

Discover Magazine: Size and Scale: Teacher's Guide

Grade Level: 9-12

Curriculum Focus: Mathematics

Lesson Duration: One class period

Program Description

One-size-fits-all may work for mittens, but it doesn't work for anything else. "Scale of Flight" reveals the physics involved in taking to the air. "Being the Right Size" explains the variety of shapes and sizes in the animal kingdom. "Skyscrapers" explores the engineering that allows modern superstructures to stand so tall. "Peoria and Beyond" brings the solar system down to earth.

Onscreen Questions

Part I: Before watching the video

- What do you know about how birds and insects fly?
- Talk about the different factors that could influence their flight, such as the size and shape of their wings.
- As you watch the program, look for similarities and differences in the body structures and flight capabilities of two types of flying animals.

Part I: After watching the video

- Discuss how you would modify the human body for flight. Keep in mind aerodynamics, human vision, hand dexterity, muscular development, and body control. Then make a drawing of how a flight-adapted human might look.

Part II: Before watching the video

- Animals come in a variety of sizes and shapes. Make a list of factors that are affected by the size and shape of an animal, such as strength, speed, and agility.
- While watching the program, look for reasons why animal size is limited.

Part II: After watching the video

- A cat's skeleton makes up about 7 percent of its total body mass, while an elephant's skeleton makes up 13 percent. Compare the movements of these two animals.
- How do their respective skeletal systems limit them? How do they benefit them?

Part III: Before watching the video

- What are some challenges in designing and building skyscrapers?
- Why might it be challenging to live and work in a skyscraper?
- As you watch the program, keep track of the way each challenge has been met. Decide if the benefits outweigh the physical and social costs of skyscrapers.

Part III: After watching the video

- A skyscraper could theoretically be built a mile high and contain all of life's necessities. Discuss what might happen to our society if people could live and work in skyscrapers without ever leaving them.

Part IV: Before watching the video

- What do you know about the sizes of the planets in our solar system?
- What do you know about the distances between the planets?
- As you watch the program, note how astronomer Sheldon Schaefer overcame the obstacles of size and distance with his model. Judge how well the model works.

Part IV: After watching the video

- Because we can't see the whole solar system, astronomers rely on models for a complete view of it. Discuss the difficulties in creating a scale model of the solar system.
 - Can you think of other things that we can see only with models?
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Lesson Plan

Student Objective

- Understand that the relative sizes of bodies in our solar system affect life on Earth.
- Understand that by using mathematical proportions, we can create scale models of parts of our solar system.

Materials

- Reference materials on the solar system, as well as a computer with Internet access to aid research.
- Modeling clay
- Centimeter rulers
- Marbles
- String for diameters



Procedures

1. Tell your students that during Apollo missions to the moon in the 1960s and 70s, astronauts placed a mirror on the moon's surface so they could measure distances precisely between Earth and the moon. By reflecting a laser beam from Earth off the mirror, scientists on Earth could observe the beam's round-trip time and calculate the distance to the moon within a centimeter. Students will use those measurements to create their own scale models of the Earth-moon system.
2. Divide students into groups and distribute materials. Give students the following information or have them research it: The moon's diameter is 3,476 kilometers, Earth's diameter is 12,734 kilometers, and the average distance to Earth from the moon is 384,000 kilometers. (Note: This distance changes slightly over time.)
3. Explain that the marble represents the moon. With the information at hand, challenge groups to devise a method to determine the relative diameter of Earth and make a clay model of it. Then have students determine the relative distance between the clay Earth and marble moon.
4. Students should come up with the following methods:
 - To obtain the diameter of the marble, use string to measure the circumference of the marble. Then measure the string, using the equation $C = d$ (where C is circumference and d is diameter). Use the actual diameters of the moon and Earth to obtain a scale. Apply that scale to the diameter of the marble to arrive at the diameter of the clay Earth. (Note: Students measuring the circumference in centimeters should convert it to kilometers.)
 - To obtain the distance between the clay Earth and marble moon, apply the same scale to the actual average distance to Earth from the moon.
5. Allow time for students to create their scale models of the Earth-moon system.
6. When the groups have completed their models, discuss with the class how the distance between the moon and Earth affects life on Earth. (Example: A slight change in the moon's distance affects Earth's tides.)
7. Discuss the difficulties of creating an entire solar system model that takes into account the sizes of the planets, their distances from the sun, and their distances from each other.

Assessment

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

- **3 points:** Groups develop successful plans for determining scale, size, and distance; model accurately constructed to scale.
- **2 points:** Groups need help developing plans for determining scale, size, and distance; model accurately constructed to scale.
- **1 point:** Groups unable to develop plan for determining scale, size, and distance; model inaccurately constructed.



Vocabulary

astronomical unit

Definition: The average distance of separation between the sun and Earth

Context: One astronomical unit is equal to 93 million miles. It takes light a little more than eight minutes to travel this distance.

gravity

Definition: A fundamental physical force that is responsible for interactions that occur because of mass between objects

Context: The force of gravity made it difficult to lift the heavy box.

light-year

Definition: The distance light travels in one year; equivalent to approximately 5.88 trillion miles

Context: Light travels at the speed of 186,000 miles a second, or about 5.88 trillion miles a year – the distance astronomers call a light-year.

proportion

Definition: A ratio; the relation of one part to another or to a whole

Context: He paid the rent with a large proportion of his wages; he used a smaller proportion to buy food.

volume

Definition: The amount of space occupied by a three-dimensional object as measured in cubic units

Context: The volume of the crowd was too large to fit inside one room.

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 link:

<http://www.mcrel.org/compendium/browse.asp>

This lesson plan addresses the following national standards:

- Mathematics – Understands and applies basic and advanced properties of the concepts of measurement
- Science – Earth and Space Sciences: Understands the composition and structure of the universe and the Earth's place in it



The National Council of Teachers of Mathematics (NCTM)

The National Council of Teachers of Mathematics (NCTM) has developed national standards to provide guidelines for teaching mathematics. To view the standards online, go to <http://standards.nctm.org/>.

This lesson plan addresses the following math standard:

- Measurement
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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>

