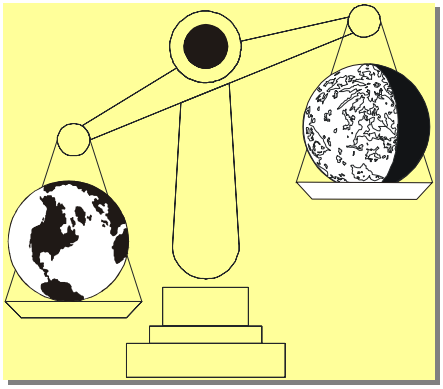

#8811

MASS

Grade Levels: 8-12
15 minutes
CAMBRIDGE EDUCATIONAL 1999
2 Instructional Graphics Enclosed

DESCRIPTION

An animated cave man and everyday demonstrations help viewers understand the connection between mass, matter, inertia, force, weight, and acceleration. Clearly explains the difference between mass and weight. Introduces Newton's Second Law of Motion and briefly reviews the presented material.

ACADEMIC STANDARDS

Subject Area: Physical Sciences

- Standard: Understands forces and motion
  - Benchmark: Understands general concepts related to gravitational force (e.g., every object exerts gravitational force on every other object; this force depends on the mass of the objects and their distance from one another; gravitational force is hard to detect unless at least one of the objects, such as the Earth, has a lot of mass)

INSTRUCTIONAL GOALS

1. To explain the basic physical concepts associated with force, mass and acceleration.
2. To perform calculations using provided equations.

BACKGROUND INFORMATION

Mass is the measure of *inertia*, an object's resistance to changes in speed or direction. Inertia is a property of matter.

If no matter is added or taken away from an object, its mass remains the same. If it is moved from the Earth to the Moon or even into the vacuum of space, its mass will remain constant.

Weight is the measure of the force of gravity on an object. A *force* is a push or pull on an object. Both weight and force are measured in newtons in the metric system and pounds in the English system. A newton equals about one kilogram-meter per second squared.

Newton's Law of Gravity states that every object in the universe attracts every other object in the universe in a force proportional to the objects' masses and inversely proportional to the square of the distance between their centers. In other words, everything that has mass pulls on everything else that has mass.

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Newton's Second Law of Motion states that force is equal to mass times acceleration, or:

f = m x a

Acceleration is the change in an object's velocity or direction over time. The most common unit of mass in the metric system is the kilogram. There is no actual unit for mass in the English system, although some textbooks refer to a unit of mass as a *slug*.

A variation of Newton's Second Law can be used to determine the weight of an object. In the following equation, we can replace "f," the force, with "w," the weight of an object. Because weight is the pull of gravity, we can replace the "a" in the equation with "g," the acceleration due to gravity. The acceleration due to gravity on the Earth is 9.8 meters per second squared. The resulting equation is weight equals mass times the acceleration due to gravity, or:

w = m x g

VOCABULARY

1. acceleration
2. force
3. inertia
4. kilogram
5. mass
6. Newton
7. Newton's Law of Gravity
8. Newton's Second Law of Motion
9. slug
10. weight

AFTER SHOWING

Applications and Activities

1. Why do two objects of similar size have different weights? Examples might include a soccer ball and a bowling ball, or a piece of wood and a rock of similar size.
   Example 1: The mass of a man is 68 kilograms. The man's weight on Earth equals 68 kilograms times the acceleration due to gravity on Earth. The equation would look like this:

   w = m x g

   or

   w = 68kg x 9.8 m/sec²

   Example 2: Because the Moon has less mass than the Earth, it has less gravitational pull. The gravitational pull of the Moon is about one-sixth that of the Earth, or around 1.6 meters per second squared. To determine the weight of the man on the Moon, use the same equation, only this time substituting 1.6 for the acceleration due to gravity.

   w = 68kg x 1.6 m/sec²

2. Complete the worksheet of review questions. (See INSTRUCTIONAL GRAPHICS.)

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RELATED RESOURCES

Captioned Media Program

- Acceleration #8599
- Exploring Gravity #3121

World Wide Web

The following Web sites complement the contents of this guide; they were selected by professionals who have experience in teaching deaf and hard of hearing students. Every effort was made to select accurate, educationally relevant, and "kid-safe" sites. However, teachers should preview them before use. The U.S. Department of Education, the National Association of the Deaf, and the Captioned Media Program do not endorse the sites and are not responsible for their content.

- **YOUR WEIGHT ON OTHER WORLDS**

http://www.exploratorium.edu/ronh/weight/index.html

Find out what you might weigh on Mars, Jupiter, the Sun, and other planets! The difference between weight and mass are explained, as well as the relationship between gravity and mass and distance.

- **MEN OF MATHEMATICS, PHYSICS, AND ASTRONOMY**

http://octopus.phy.bg.ac.yu/web_projects/giants/giants.html

Click on "Sir Isaac Newton" and get a detailed biography of this English physicist and mathematician. Includes "Influence of the scientific revolution," his career, "Universal gravitation," and other points in his life.

- **MASS MEASUREMENTS ABOARD SPACE STATION SKYLAB**

http://www-spof.gsfc.nasa.gov/stargaze/sskylab.htm

Mass measurements aboard "Skylab" were part of the medical experiments conducted. Prior to the "Skylab" mission, it was observed that both U.S. and Russian astronauts returning from space had lost weight. Read theories and how they observed this process.

INSTRUCTIONAL GRAPHICS

- REVIEW QUESTIONS
- ANSWERS TO REVIEW QUESTIONS

REVIEW QUESTIONS

1. Mass is the measure of _____, a property of matter that causes an object to resist motion.

2. The most common unit of measuring mass in the metric system is the _____.

3. If an object is moved from the Earth to the Moon, or even to the vacuum of space, its _____ remains constant.

4. Weight is measured in _____ in the metric system.

5. An object has to have a lot of mass to have a noticeable _____ pull.

6. _____ is the measure of the pull of gravity on an object.

7. _____ is the change in an object's velocity or direction over time.

8. What do the letters in the formula **w = m x g** stand for?

9. _____ is the stuff that makes up everything in the universe.

Answers

REVIEW QUESTIONS

1. Mass is the measure of **inertia**, a property of matter that causes an object to resist motion.
2. The most common unit of measuring mass in the metric system is the **kilogram**.
3. If an object is moved from the Earth to the Moon, or even to the vacuum of space, its **mass** remains constant.
4. Weight is measured in **newtons** in the metric system.
5. An object has to have a lot of mass to have a noticeable **gravitational** pull.
6. **Weight** is the measure of the pull of gravity on an object.
7. **Acceleration** is the change in an object's velocity or direction over time.
8. What do the letters in the formula **w = m x g** stand for?

   Weight equals Mass times the acceleration due to Gravity

9. **Matter** is the stuff that makes up everything in the universe.