NATIONAL GEOGRAPHIC

RESOURCE LIBRARY
ACTIVITY : 50 MINS

Planetary Size and Distance Comparison

Students use metric measurement, including astronomical units (AU), to investigate the relative size and distance of the planets in our solar system. Then they use scale to model relative distance.

GRADES

6 - 8

SUBJECTS

Earth Science, Astronomy, Experiential Learning, Mathematics

CONTENTS

2 Images, 4 PDFs, 1 Link

OVERVIEW

Students use metric measurement, including astronomical units (AU), to investigate the relative size and distance of the planets in our solar system. Then they use scale to model relative distance.

For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/planetary-size-and-distance-comparison/

Program

WILDEST WEATHER IN THE SOLAR SYSTEM

DIRECTIONS

1. Review planet order and relative sizes in our solar system.

Display the NASA illustration: All Planet Sizes. Ask students to point out the location of Earth. Then challenge them to identify all of the planets, outward from the sun (left to right): inner planets Mercury, Venus, Earth, Mars; outer planets Jupiter, Saturn, Uranus, Neptune, and Pluto. Remind students that Pluto is no longer considered a planet in our solar system; it was downgraded to the status of dwarf planet in 2006. Point out the locations of the asteroid belt (between Mars and Jupiter) and Kuiper belt (past Pluto) if they were included in this illustration. Explain to students that the illustration shows the planets in relative size. Ask: *What do you think relative size means?* Elicit from students that the pictures show how big the planets are when compared to each other and to the sun. Ask: *Which planet is the smallest?* (Mercury) *Which is the largest?* (Jupiter)

2. Have students gather data and compare planet sizes.

Divide students into small groups. Distribute one copy of the worksheet Planetary Size Comparison to each group. Have groups use the Planet Size Comparison interactive to find and record data on planet diameters and ratios. Ask:

- *What do you notice about the size of the planets?* (Possible response: The inner, rocky planets are smaller than the outer, gaseous planets.)
- *How do you think the sizes of the planets compare?* (Possible response: There is a big difference in the sizes of the planets. Some are fairly small and others are extremely large.)
- *Would it be easy to model the planet sizes? Why or why not?* (Possible response: No, because of the great differences in size.)
- *How could we model differences? What everyday objects could represent planets and the sun?* (Possible responses: peas/beach ball; grains of sand/orange)

Have students discuss the answers in their small groups. Then regroup as a class to discuss students' ideas.

3. Build background about the astronomical unit (AU).

Explain to students that an astronomical unit, or AU, is a simplified number used to describe a planet's distance from the sun. It is a unit of length equal to the average distance from Earth to sun, approximately 149,600,000 kilometers (92,957,000 miles). Only Earth can be assigned AU 1. Planets farther away would have AU greater than 1; planets closer would have AU less than 1. Ask: *Why do you think scientists find it helpful to use astronomical units?* (Possible response: Distances in the solar system are very large. Using AU helps keep the numbers manageable, or smaller, so we can easily calculate very large distances.) *What are the challenges of using kilometers or miles instead?* (Possible response: Using kilometers or miles would make calculations more difficult and could produce errors in measurements required to accurately send a probe or lander to another planet.) Explain to students that the astronomical unit provides a way to express and relate distances of objects in the solar system and to carry out astronomical calculations. For example, stating that the planet Jupiter is 5.2 AU (5.2 Earth distances) from the sun and that Pluto is nearly 40 AU allows you to more easily compare the distances of all three bodies.

4. Introduce the modeling activity.

Tell students that they are going to stand in for the planets and planetary objects in order to create a model of relative planetary sizes and relative distances. Display the NASA illustration: How Big is the Sun? to give students a sense of the relative sizes of planets compared to an everyday object like a basketball. Make sure students understand that the distances between the planets are very large compared to the sizes of each planet. This makes it extremely difficult to create an exact scale of our solar system, so this activity will focus on the distance comparison.

5. Have groups create models of relative planetary distances.

Divide students into groups of 9, 10 or 11, depending on class size. (If 9, one student represents the sun and the remaining students represent 8 planets; If 10, the sun, planets, and asteroid belt; If 11, the sun, planets, asteroid belt, and Kuiper Belts) Take students to a large area, such as the gymnasium or empty parking lot. You'll need enough space for each group to spread out and create their model, using the following scale, with each step equaling approximately 1 meter (about 3.28 feet):

- Sun: stands at the edge of the area
- Mercury = 1 step from sun
- Venus = 2 steps from sun
- Earth = 2.5 steps from sun
- Mars = 4 steps from sun
- Asteroid belt = 8 steps from sun
- Jupiter = 13 steps from sun
- Saturn = 24 steps from sun
- Uranus = 49 steps from sun
- Neptune = 76 steps from sun
- Kuiper belt = 100 steps from sun

Emphasize that at this scale, the sun would be less than 1.3 centimeters (0.5 inches) in diameter. Ask students to describe what they notice about planetary distances from the model. If needed, allow one student from each group to put an object in their place and walk around their group's model to make observations.

6. Have students make a math connection.
Distribute copies of the worksheet Stepping Out the Solar System to each group. Have students recalculate the number of paces for each planet's orbit, as constrained by the size of the available area. Use the provided answer key to check groups' work. Then have students recreate the model.

Modification

If you do not have enough space to do the kinesthetic model, you can modify this activity to have students create a string-and-bead solar system model in the classroom by converting astronomical units to a 10 centimeter/AU (4 inch) scale. Students will need a string 4.5 meters long. Have students tie beads in place to represent planetary distances.

Sun 0.0 AU=0 cm

Mercury 0.4 AU=4 cm

Venus 0.7 AU=7 cm

Earth 1.0 AU=10 cm

Mars 1.5 AU=15 cm

Asteroid Belt 2.8 AU=28 cm

Jupiter 5.2 AU=52 cm

Saturn 9.6 AU=96 cm

Uranus 19.2 AU=192 cm

Neptune 30.0 AU=300 cm

Tip

Make sure students understand that these are only models or visualizations of the relative distances between the planets and the sun. Planets all orbit the sun at different velocities, so they rarely form a straight line from the sun. Instead, they appear somewhere along their orbital paths.

Informal Assessment

Have students work independently to summarize, in writing, what they learned about our solar system, including:

- locations of planets in relation to the sun and one another
- relative sizes of planets, including Earth
- relative distances of planets
- any conclusions they can draw about the locations of the asteroid belt and Kuiper belt

Extending the Learning

Encourage students to practice backyard astronomy. At certain times of day and year, it's possible to view planets Mercury, Venus, Mars, Jupiter, and Saturn with the naked eye. Students can use *Sky and Telescope Magazine's* Sky at a Glance feature to find out what planets are visible in the night sky and where to look. Ask students to report back to the class with what they observed.

OBJECTIVES

Subjects & Disciplines

- **Earth Science**
  - Astronomy
- Experiential Learning
- Mathematics

Learning Objectives

Students will:

- calculate and model planetary distances by converting astronomical units (AU)
- compare planetary sizes using data

- analyze relative planetary sizes and distances using a kinesthetic model and data

Teaching Approach

- Learning-for-use

Teaching Methods

- Discussions
- Hands-on learning
- Modeling

Skills Summary

This activity targets the following skills:

- Critical Thinking Skills
  - Analyzing
  - Understanding

National Standards, Principles, and Practices

NCTM PRINCIPLES AND STANDARDS FOR SCHOOL MATHEMATICS

• **Measurement (6-8) Standard 1:**
Understand measurable attributes of objects and the units, systems, and processes of measurement

NATIONAL SCIENCE EDUCATION STANDARDS

• **(5-8) Standard D-3:**
Earth in the solar system

Preparation

What You'll Need

MATERIALS YOU PROVIDE

- Paper
- Pencils

REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: 1 computer per small group, Projector, Speakers
- Plug-Ins: Flash

PHYSICAL SPACE

- Classroom
- Gymnasium
- Parking lot

GROUPING

- Large-group instruction

BACKGROUND & VOCABULARY

Background Information

Our solar system includes the sun and eight planets that orbit around the sun. The smaller, inner planets include Mercury, Venus, Earth, and Mars. The inner planets are rocky and have diameters of less than 13,000 kilometers. The outer planets include Jupiter, Saturn, Uranus, and Neptune. The outer planets are called gas giants and have a diameter of greater than 48,000 kilometers. Pluto, which used to be considered the ninth planet, is now classified as a dwarf planet and part of the Kuiper Belt. The main asteroid belt lies between the orbits of Mars and Jupiter, separating the inner and outer planets. Relative size means how big the planets are when compared to each other and the sun. Relative distance means how far apart the planets are when compared to each other and the sun.

Prior Knowledge

["planets in our solar system","order of planets"]

Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition
asteroid belt	*noun*	area of the solar system between the orbits of Mars and Jupiter filled with asteroids.
astronomical unit	*noun*	(AU) (150 million kilometers/93 million miles) unit of distance equal to the average distance between the Earth and the sun.
diameter	*noun*	width of a circle.
dwarf planet	*noun*	celestial body that is nearly spherical but does not meet other definitions for a planet.
planet	*noun*	large, spherical celestial body that regularly rotates around a star.
relative distance	*noun*	length between two points relayed in non-physical units such as time.
relative size	*noun*	rough measurement using depth perception, as how something far from the viewer looks smaller.
scale model	*noun*	copy of an object that is larger or smaller than the actual object, but maintaining the same proportions.
solar system	*noun*	the sun and the planets, asteroids, comets, and other bodies that orbit around it.

For Further Exploration

Video

- National Geographic Video: Solar System 101

Websites

- Nat Geo Movies: Wildest Weather in the Solar System

- NASA: Solar System Exploration—Planets
- National Geographic Science: Space

FUNDER