Gravity and Weight

Instructional Objectives

The student, after participating in previewing and postviewing activities from the teacher's print and viewing the instructional video, will be able to:

1. describe an experiment that would demonstrate why weight is not considered a property of an object,
2. explain the fundamental difference between weight and mass, and
3. describe at least two situations where a scientist uses mass to investigate a phenomenon (teacher print).

Synopsis

In this program, the student is given the opportunity to explore the difference between weight and mass. A means for measuring mass on the earth is shown. The concept of weight being defined in terms of gravity is developed. Weights of an object at several example locations in the solar system are compared.

The students also have an opportunity to predict the order of increasing mass of various objects and then see their predictions tested in the TV studio. The activity of prediction also gives greater opportunity for interactivity in the classroom. If you wish, you can pause the tape and solicit the students' predictions. In closing, the concept that the strength of gravity is a function of mass and will vary in the universe by the location at which it is measured is developed.

The role of the Public Affairs Assistant at the Space Telescope Science Institute is profiled in this program. The link between the general public or "the outside world" and the scientists within the Space Telescope Science Institute is made by the Public Affairs Office. We will have an opportunity to meet one of the people in this office and learn how she supports the mission of the Hubble Space Telescope.

Vocabulary

Cycle - One complete movement of an object, such as one revolution of the earth around the sun, or one revolution of a car around a race track. A cycle in an oscillating device (as used in this program) is from one side to the other and back again.

Gravitation - One of the four fundamental forces in nature (the others being electromagnetic, strong nuclear, and weak nuclear forces). Gravitation is an attraction of all matter for other matter and to itself. The force of gravitation between two objects is stronger the greater their masses, and weaker the farther away the objects are from each other. Ordinarily we only detect the gravitational effect of a very large amount of mass. Delicate laboratory measurements are required to detect the force of gravitation between small objects.

Inertia - The property of matter that requires a force to act on it in order to change its state of motion. Momentum is a measure of inertia and is the product of mass and velocity.

Mass - The measure of the total amount of material in a body, defined either by the inertial properties of the body or by its gravitational influence on other bodies.

Oscillation - A single oscillatory cycle where the cycles are to swing back and forth with a regular, uninterrupted motion.

Physical Property of Matter - A characteristic of matter that can be studied without changing the makeup of a substance. Color, taste, odor, and melting temperature are physical properties. The physical properties of a kind of matter stay the same regardless of the shape or amount of that matter. When physical properties of matter are listed, the conditions under which they were observed should be described.

Pressure - Force acting on a unit area. The amount of pressure depends on the size of the force and the area on which the force acts.

Resistance - A force that opposes an effort force. To move an object the effort force, or the force that is applied to do work, must be greater than the resistance force.

Previewing

Discuss the role gravity plays in our lives. How would our lives be different if the earth were much smaller, say the size of the moon?

Have the students describe things they do every day such as play sports, run, jump, or eat, as they would occur on the moon.

Ask the students to define weight.

Ask the students to define mass.

Postviewing

Have the students predict the order of weight and mass of a set of objects. Do not weigh the objects yet; just record their predictions. Have the students weigh each object in the set and record the weights on the board. Were the students' predictions accurate? Ask the students what influenced their ordering of weight? of mass?

Using an oscillating device, such as the one used in the studio, determine the relative mass of each of the objects. Have the students participate by counting the oscillations, recording them on the board, and timing the period.

Ask the students to discuss the role of a public affairs office. Why is the public affairs office important to the passing of scientific information to the general public? What sort of background would be helpful if the student wanted to work in a public affairs office?

Active Involvement

Using an irregular shape cut from cardboard, have the students determine the center of mass using a plumb line (string with a weight). Have students try various shapes, predicting the location of the center of mass before they use the plumb line to locate it.

Ask the students to look up the percent of earth's gravity for each of the planets in our solar system as well as the mass of the planets. Discuss the relationship of mass and gravity. How would life be different if we lived on a more massive planet?

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See for Yourself: Experiments/Projects

STARFINDER
PROGRAM 9

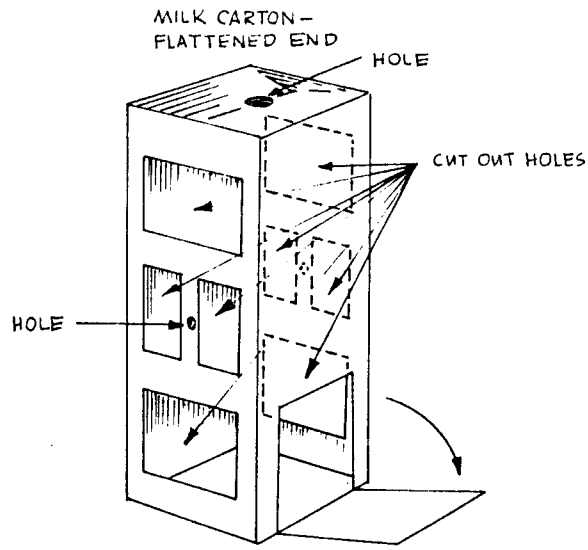
Weight and the Paddle Wheel

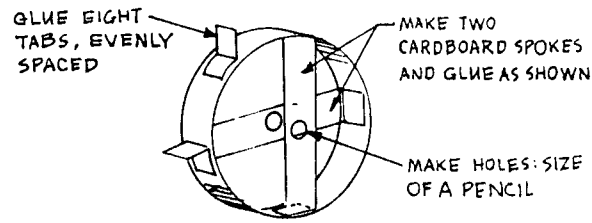
▶ MATERIALS:

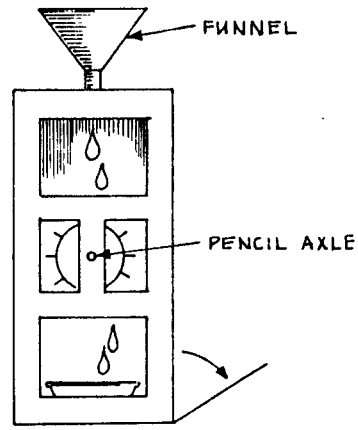
- empty milk carton
- empty plastic yogurt container
- cup or beaker
- funnel
- glue and transparent tape
- scissors
- long pencil (for axle)
- water (l/2 c.)
- sand (l/2 c.)
- gravel (1/2 c.)
- other substances of your choice
- pen
- ruler or straightedge
- compass
- stopwatch
- graph paper
- colored pencils or markers

▶ DIRECTIONS:

1. Wash out the milk carton and the yogurt container. Using the straightedge, mark out the shapes indicated in the diagram on two opposite sides of the milk carton. Cut out these shapes. Be sure to leave the carton in place between the two half windows. This will later hold your axle. Save the cut-out pieces for later use. Collapse the top of the milk carton.
2. Cut a 1″ ring of plastic from the yogurt container. This will form the wheel. Cut eight 3/4″ by 1″ strips of plastic from the container. Fold each of these so that one-half measures 3/4″ by 1/2″. The paddles should be glued onto the wheel so that they are approximately equidistant. How will you figure out where to put them? Record how you will do it. Glue the paddles onto the wheel.
3. Measure the diameter of your wheel. Cut 2 strips of the milk carton scraps, each one inch longer than the diameter of the wheel. Fold each end of the strip down 1/2″. Attach these spokes to the wheel, gluing or taping them to the inside of the wheel as shown in the diagram. Make 4 holes, large enough for a pencil, through the spokes and in the milk carton so that the holes line up level with the bottom of the carton.
4. Measure the diameter of your funnel about l″ from the neck. Using this measurement, draw a circle with your compass on a piece of paper with the same diameter. Cut out the disc. Using the disc as a template, place it on top of the milk carton. Trace around the disc with your pen. Cut along the circle through the top of the milk carton. This will be the hole in which to place the funnel.







5. Assemble your paddle wheel by placing the pencil through the milk carton and paddle wheel. Insert the cup or beaker at the base of the carton and place the funnel at the top of the carton.
6. Predict which of the substances will flow through the paddle wheel the quickest. Write down your predictions and state why you think so.
7. Select an order for your substances, leaving water and any other liquids for last. You are going to time the process from the moment you begin to pour the substance until it is collected in the cup or beaker. Repeat the process with the same substance three or more times (trials) until your times get close together. Record all of your times.
8. Repeat for each substance in your set for the same number of trials. Record all of your measures.
9. Display your data on a graph. Place the time on the y-axis (vertical) and trials on the x-axis (horizontal). Use a different color or symbol to indicate each substance. Be sure to include a key for the substances.
10. Explain your findings. Why did you get the results you did? To see if you are correct, think of other substances that ought to behave in the same way. Try out these substances in your paddle wheel. What results did you collect?
11. What are the roles of gravity and texture in the paddle wheel's movement?

Siphons

▶MATERIALS

- 2 large plastic bottles of equivalent size
- utility knife or heavy duty scissors
- clear plastic tubing (approximately 30" long)
- text book
- water

▶DIRECTIONS

1. Cut the top few inches off each of the plastic bottles so that the containers are still the same height. Fill one of the containers 3/4" full of water. Push the plastic tubing down into the bottle of water. Put your finger over one end of the tubing. Lift that end of the tubing out of the water and place it in the second container.
2. Record the results. At what point does the water stop flowing? Why?
3. Repeat the experiment changing the height of one of the containers. (Slide a textbook underneath the bottle.) Record the results. At what point does the water stop flowing? Why?
4. Explain why you think a siphon behaves the way it does. What is the role of gravity in this process?

Career Profile

CHERYL S. GUNDY
Public Affairs Assistant
Education: High School Diploma
Various certificates of achievement

Chief Responsibilities

As a public affairs assistant, Cheryl Gundy is responsible for carrying out the day-to-day operations of the Educational and Public Affairs Office (EPAO) of the Space Telescope Science Institute. The Public Affairs Office provides the public, news media, and educators with the latest information on Space Telescope discoveries and ongoing research conducted at the Institute. Cheryl assists the Department Head and Public Information Officer in the production of news releases, educational videotapes, photographs, brochures and posters.

A Typical Day

An important part of Cheryl's job is gathering information. Generally she begins the day at 9 a.m. by scanning the newspapers and electronic mail for interesting news on the project. This helps to prepare her for any calls which might come in from news sources interested in doing follow-up articles. A meeting with the EPAO staff also helps to further define the course of activity for the day.

Cheryl will handle many of the calls coming into the office from various media sources by providing background information about the Institute and the telescope. She will also coordinate requests for interviews with Institute scientists.

Much of Cheryl's work involves the coordination of public outreach activities such as the Institute's Speaker's Bureau, which serves to educate the public about the status of the project. She arranges for talks to be given either on site at the Institute or at a location chosen by the requestor.

Career Viewpoint

Cheryl's job allows her to work with many different kinds of people over the course of a day. She must be able to relate to people of all ages and professions diplomatically and in a timely manner.

Although she prepared to attend college, she elected to also follow vocational and technical courses of study in secretarial science. She believes that flexibility, interpersonal skills, self confidence, and experience are very important. These qualities allowed her to advance successfully from secretary to her current position.

Content Consultants for STARFINDER – Program 9

Eric Chaisson
Space Telescope Science Institute
Operated by AURA for NASA

Wayne Ganson
Vergennes Union High School
Vergennes, VT

Harry Neuman
Parkville High School
Baltimore, MD

Teacher's Guide

Writers
Pat Murphy
Barbara Bourne

Editor
Kate Harrison

Illustrator
Robert Jones

Logo Design
Dave Weaver

Graphic Design
Bob Lindler
The Design Co-op

Typesetting
Blue Heron Typesetters