheet of paper.
7. Have students meet in their groups to discuss possible reasons for these results. They should conclude that air resistance, a type of friction, is slowing down the feather and the sheet of paper.
8. Ask students what they think would happen if they performed the same experiment in a vacuum, which has no air in it. (The feather would fall at the same rate of speed as a ball or a brick.)
9. Each student should write a report explaining the results of the experiments and drawing conclusions regarding the effects of both gravity and air resistance on the acceleration of falling objects. Encourage students to accompany their paragraphs with labeled drawings and diagrams.

Discussion Questions

1. Describe how the human body has adapted to the force of gravity on Earth over time. How might it have evolved if gravity had not been present?
2. Compare and contrast the force of gravity on Earth with the force of gravity on one of the other planets in our solar system. Which planet has a stronger gravitational force? What would be the effects on astronauts' bodies when visiting this planet for an extended period of time?
3. Describe the physical features on the Earth's surface that were influenced by gravity during their formation or that are influenced by it now. How would these features look if Earth's gravitational force were significantly weaker or stronger?
4. Discuss Newton's Laws of Motion. Which law or laws involve the force of gravity? Give examples of each law of motion that occurs in your everyday life.

5. A roller coaster is usually designed to give its riders the sense of defying the laws of gravity. Sometimes the back car is moving slightly faster than the others, thanks to the acceleration due to gravity, and at other times the first car is going slightly faster. With that in mind, which seat in a roller coaster is the scariest? How might a roller coaster designer make a roller coaster that gives the greatest sensation to the passengers?
6. Describe the gravity experiments conducted by Galileo, Newton, and Cavendish. How were these experiments similar? How did these scientists build on each other's research and observations to make their discoveries?

Assessment

Use the following three-point rubric to evaluate students' work during this lesson.

- 3 points: Student reports include accurately recorded results; illustrations or diagrams clearly labeled; conclusions explained logically in well-written, well-organized paragraphs.
- 2 points: Student reports include adequately recorded results; illustrations or diagrams included; paragraphs lacking in organization.
- 1 point: Student reports include sketchy or inaccurate results; no illustrations or diagrams; conclusions lacking in logic; paragraphs poorly organized.

Vocabulary

atrophy

Definition: Decrease in size or wasting away of a body part or tissue.

Context: Muscles atrophy when a body spends time in space.

gravity

Definition: the mutual force of attraction between all objects that have mass; the force of attraction that the Earth or another celestial body exerts on an object on or near its surface.

Context: Gravity is the force of attraction all celestial bodies have upon objects at their surface.

ligament

Definition: A tough band of tissue connecting bones or cartilage at a joint or supporting an organ in place.

Context: Ligaments become loose after time in weightlessness.

supernova

Definition: The explosion of a very large star in which the star may reach a maximum intrinsic luminosity one billion times that of the sun.

Context: The rare phenomenon of the supernova is caused by the force of gravity on a star.

weightless

Definition: Lacking apparent gravitational pull.

Context: When an object or body is released into outer space, it seems to be weightless.

Academic Standards

Mid-continent Research for Education and Learning (McREL)
McREL's Content Knowledge: A Compendium of Standards and Benchmarks for K-12 Education addresses 14 content areas. To view the standards and benchmarks, visit http://www.mcrel.org/compendium/browse.asp.

This lesson plan addresses the following national standards:

- Science—Space Science: Understands the composition and structure of the universe and the Earth's place in it.
- Science—Physical Science: Understands forces and motion.
- Science—Nature of Science: Understands the scientific enterprise.
- Science—Earth Science: Understands Earth's composition and structure.

National Academy of Sciences
The National Academy of Sciences provides guidelines for teaching science in grades K-12 to promote scientific literacy. To view the standards, visit this Web site:
http://books.nap.edu/html/nses/html/overview.html#content.

This lesson plan addresses the following national standards:

- Physical Science: Motions and forces

Support Materials

Develop custom worksheets, educational puzzles, online quizzes, and more with the free teaching tools offered on the Discoveryschool.com Web site. Create and print support materials, or save them to a Custom Classroom account for future use. To learn more, visit

- http://school.discovery.com/teachingtools/teachingtools.html

---