THINKING AND ACTING LIKE A SCIENTIST

TEACHER'S GUIDE

Planetary Scale

What patterns do I find in comparing planet sizes and the distances between them?

GRADES 6–8

Earth & Space

VAN ANDEL EDUCATION INSTITUTE

VAEI.ORG

INQUIRY-BASED SCIENCE

Planetary Scale

Grade Level/ Content	6–8/Earth and Space Science
Lesson Summary	In this lesson, students analyze and interpret data to make a scale drawing of the solar system.
Estimated Time	2, 45-minute class periods
Materials	Various sizes of round objects, pencils, meter sticks, rulers, compasses, calculators, art materials, Observation Form, Assessment Form, journal
Secondary Resources	The Planets: Planet Facts Exploratorium: Build a Solar System Keith's Think Zone: Solar System Scale Model Calculator
NGSS Connection	**MS-ESS1-3** Analyze and interpret data to determine scale properties of objects in a solar system.
Learning Objectives	• Students will create a scale model of the solar system. • Students will compare different scale models to determine the most appropriate scale model for their school/classroom. • Students will analyze data to determine patterns in planet sizes and distances between them.

What patterns do I find in comparing planet sizes and the distances between them?

Our solar system is vast. The size of the planets and distances between them is great. It is difficult to compare the planets and gain an understanding of the scale of the solar system. Scientists often use scale models and drawings to make it easier to compare the sizes of and distance within the solar system. These models and drawings do not offer exact replicas of objects in space. They do help scientists gain a general idea of key characteristics, such as the distance between Earth and Mars or how large Jupiter is compared to Mercury. In this investigation, students are given a scale to create a model of the solar system. They compare the scale models from other groups and determine the most appropriate scale for their location. They build a class model and use that model to determine patterns in planet sizes and distances between them.

Investigation is based on the Van Andel Education Institute (VAEI) Instructional Model for Inquiry-Based Science. In all investigations:

Students don't know the "answer" they are supposed to get.

Students play a driving role in determining the process for learning.

Teachers and students construct meaning together by journaling.

Students are working as hard as the teacher.

Part 1

INVESTIGATION SETUP

Students will need:

- Observation Form
- Assessment Form
- Journal
- Round objects of various sizes (sesame seeds, ping pong ball, tennis ball, softball, beach ball, etc.)
- Art materials to create model (clay, construction paper, large paper, etc.)
- Pencils
- Meter sticks
- Calculators
- Ruler
- Scissors
- Compasses

Part 2

INVESTIGATION FACILITATION

Question

Introduce the investigation question.

What patterns do I find in comparing planet sizes and the distances between them?

CURIOSITY

Show students the collection of round objects, or objects with round ends, on the table. Ask students to consider how the objects could be used to represent the planets in the solar system. Students may speculate which object could be used to represent each planet.

Personal Knowledge

Students capture what they already know about planets and their characteristics.

- Find out what students already know about the planets and their characteristics.
- Have students identify questions they have about the planets and record those questions in their journals.
- Generate a class list.

DISCOURSE

Have students participate in a *Take 10 Steps* activity to promote discourse and collaboration. Give students two minutes to think and respond to the prompt. Then, have them walk 10 steps in any direction. They will share their list with the person closest to them. They will continue this process until time is up. Students will share their ideas with the class.

Investigation Plan

Students identify the best scale to find patterns in the distances between planets and the sizes of each planet.

- Divide students into groups of four.
- Distribute the Observation Form for this investigation. Review the process for the investigation.
- Assign each group a different scale* (1mm= 100km, 1 mm = 1000 km, 1 mm = 10000 km, 1 mm = 100000 km, 1 mm = 1000000 km).
- Allow students to use calculators to determine the scaled diameters and distances, and record this information on their **Observation Form**.
- Have each group build their model of the solar system. This may be a challenge for the smaller and large scales. Encourage students to do what they can and use these challenges as discussion points when the class determines the most appropriate scale to use.
- Have each group determine the benefits and limitations of their scale and record their observations in their journals. Ask students: *What are the benefits of your scaled model? What are the limitations of your scaled model?*
- Discuss the benefits and limitations of each scale with the class.
- As a class, determine the best scale to use to create a class model of the solar system. This scale may not be one of the scales assigned, but possibly in-between two scales. This will vary depending on where you create your class model (in the classroom, within the entire school, outside, football stadium, etc.).
- Build the class scaled model. (Only build the class model if the scale that is chosen has not already been built by another group.)
- This scale model will be used in the data analysis process.

CRITICAL THINKING

Use the Fair Test checklist to help students think critically about the investigation plan. Help them understand that a good investigation involves significant research and the use of credible sources. The more critically students think about their investigation plan, the more confident they will be in their results.

STUDENT CHOICE

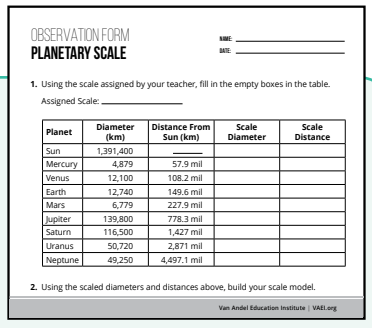
Students share their models and their observations with the class. Students determine which scale is best for modeling the solar system.

*You can determine the different scales for your students to use based on your physical space and instructional needs.

Observation

Students record their data.

Have students use the Observation Form to calculate their scaled diameters and distances. In their journals, have students observe the limitations and benefits of their assigned scale model.



OBSERVATION FORM
PLANETARY SCALE

NAME: _____
DATE: _____

1. Using the scale assigned by your teacher, fill in the empty boxes in the table.

Assigned Scale: _____

Planet	Diameter (km)	Distance From Sun (km)	Scale Diameter	Scale Distance
Sun	1,391,400	_____		
Mercury	4,879	57.9 mil		
Venus	12,100	108.2 mil		
Earth	12,740	149.6 mil		
Mars	6,779	227.9 mil		
Jupiter	139,800	778.3 mil		
Saturn	116,500	1,427 mil		
Uranus	50,720	2,871 mil		
Neptune	49,250	4,497.1 mil		

2. Using the scaled diameters and distances above, build your scale model.

Van Andel Education Institute | VAEI.org

Observation Form

Part 3

INVESTIGATION ANALYSIS AND DEVELOPMENT OF CLAIM

Data Analysis

Students make sense of their data by organizing it and representing it visually.

- Have students analyze the chosen class scale model. They may wish to use the Data Analysis prompt as a guide.
- Have students **evaluate** their data for trustworthiness.
- Then, have them analyze their data to find patterns and trends. They may **organize** the data and/or **represent** it visually to construct meaning. For this investigation, their class model will serve as the organization and representation.
- Have students **interpret** what the identified patterns or trends mean.
- Ensure they have enough data that it can be used as evidence to support a claim.

Secondary Knowledge

Students use secondary sources to understand how the sizes of objects in space and the distances between them differ.

The Planets: Planet Facts
Exploratorium: Build a Solar System
Keith's Think Zone: Solar System Scale Model Calculator

- Use these resources to help clarify misconceptions or to give students a broader understanding of the relationship between objects in the solar system.
- Allow students to expand the investigation by grouping or modeling planets based on other characteristics, such as average temperature, and see if size and distance are related to those characteristics.
- Have students use this information in the reasoning portion of their explanation.

Explanation

Students write a claim and provide evidence and reasoning to support it.

- Have students use what they've discovered from their analyzed data to write an explanation that answers their investigation question. Students may wish to use the Explanation prompt as a guide. Have them write their explanation in their journal.
- Have students develop a **Claim** to answer the question: What patterns do I find in comparing planet sizes and the distances between them?
- Then, have them add **Evidence** (the analyzed data) to support their claim.
- Finally, have them add **Reasoning** to their claim. Reasoning should include the information obtained from this investigation as well as science principles they have learned.

Claim

The four planets closer to the sun are smaller and closer together. The four planets farther away from the sun are larger and have much greater distances between them.

Continued

Evidence

Mercury, Venus, Earth, and Mars have diameters ranging from 4,879 km for Mercury to 12,756 km for Earth. Jupiter's diameter is more than 10 times that of Earth at 142,984 km. Mars' distance from the sun is 227.9 x 10^6 km, while Jupiter's distance from the sun is 3 times farther and Neptune is 20 times farther from the sun.

Reasoning

Investigation: My investigation gave me the details about the diameter of each planet, the radius of each planet's orbit, and the volume of each planet.

Science: The terrestrial planets, or inner planets, are smaller and closer to the sun. The gaseous planets, or outer planets, are larger and farther from the sun. The terrestrial planets are solid, while the gaseous planets are made up of gases, dust, and solid materials.

Evaluation

Students reflect on the investigation.

Ask students:

- What surprised them about the class model.
- What question they would like to investigate next.

Part 4

INVESTIGATION ASSESSMENT AND EXTENSION

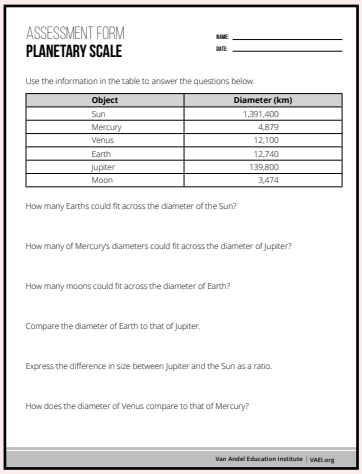
Application

Students demonstrate understanding of how the size and distance of objects in the solar system differ by analyzing and interpreting a set of data.

- Have students determine the appropriate scale for a solar system model covering their city. Use a local map to plot where each of the planets would be. You may use the video from Discovery Education, *Size and Scale: Peoria and Beyond* if you have a subscription, before the students build their city model.
- Have students look up the diameter of three other objects in the solar system. For example, students could look up the diameter of the moon and moons of Jupiter and/or Saturn. They can attempt to model other solar system objects using the class scale determined in this investigation. Students can find a list of objects here: *http://www.astronoo.com/en/articles/objects-of-the-solar-system.html*

Assessment

- Evaluate students on how well they:
  - created a model of the solar system using an assigned scale.
  - described, from the class model, the patterns in planet sizes and distances between them.
- Use the Assessment Form to evaluate student learning about planet sizes and distances from the sun.



ASSESSMENT FORM

PLANETARY SCALE

NAME: _____

DATE: _____

Use the information in the table to answer the questions below.

Object	Diameter (km)
Sun	1,391,400
Mercury	4,879
Venus	12,100
Earth	12,740
Jupiter	139,800
Moon	3,474

How many Earths could fit across the diameter of the Sun?

How many of Mercury's diameters could fit across the diameter of Jupiter?

How many moons could fit across the diameter of Earth?

Compare the diameter of Earth to that of Jupiter.

Express the difference in size between Jupiter and the Sun as a ratio.

How does the diameter of Venus compare to that of Mercury?

Van Andel Education Institute | VAEI.org

Assessment Form

For additional lessons or to customize this lesson, go to www.nexgeninquiry.org.

nexgen inquiry®
Empowering Teachers. Engaging Students.

OBSERVATION FORM
PLANETARY SCALE

NAME: _____

DATE: _____

1. Using the scale assigned by your teacher, fill in the empty boxes in the table.

Assigned Scale: _____

Planet	Diameter (km)	Distance From Sun (km)	Scale Diameter	Scale Distance
Sun	1,391,400	_____		
Mercury	4,879	57.9 mil		
Venus	12,100	108.2 mil		
Earth	12,740	149.6 mil		
Mars	6,779	227.9 mil		
Jupiter	139,800	778.3 mil		
Saturn	116,500	1,427 mil		
Uranus	50,720	2,871 mil		
Neptune	49,250	4,497.1 mil		

2. Using the scaled diameters and distances above, build your scale model.