Putting Earth In Its Place

Overview:

During this activity, students build a model of our Solar System to gain insight into the relative sizes and distances involved.

Objectives:

The student will:
- create a scale model of the solar system;
- understand and use the Astronomical Unit measuring system;
- calculate model planet diameters using the Earth Radii measuring system; and
- understand the relative size and distance from the sun, of planets in our solar system.

Materials:

- Marker
- Calculator
- Meter stick
- Small flashlight (optional)
- Adding machine paper (40 meters per group of students)
- Small marble (should be 11 mm, some are 15 mm)
- Long area at least 50 meters long to build the model
- Student Worksheet: "Putting Earth In Its Place"

Answers to Student Worksheet:

Data: See table at right

Analysis of Data:
1. c
2. a
3. Venus

Conclusion: See table at right

Further Questions:
1. One Astronomical Unit is equal to the distance between the sun and Earth. Therefore, planets that orbit closer to the sun than Earth orbits are less than one Astronomical Unit from the sun.
2. Answers will vary

Celestial Object	Distance Model Sun (in meters)	Diameter of Model Object (in millimeters)
Sun	0.0	10.93
Mercury	0.4	0.04
Venus	0.7	0.095
Earth	1.0	0.1
Mars	1.5	0.055
Jupiter	5.2	1.12
Saturn	9.5	0.945
Uranus	19.2	0.4
Neptune	30.1	0.39
Pluto	39.5	0.02

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Activity Procedure:

1. In preparation for this activity, find a space at least 40 meters long in which students can create their models.
2. Explain that distances in our solar system are so great that is difficult to envision the relative size and space between the planets and our sun. A scale model can illustrate the relative size and position of the planets.
3. Distribute the Student Worksheet: “Putting Earth In Its Place” and explain that the worksheet contains instructions for building a scale model of the solar system. Explain that because of the great distances involved, students will need to use different units of measurement to keep the numbers small. Two commonly used units of measurement for the solar system include Astronomical Units and Earth Radii. Ask students to read about these units of measurement in the “Background Information” section of the worksheet.
4. Show students a meter stick and explain that in the scale model, Earth will be 1 meter from the sun. Ask students to predict the scale distances between the sun and each of the other planets in the “Hypothesis” section of their worksheet.
5. Divide students into groups and distribute adding machine paper, a marble, a marker, a meter stick and calculators to each group. Ask students to follow the instructions on their worksheet to build a model of the solar system. If necessary, demonstrate calculations required within the data tables.
6. If this activity is done in a dark area, ask a student hold a small flashlight (about 11 mm in size), and stand at the sun on the model. Ask other students in the group to stand in the model at the locations of various planets. Students should realize that from Pluto, our sun would look only like a very bright star.
7. Discuss student conclusions about the relative distances within our solar system. Ask students how this model is similar to and different from the actual solar system.

Name: ____ **Student Worksheet**

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Testable Question:

Compared to the distance from Earth to the sun, how far away from the sun are the other planets?

Background Information:

Distances in our solar system are so big that we need to use different units of measurement to keep the numbers small. Two commonly used units of measurement for the solar system include Astronomical Units and Earth Radii.

Astronomical Units:
When discussing the distances between planets and the sun, scientists use the measurement of Astronomical Units (AU). One Astronomical Unit is approximately equal to the average distance between Earth and the sun (149,600,000 kilometers).

$$1 \text{ A.U.} = 149{,}600{,}000 \text{ km}$$

For example, Jupiter is 778,330,000 km from the Sun. This is a big number! Instead scientists say that Jupiter is 5.2 AU from the Sun.

$$778{,}330{,}000 \text{ km} \div 149{,}600{,}000 \text{ km/A.U.} = 5.2 \text{ AU}$$

Earth Radii:
When discussing the diameter of planets or the distance between a planet and its moon, scientists often use the measurement of Earth Radii (R_E). The radius of a sphere is equal to the distance from the surface to the center. One Earth Radius is equal to the average distance from the surface of Earth to the center (6371 km).

$$1 R_E = 6371 \text{ km}$$

Hypothesis:

During this activity, you will build a scale model of the solar system in which a model Earth will be 1 meter from a model sun. How far do you predict each of the other planets should be from the model sun? Write your hypotheses:

Mercury	________	Mars	________	Uranus	________
Venus	________	Jupiter	________	Neptune	________
Earth	1 meter	Saturn	________	Pluto	________

Name: ____ **Student Worksheet**

Putting Earth In Its Place

Build a Model:

Materials:

- Adding machine paper
- Marker
- Meter stick
- Marble
- Calculator
- Area at least 50 meters long to build the model

Procedure:

1. Perform the calculations shown to complete the data tables below.
2. After the data tables are complete, gather your adding machine paper, marble, marker, meter stick and data tables and move to an area at least 50 meters long to build your model.
3. Start the model by marking the position of your model sun on one end of the adding machine tape. Place the marble on this mark to represent the sun. All distances will be measured from this point.
4. Look at the Distance Data Table. Find the distance Mercury should be from the model sun. Unroll the adding machine tape and measure the distance from the sun to Mercury on the model.
5. Mark this location with a dot that represents the model size of the planet by referring to the Diameter Data Table. Mercury is a very small dot!
6. Repeat steps 4 and 5 for all the planets.

Data:

Distance Data Table:

Celestial Object	Actual Distance from Sun in Astronomical Units (AU)		Scale Factor 1 meter/AU		Distance from Model Sun (in meters)
Sun	0.0	x	1	=	0.0
Mercury	0.4	x	1	=	
Venus	0.7	x	1	=	
Earth	1.0	x	1	=	1.0
Mars	1.5	x	1	=	
Jupiter	5.2	x	1	=	
Saturn	9.5	x	1	=	9.5
Uranus	19.2	x	1	=	
Neptune	30.1	x	1	=	
Pluto	39.5	x	1	=	

Diameter Data Table:

Celestial Object	Diameter of Object in Earth Radii (R_E)		Scale Factor 0.05 millimeter/R_E		Diameter of Model Object in millimeters (mm)
Sun	218.6	x	0.05	=	10.93
Mercury	0.8	x	0.05	=	
Venus	1.9	x	0.05	=	
Earth	2.0	x	0.05	=	0.1
Mars	1.1	x	0.05	=	
Jupiter	22.4	x	0.05	=	1.12
Saturn	18.9	x	0.05	=	
Uranus	8.0	x	0.05	=	
Neptune	7.8	x	0.05	=	
Pluto	0.4	x	0.05	=	

Name: ____ **Student Worksheet**

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Analysis of Data:

1. How does the distance between Earth and the sun compare to the distance between Mars and the sun?
   a. Mars is half as far from the sun as Earth is from the sun.
   b. Mars and Earth are the same distance from the sun.
   c. Mars is one and a half times further from the sun than Earth is from the sun.
   d. Mars is twice as far from the sun as Earth is from the sun.

2. How does the diameter of Mars compare to the diameter of Earth?
   a. Mars' diameter is about half of Earth's diameter.
   b. Mars' diameter is about the same as Earth's diameter.
   c. Mars' diameter is about one and a half times Earth's diameter.
   d. Mars' diameter is about twice Earth's diameter.

3. Which planet is closest to the size of Earth? ______________________________

Conclusion:

How far from the model sun was each of the model planets?

Mercury	________	Mars	________	Uranus	________
Venus	________	Jupiter	________	Neptune	________
Earth	1 meter	Saturn	________	Pluto	________

Were your hypotheses proved or disproved? Explain your answer.

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Further Questions:

1. Why do the planets located between Earth and the sun have model distances of less than 1 AU?

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2. How is this model similar to our solar system? How is it different?

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